ISSN: 0973-6875

Volume: 10, Issue: Special Issue, NSIC 2025

Special Issue in “International Journal of HIT Transaction on ECCN”

Proceedings of 1st National Symposium on IoT and Cloud-computing (NSIC 2025)

Published By

Haldia Institute of Technology, Haldia, West Bengal, India

Funded by: Anusandhan National Research Foundation (ANRF), Science & Engineering Research Board (SERB) Symposia Scheme

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Prof. (Dr.) Chanchal Kumar De
Prof. Jyoti Prasad Bandyopadhyay
Dr. Jagannath Samanta
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INVITED SPEAKERS:

1. Prof. (Dr.) Jaydeb Bhaumik, Professor, Dept. of Electronics & Telecommunication Engg, Address: Room No. T-5A-11, Dept. of ETCE, Jadavpur University, Kolkata-700032
2. Dr. Debasis Giri, Associate Professor, Dept. of Information Technology, Maulana Abul Kalam Azad University of Technology, West Bengal (formerly known as WBUT), Haringhata, Nadia, Pin – 741249
3. Dr. Prabir Kumar Saha, Associate Professor, Dept. of Electronics & Communication Engg, National Institute of Technology, Meghalaya, Bijni Complex, Laitumkhrah, Shillong, Meghalaya 793003
4. Mr. Probal Chatterjee, Data & Analytics (India), TechM-Kolkata-DLF Phase 2
5. Dr. Padmalochan Bera Associate Professor, School of Electrical and Computer Sciences , Indian Institute of Technology Bhubaneswar Bhubaneswar, 752050, Orissa, India
6. Prof. (Dr.) Arijit De, Professor, Department of Electronics & Electrical Communication Engg. IIT, KGP, India

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Preface

It is with great pleasure to welcome you to the National Symposium on “IoT and Cloud-computing: Smart Solutions for Tomorrow”, NSIC2025 will be organized by Dept of ECE, Haldia Institute of Technology, Haldia on 09-10 January, 2025. NSIC 2025 provides a high-quality national academic and industrial exchange forum for experts, scholars, students in the field of intelligent systems, cloud computing and Internet of Things. The main objective of NSIC2025 is to address challenges of clouds and IoT systems from the sensors/machines to the end-users attached to the Cloud while considering the 6G network connecting both IoT and Cloud domains.

We are honored to organize NSIC2025 at Dept of ECE, Haldia Institute of Technology, Haldia and we are looking forward to your contributions to the continued success of the symposium. All accepted and presented papers will be submitted for publication in a special Issue in “International Journal of HIT Transaction on ECCN” with ISSN: 0973-6875.

In response to call for papers of NSIC2025, a total of 70 papers were submitted for presentation and inclusion in proceedings of symposium. These papers were evaluated and ranked based on their novelty, significance and technical quality by at least two reviewers per paper. After a careful and blind refereeing process, 30 papers were selected for inclusion in the proceeding. These papers cover current research in IoT and Clod Computing domain. The symposium hosted number of offline talks by Prof. (Dr.) Jaydeb Bhaumik, Professor, Dept. of Electronics & Telecommunication Engg,

Dr. Prabir Kumar Saha, Associate Professor, Dept. of Electronics & Communication Engg, National Institute of Technology, Meghalaya. Number of expert from different IITs, NITs also provided the lecture through online mode.

A symposium of this kind would not be possible without the full support from different committee members. The organizational aspects were looked after by the organizing committee members who spent their time and energy in making the conference a reality. We also thank all the technical program committee members and additional reviewers for thoroughly reviewing the papers submitted to the conference and sending their constructive suggestions to improve the quality of papers. Our hearty thanks to Springer for agreeing to publish the conference proceedings.

Special thanks to the “Anusandhan National Research Foundation (ANRF), Science & Engineering Research Board (SERB) Symposia Scheme), Government of India, for their financial support to conduct the symposium for grant success.

We are indebted to Haldia Institute of Technology for sponsoring and supporting the event. Last but not the least; our sincere thanks go to all speakers, participants all authors who have submitted papers to NSIC2025.
We sincerely hope that the readers will find the proceedings stimulating and inspiring.

Prof. (Dr.) Chanchal Kumar De
Prof. Jyoti Prasad Bandyopadhyay
Dr. Jagannath Samanta
Dr. Banibrata Bag
Dr. Avishek Das
Dr. Sudipta Bardhan

Message from the Volume Editors

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We are grateful to the speakers, participants, reviewers, organizers, sponsors and Haldia Institute of Technology for their support and help, without which it would have been impossible to organize the conference. We express our gratitude to the organizing committee members who work behind the scene tirelessly in taking care of the details in making this conference a success.

Prof. (Dr.) Chanchal Kumar De
Prof. Jyoti Prasad Bandyopadhyay
Dr. Jagannath Samanta
Dr. Banibrata Bag
Dr. Avishek Das
Dr. Sudipta Bardhan

About the Editors

Prof. Chanchal Kr. De is an Associate Professor at the Department of Electronics and Communication Engineering, Haldia Institute of Technology, West Bengal, India. He received his Ph.D. from National Institute of Durgapur in 2015. He has 18 years of teaching experience. His research interests include radio resource management in wireless networks, OFDM technology, cooperative communication and cognitive radio networks and he has published more than 30 research articles in various journals and conferences.

Prof. Jyoti Prasad Bandyopadhyay former Professor, Former UGC Emeritus Fellow, Institute of Radio Physics and Electronics, University of Calcutta & Former Director, Center of Millimetre wave Semiconductor Devices and Systems, a joint venture of DRDO, Delhi and CU.

Dr. Jagannath Samanta is an Associate Professor in the Department of Electronics & Communication Engineering at the Haldia Institute of Technology, Haldia, West Bengal, India. He received the B. Tech. and M.Tech degree in Electronics and Communication Engineering from West Bengal University of Technology, West Bengal, India, in 2005 and 2008, respectively. Dr. Samanta received Gold Medal during M.Tech degree. He received his Ph.D. (Tech) degree from the Institute of Radio Physics & Electronics in 2018. His research interests include Digital VLSI Design, Error Correcting Codes, IoT in Emerging Applications. He has published more than 60 research papers in International Journals that include IEEE Transactions, Springer etc and International Conferences. He is the reviewers of referred journal like IEEE Transactions, Springer, Elsevier, etc.

Dr. Banibrata Bag completed his Bachelor of Engineering (BE) in Computer Science and Engineering from Dr. B.C. Roy Engineering College, Durgapur, India, in 2004, followed by a Master of Technology (M.Tech) in Electronics and Communication Engineering from Techno Main Salt Lake, Kolkata, India, in 2009. In 2010, he joined the Department of Electronics and Communication Engineering (ECE) at Haldia Institute of Technology, Haldia, India, as an assistant professor. He completed his PhD at Jadavpur University, Kolkata, India, in 2022 and subsequently conducted post-doctoral research at the Graduate School of Science and Technology, Niigata University, Japan. Currently, he holds the position of associate professor in the ECE at Haldia Institute of Technology. His research interests focus on millimeter-wave and terahertz radio propagation channel modeling, optical wireless communications, Reconfigurable Intelligent Surfaces, and MIMO communication.

Dr. Avishek Das completed his B.E degree in Electronics and Communication Engineering and M.Tech (the project was done on Microwave at Antenna Division in SAMEER-Centre for Electromagnetics, Chennai) in E.C.E (Microwave) from The University of Burdwan, West Bengal, India in 2008 and 2010, respectively. He received an MBA degree in Human Resource from Sikkim Manipal University in the year 2014 and completed his PhD degree in 2020 from National Institute of Technology, Durgapur, West Bengal, India under Visvesvaraya PhD Scheme for Electronics and IT, Ministry of Electronics and IT, Government of India. He was associated as a post PhD researcher at National Institute of Technology, Durgapur, on the project funded by Science and Engineering Research Board, Department of Science and Technology, Government of India (Grant No. EEQ/2017/000519 dated 23/03/2018). Presently, he is working as associate professor in the Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, West Bengal, India and attached at National Institute of Technology, Durgapur, India, as PhD supervisor. His research interests include the application of evolutionary optimization techniques for the design of Antenna Arrays. He has published more than 41 research papers in International Journals and Conferences.

Dr. Sudipta Bardhan received BE degree from Burdwan University, M.Tech degree in VLSI Design and Microelectronics Technology from Jadavpur University, Kolkata, India, in 2009 & Ph.D. degree in the School of VLSI Technology, Indian Institute of Engineering Science and Technology, Shibpur, Howrah, India. Currently is a faculty member of Haldia Institute of Technology, Haldia. His current research interests include the modeling and simulation of nanoscale devices.

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ORIGINAL CONTRIBUTION

HEART RATE MONITORING SYSTEM USING IOT

[1]Rajashree Sardar, [2]Rajesh Ghorai,[3]Milan Pramanik, [4]Santanu Maity, [5]Kisalaya Chakrabarti
[1,2,3]UG Student, Department Of ECE, Haldia Institute Of Technology, Haldia, Purba Medinipur, West Bengal
[4]Assistant Professor, Department Of ECE, Haldia Institute Of Technology, West Bengal, India
[5]Professor, Department Of ECE, Haldia Institute Of Technology, West Bengal, India

ABSTRACT

A vital component of healthcare, heartbeat monitoring is important for both identifying and treating cardiovascular disorders. Technology has led to the emergence of several heart rate monitoring techniques, from conventional electrocardiograms (ECGs) to contemporary wearable. This essay examines the importance of heartbeat monitoring, the methods used, the applications that are now being used in clinical and individual health, and the potential future developments in this area.

KEYWORDS: IoT, ECG, PPG, ICG, HRV

1. INTRODUCTION

An essential organ in the human body, the heart is in charge of blood and oxygen circulation, the body's normal operation, and overall health maintenance. The heart's chambers contract rhythmically in response to signals from the Sinoatrial (SA) node, producing heartbeats, which are essential for life to continue. Nonetheless, health problems related to one's heart are a major reason for killing people every year around the globe. In case of India, heart diseases are particularly worrying, with tens of thousands of cardiovascular disease-related deaths being registered annually. The increasing demand of the health sector implies that the time has arrived for efficient, continual health monitoring systems to minimize risks associated with health and to cut short the response times in emergency situations.

To deal with the above issues, our paper presents an IOT-based system for tracking the heart rate of a patient and provides the solution of medical dependence on hospital visits and treatment in time. The hacker said it was possible to monitor vital health parameters, e.g., heart rate, and send real-time data to doctors via either mobile devices or computers by means of advanced IOT and wireless sensor technologies. This method improves not only the convenience of continuous monitoring but also allows the physicians to quickly make informed decisions and access patient data regardless of the place and time. Using low-cost, technically mature components such as Arduino and Raspberry Pi, the suggested system can make a patient or elderly person in need of mobility a quote in a home environment. This invention introduces the IOT trend with a fairly pronounced impact on healthcare, whereby it has become the way the x-ray is taken today and a technique for analyzing heart firmness is realized, telling him early enough that he is developing a condition and then initiating preventive care to put efforts also on the efficient management of such conditions.

1.1 TABLE 1

AGE	AVG HEART RATE
NEWBORN	110-170 BPM
5-7 YEARS	85-150 BPM
10-12 YEARS	70-130 BPM
ADULT	60-120 BPM
ATHLETE	60-100 BPM

2. METHODS FOR TRACKING HEART RATE

*Corresponding Address: rajashreesardar257@gmail.com

DOI: 10.5281/zenodo.14591072

2.1 ELECTROCARDIOGRAPHY (ECG):

For cardiac monitoring, electrocardiography is still the gold standard. An ECG captures the heart's electrical activity over time by applying electrodes to the skin. The waveform that is produced gives information on electrical conduction, rhythm, and heart rate. Traditional ECG s must be administered by a physician, although portable ECG equipment is becoming more and more accessible for use at home [1].

2.2 PHOTOPLETHYSMOGRAPHY (PPG):

PPG is a non-invasive method that measures variations in blood volume in micro vascular tissue using light. Wearable technology, such as fitness trackers and smart watches, frequently uses this technique. PPG sensors enable for real-time heart rate monitoring by emitting light and measuring how much of it is absorbed by the blood.

2.3 IMPEDANCE CARDIOGRAPHY (ICG):

This technique estimates cardiac output and blood flow by measuring the electrical impedance of the thorax. Impedance Cardiography provides a continuous, non-invasive way to evaluate heart function, even though it is less popular than ECG and PPG, especially in clinical settings.

2.4 HEART RATE VARIABILITY (HRV):

The differences in the intervals of time between successive heartbeats are examined by HRV analysis. It offers information on the functioning of the autonomic nervous system and general cardiovascular health. HRV is being used more and more in clinical and fitness applications, and it can be evaluated using ECG or PPG data [2].

3. HEARTBEAT MONITORING APPLICATIONS

3.1 MEDICAL DIAGNOSTICS:

For the diagnosis of myocardial infarctions, arrhythmias, and other cardiovascular conditions, heartbeat monitoring is essential. By enabling prompt responses, ongoing monitoring may lower rates of morbidity and death.

3.2 ONLINE MEDICAL SERVICES:

The growth of telemedicine has made it easier for medical professionals to monitor patients remotely and track their heart rates in real time. This method enhances patient outcomes, especially for patients who need ongoing care due to chronic illnesses.

3.3 WELL-BEING AND EXERCISE:

Wearable technology with PPG sensors enables users to monitor their heart rates while exercising. With the use of this data, users may control their stress levels, maximize their workouts, and preserve their general health.

3.4 PUBLIC HEALTH AND RESEARCH:

Researchers can better understand population health trends and the influence of lifestyle factors on cardiovascular health by using heartbeat tracking in epidemiological studies.

4. ADVANCEMENTS IN HEARTBEAT MONITORING

4.1 BETTER WEARABLE TECHNOLOGY:

We may anticipate the creation of increasingly complex wearable’s with numerous sensor integration as technology develops. Comprehensive health data, such as heart rate, oxygen saturation, and stress levels, may be provided by these devices [3].

4.2 THE UTILIZATION OF AI AND MACHINE LEARNING:

The accuracy of data interpretation in heartbeat monitoring can be improved by integrating AI and machine learning. Algorithms can spot trends that could point to possible health problems, enabling earlier action [4].

4.3 CUSTOMIZED HEALTH CARE:

Future heartbeat monitoring may concentrate on specialized methods for cardiovascular health due to the growing availability of personalized health data. This could involve food advice and exercise plans that are specifically tailored to each person's heart rate patterns.

4.4 INTERNET OF THINGS INTEGRATION:

Heartbeat monitoring could undergo a revolution because to the Internet of Things, which makes it possible for gadgets and healthcare providers to share data easily. Remote therapies and in-the-moment health assessments can be made easier by this connectivity.

5. SYSTEM DESIGN

The system can be described in two halves: one is hardware and another one is software.

5.1 HARDWARE

MICROCONTROLLER:

NodeMCU is a Lua based open source firmware and development board that is designed for IoT applications. It is a firmware that is compatible with the ESP8266 Wi-Fi SoC developed by Espressif Systems, as well as a hardware that is built on the ESP-12 module.

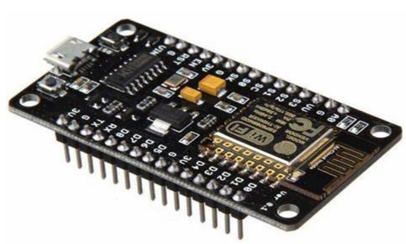

Figure 5.1: ESP 8266

PULSE OXIMETER

The MAX30100 sensor functions as a heart rate monitor and a pulse oximeter. This is achieved by the sensor's design, which comprises two LEDs, a photo detector, optimized optics, and low noise signal processing elements. It is very convenient to be interfaced with microcontrollers like Arduino, ESP32, Node MCU etc. to make a skilled tool for the Heartbeat and oxygen saturation check.

Figure 5.2: MAX30100

LCD DISPLAY

LCD is one of the most prevalent electronic display modules employed in a vast number of applications such as different circuits & devices like mobile phones, calculators, computers etc. Mostly these displays are preferred multi-segment LEDs and seven segments.

There are a number of benefits of the LCD display module which include the following: being very cheap, simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

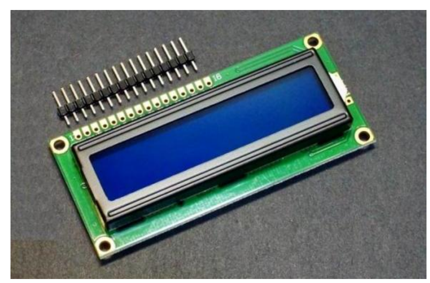

Figure 5.3: LCD Display

5.2 SOFTWARE

BLYNK APP:

Blynk is an enabling platform that enables you to develop mobile applications for Arduino or your PC like Raspberry Pi using your smartphone. To accomplish this goal, the designers of Blynk made ease of the app development the top priority. Thus, the code can be made with just a few touches, which can enable the clients to add widgets and carry out the obtained data, making the client interact with the connected device. Therefore, you can control the likes of your device's LEDs or engines, communicate with sensors placed in numerous locations—like soil moisture monitoring in a garden—and run programs such as irrigation by simply using your cellphone.

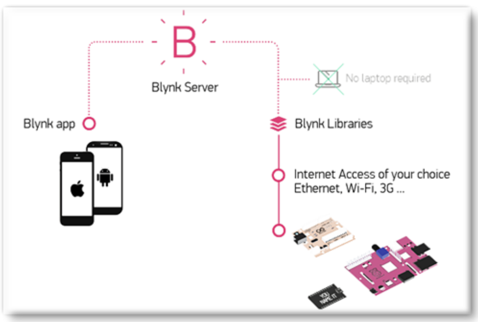

Figure 5.4: Representation of from where data is sent and received

ARDUINO IDE:

The Arduino IDE is a development platform mainly designed for programming motherboards such as the NodeMCU. It enables developers to write, compile, and set microcontroller variations to their boards using the software.
Types of the Arduino IDE features that will be included in this paper are:
Code Development: The Arduino IDE is the best place to get the C code to regulate the heart rate sensor as well as the display modules in the monitoring system.
Libraries: This project demands the use of libraries such as BlynkSimpleEsp8266.h, MAX30100_PulseOximeter.h, and LiquidCrystal_I2C.h, all of which can be integrated with the Blynk platform, data acquisition from the MAX30100 in the heart rate sensor, and the display of results on the LCD.
Serial Monitor: The Serial Monitor of IDE in this case is a tool used for debugging that helps display accurate sensor readings such as BPM and SpO2 from the MAX30100 sensor. This gives a guarantee that sensor data are properly calibrated before they are sent to the Blynk app and presented on the LCD.

6. BLOCK DIAGRAM

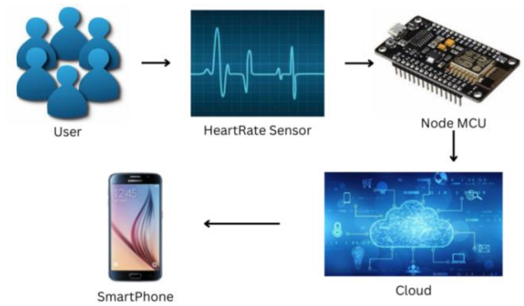

Figure 6.1: Block Diagram

7. CIRCUIT DIAGRAM

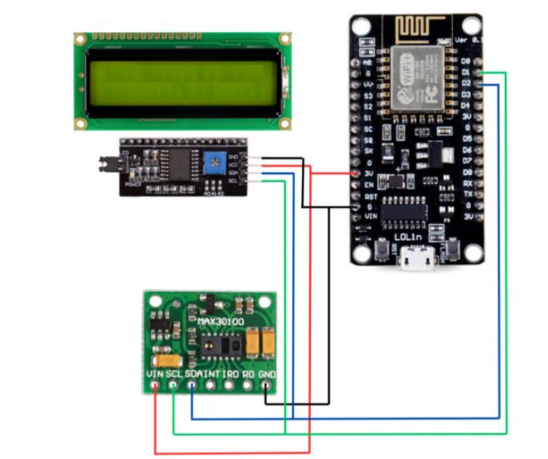

Figure 7.1: Circuit Diagram

8. RESULTS AND ANALYSIS

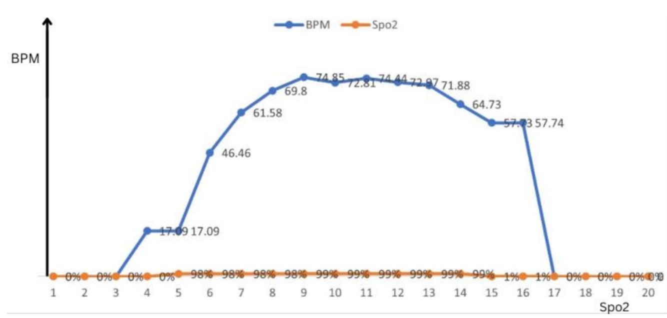

Figure 8.1: Representation of heart rate(BPM) and oxygen saturation (SpO2)

The graph provides a representation of heart rate (BPM) and oxygen saturation (SpO2) values collected during a monitoring session.

- The BPM values exhibit a bell-curve trend, rising gradually to a peak (around 74–75 BPM) and then declining.
- Outliers, such as low values at the start (17.09) and at the end (0 BPM), indicate potential sensor initialization issues or measurement noise.
- The heart rate values primarily align with normal resting levels (60–100 BPM), indicating stable physiological conditions for the majority of the session.
- SpO2 values remain stable and consistently high (98–99%), confirming normal oxygen saturation levels.
- Minor dips (e.g., 96%) do not deviate significantly, reinforcing the reliability of the sensor.

9. OBSERVATIONS

1) The heart rate readings exhibit noticeable fluctuations, with stable periods observed in the range of 64–77 BPM, indicating the normal resting or mildly active state of the subject.
2) The MAX30100 sensor performed well in detecting heart rate and SpO2 levels during stable conditions.
3) SpO2 values remained predominantly stable at 98–99%, demonstrating reliable oxygen saturation monitoring throughout the test session.
4) The gradual bell-curve trend of heart rate values suggests a correlation with normal physiological variations during the monitoring period.
5)
6) Peaks in heart rate readings (around 74–77 BPM) and subsequent drops indicate changes in the subject's activity or rest state.
7) The system is well-suited for continuous heart rate monitoring in stable environments but may require further optimization for dynamic or ambulatory conditions.

10. CONCLUSION

Overall Stability:

- The heart rate values are generally within a typical range, assuming the person is at rest or in a low-activity state.
- Confidence levels of 100% during events confirm the reliability of these measurements.

Sensor Artifacts:

- Outlier values (e.g., 7.51 bpm, 42 bpm) and reduced confidence percentages might reflect sensor noise, poor contact, or motion artifacts. These should be excluded from analysis for accurate interpretation.

Actionable Insights:

- The data is from a heart rate monitoring project
- (e.g., MAX30100), must ensure proper calibration and test the setup to reduce artifacts. Additionally, implement a filter to ignore outlier values that are biologically implausible.
- Focus on readings with 100% confidence for further analysis and visualization, as these are likely the most accurate.

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ORIGINAL CONTRIBUTION

Design and Implementation of an Efficient Arduino-Based Smart Home Automation System

[1]Pritam Jana, [2]Jagannath Samanta, [2]Tapan Maity,

[1]*PG student, Dept. of ECE, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2]*Department of ECE, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

In this paper we try to present the circuit design and development enactment of smart home automation system which can be used by one Arduino Uno R3 with some special sensors. To showcase the efficacy of the system, it integrates with a variety of devices such as temperature sensor, distance sensor and ambient light sensor, gas sensor. By implementing this sensors data, system can automate the household functionalities like controlling the light, room temperature and security. Arduino Uno R3 takes action based on some parameters like ambient light and temperature, toxic gas, water level. This projects aims to provide an inexpensive, easily recreatable solutions modern households promoting handiness, safety and energy sustainability through IoT-based solutions.

KEYWORDS: Arduino Uno R3, PIR sensor, TMP36, Tinkercad

1. INTRODUCTION

A smart home automation system is a holistic approach that enhances comfortable living, energy sustainability and security by automating home efficiency solutions. Using interconnected sensors and devices like temperature, gas, light, distance and water level sensors, system allows for real time monitoring and control over household essentials. This system typically managed through a main controller like an Arduino. Smart Home Automation not only improves living comfortable but also consumes less energy, which makes it a permanent and suitable choice. As, technology advances, smart home system can also connect with internet of things(IoT),which allows remote access, controlling with smart phones and voice assistant or Artificial Intelligence(AI). This modern approach of Smart Home Automation system aligns with smart cities growing trends and creating an environment which are more productive, safe, adaptive and flexible. Our motivation behind this work is to create a system which enhances practicality, safeguarding and viability. Our work aims to meet those growing demands, providing user with a modern solution that improves the quality of life and support a secure living environment.

Remaining paper is organized as follows. Related works are described in section-II. Circuit diagram with proper explanations are described in section-III. Software implementation and coding part is described in section-IV. Results and Discussion are described in section-V. Applications are described in section-VI and the paper concludes at section-VII.

2. RELATED WORK

*Corresponding Address:pritamrijujana2001@gmail.com

DOI: 10.5281/zenodo.14591143

Basically our survey explores the impact of Smart Home Automation System on every day's life. How it focuses on user satisfaction, energy-saving, cost-reduction and security. Nowadays most of the people use smart technologies, especially those people who live in most of the smart cities. Most of them have any smart automation system installed in their house, like almost 68% peoples response indicates that they have at least one smart appliance like smart lighting, security camera, password protected door implemented in their house. This smart appliances also makes our lives easy and convenient. Almost 75% of user indicates that this voice control features and sensor features makes their daily routine easier and efficient. Also 60% of user response is like they got lower energy bills after implementing smart automated system. It makes their planning for long term savings and environmental benefits easier. 80% of user agreed that this automated system enhances their security system more especially when it integrates with mobile phone for sending them an alert. This particular thing helps those people who travel a lot or lives in urban area.

Already a significant amount of research going on smart automation system and it is rapidly growing technology. There are several studies which explores how smart home automation system can improves energy efficiency, home security and health monitoring, voice controlled automation, water conservation and machine learning and predictive automation. Kim j. et al. (2023) developed an energy-efficient home automation system using IoT-based smart thermostats and lighting systems that adapt to occupancy patterns [1]. Alikhazil et al. (2022) developed a different style of password protected door [2]. Sharma et al. developed a smart home automation system with wearable device and motion sensor to monitor the health of elderly people in the house [3]. Johnson and Le (2021) created the most popular voice controlled automation system that is Alexa, Google assistance to control smart home appliances [4]. Patel et al. (2020) developed a machine learning model within a smart home environment which predicts user preferences by the historical data and shows result from that [5].

3. CIRCUIT DIAGRAM

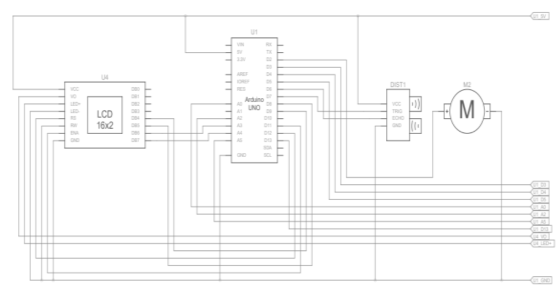

Fig 1: Block diagram of Home automation system

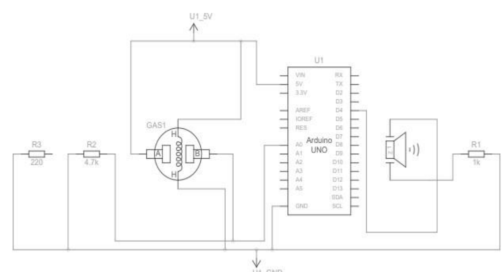

Fig 2: Block diagram of gas sensor

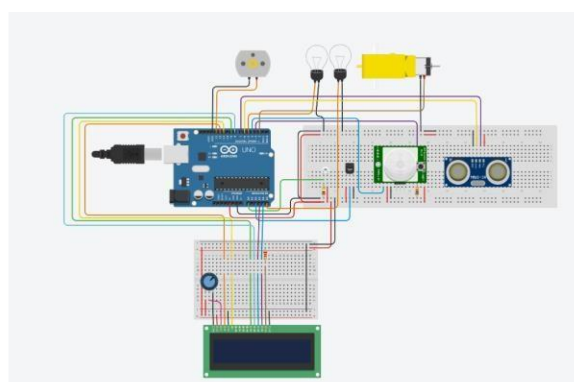

Fig 3: Circuit design of Home automation system

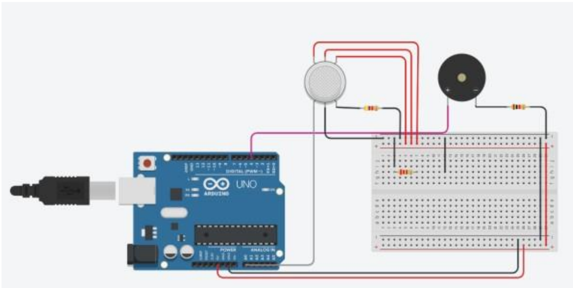

Fig 4: Circuit design of Gas sensor system

The Circuit diagram of smart home automation system is shown in Fig.3. All components are connected one Arduino UNO R3 and two breadboard. This system can run with DC because the whole system use DC motor power supply. Arduino Uno R3 is used to obtain values of physical condition through sensors connected with it. The temperature sensor TMP36 measures temperature. This sensor contains semiconductor material which changes consistently with the changing temperature. There is an ambient light sensor (Phototransistor) which senses changes in light density. It has an NPN transistor where the base is replaced by optical source. Next, there is an Passive Infrared sensor (PIR sensor) that detects changes in infrared light levels over a wide area. It detect heat energy by comparing the signals from a pair of pyro electric elements. There is also an Ultrasonic Distance sensor (4-pin), which uses sound waves to determine how far away an object is. This device emits sounds with a very high pitch and waits for the first echo to come from a nearby object. That's how it determines how far the object is. There is one gas sensor shown in the Fig.4 which detects particles of a particular substance in the air. It detects the presence of a gas by measuring the properties in it.

4. SOFTWARE IMPLEMENTATION USING ARDUINO PROGRAMMING

The programming software we used in our system is Arduino C programming software. We use this programming language because it has so many built-in and external libraries such as servo for controlling motors or liquid crystal for LCD displays, which simplify complex tasks. We use Tinkercad software which is an online tool where we can design circuits, also we can write, compile and upload code to the arduino board. DC motor used to convert electric current to rotational motion. Hobby gearmotor contains DC motor and gearbox. When the motor is powered by DC current, rotor started rotate. One potentiometer is there for changing resistance. There is a Piezo buzzer that makes noise at different frequency measured by distance sensor and work as an alarm bell while there is any toxic gas or fire alarm.

```
#include <LiquidCrystal.h>
int tempVal = A2;
int fan = 13;

int AmbSen = 0;
int outdoor = 5;

long distance;
int duration;

int Burglar = 0;

int trig=7;
int echo=6;

LiquidCrystal lcd(12, 11, 9, 8, A3, A4);
```

Fig.5: Code snippet of Library declaration, variavle declaration, and LCD setup.

Here first of all, add the liquid crystal library, which allow the control of an LCD display. Then declare some variables as temp Val as the analog input for temperature sensor. Assign pin 13 to control a fan, connect ambient light sensor to analog pin 0. Long distance and duration variable used to store the distance and duration for an ultrasonic sensor.

```
//int count = 0;

void setup()
{
  Serial.begin(9600);
  pinMode(fan, OUTPUT);
  pinMode(outdoor, OUTPUT);
  pinMode(tempVal, INPUT);
  pinMode(A0, INPUT);
  pinMode(4, INPUT);
  pinMode(A5, OUTPUT);
   pinMode(2, OUTPUT);
 pinMode(7, OUTPUT);
 pinMode(6, INPUT);
  attachInterrupt(digitalPinToInterrupt(3),stop,CHANGE);
}
```

Fig.6: Code snippet of Arduino pin configuration

It initializes a serial communication at a rate of 9600, allowing data to be monitor or debugging.

Next set the fan pin as output pin to control the fan. Set the temperature sensor pin as an input to read the data. Then attach an interrupt to pin 3, when any change from high to low or low to high detected, then stop function is called in this pin.

```
void loop()
{
//  quakeState = digitalRead(quakePin);
//  autoswitcher();
    // Temperature Controoled Fan
  float temp = analogRead(A2);    //Read the analog pin
  temp = (temp * 0.48828125) - 49;   // convert output (mv) to r
  lcd.clear();
  lcd.print("Temperature: ");
  Serial.print("Temperature: ");
  Serial.print(temp);
  lcd.print(temp);
  Serial.println(" C");  //print the temperature status
  lcd.println(" C");
  delay(100);
```

Fig.7: Code snippet of monitoring temperature data

As shown in the Fig.7, Arduino is continuously monitoring temperature data and displaying it in both monitor and LCD screen. Float temp reads the value from the temperature sensor connected to pin A2. Next line converts the raw analog value into a readable temperature in celcius. There is a delay of 100 milliseconds before repeating the loop.

```
if(temp > 28)
{
  digitalWrite(fan, HIGH);
  delay(100);
}
 else if((temp > 23) && (temp < 28))
{
  digitalWrite(fan, HIGH);
  delay(100);
}
else
{
  digitalWrite(fan, LOW);
    Serial.print("Temperature: ");
   delay(100);
}
```

Fig.8: Code snippet for conditional statement

As Fig.8 shows, if the temperature exceeds 28°C, the fan is turned ON by setting the pin to HIGH. The code then wait for 100 milliseconds before checking the temperature again. If the temperature is below 23 °C, the fan is turned off by setting the pin to LOW.

```
// Automated Outdoor Light
AmbSen = analogRead(A0);
  Serial.println(AmbSen);
  if(AmbSen < 400)
  {

    digitalWrite(outdoor, HIGH);
    delay(100);
  }
  else
  {
    digitalWrite(outdoor, LOW);
    delay(100);
  }
```

Fig.9: Code snippet for controlling automated ambient light

If the ambient light level is below 400, outdoor light is turned ON, by setting the outdoor pin to HIGH. If the ambient light level is above 400, outdoor light is turned OFF, by setting the outdoor pin to LOW. There is a 100 millisecond delay, so that system does not check the light condition continuously.

```
// Burglar Detection
Burglar = digitalRead(4);
if(Burglar == HIGH)
{
  digitalWrite(A5, HIGH);
  delay(10000);
}
else
{
  digitalWrite(A5, LOW);
  delay(100);
}
```

Fig.10: Code snippet for burglar detection

Burglar detection feature of the home automation system reads the input from PIR sensor and triggers a response when motion is detected. When burglar is high, then it turns on an alert connected to pin A5. When no motion is detected, then it turns off the alert connected to pin A5. The alarm stays active for 10 seconds.

```
 // Water Level Monitoring
digitalWrite(7,HIGH);
digitalWrite(7,LOW);
duration=pulseIn(echo,HIGH);
distance=duration*(0.034/2);
  if(distance>100)
{
digitalWrite(2,HIGH);
delay(100);
}
  else
  {
    digitalWrite(2,LOW);
    Serial.println(distance);
    delay(100);
  }
}


void stop()
{
  digitalWrite(A5,LOW);
  Serial.println(distance);
  delay(100);
 }
```

Fig.11: Code snippet for water level monitoring

If the distance is greater than 100 cm which indicates low water level, an indicator connected to pin2 is turned ON. If the distance is less than 100 cm, which indicates sufficient water level, then indicator is turned off.

```
int buzzer = 4;
int sensor = A0;
int sensorThresh = 400;

void setup()
{
pinMode(buzzer,OUTPUT);
pinMode(sensor,INPUT);
Serial.begin(9600);
}

void loop()
{
  int analogValue = analogRead(sensor);
  Serial.println(analogValue);
  if(analogValue>sensorThresh)
  {
    digitalWrite(buzzer,HIGH);
    delay(1000);
  }
  else
  {
    digitalWrite(buzzer,LOW);
    delay(1000);
  }

}
```

Fig.12: Code snippet for gas sensor

When the sensor reading exceeds 400, the buzzer is turned ON by setting the buzzer pin to high, if the reading is below under 400, the buzzer is turned off by setting the buzzer pin to low. The delay keeps the buzzer on for 1 seconds.

5. RESULTS AND DISCUSSION

After connecting all the components and uploading all the programs, the whole system will start running. All modules and Arduino are kept together with a lot of wires. This is the main area of smart home automation system.

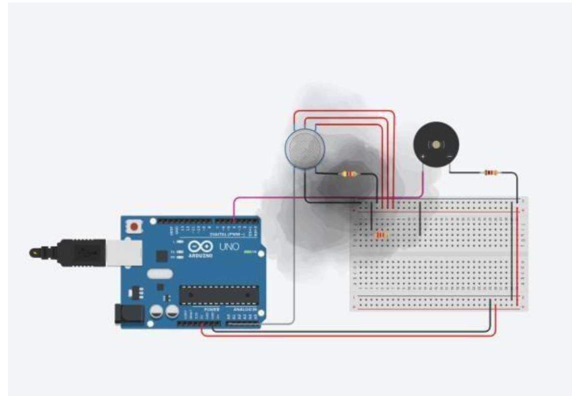

Fig.13: Working of Gas sensor

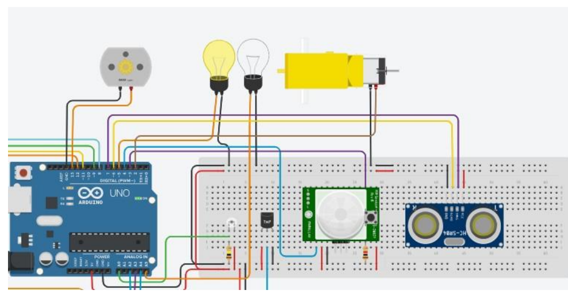

Fig.14: Working of ambient light

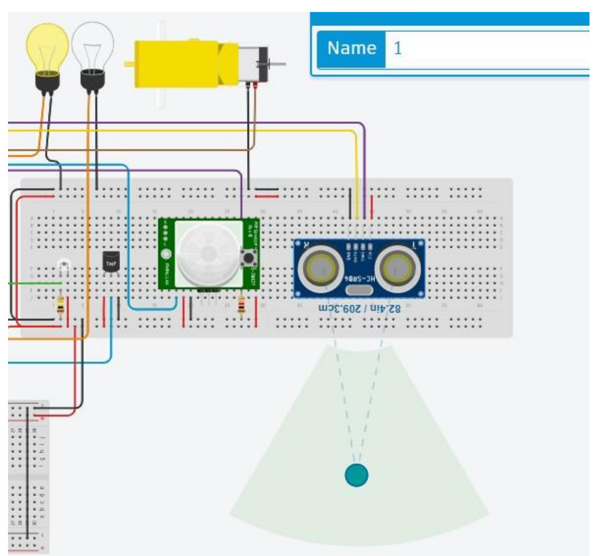

Fig.15: Working of Ultrasonic Distance sensor

ISSN: 0973-6875 DOI: 10.5281/zenodo.14591143

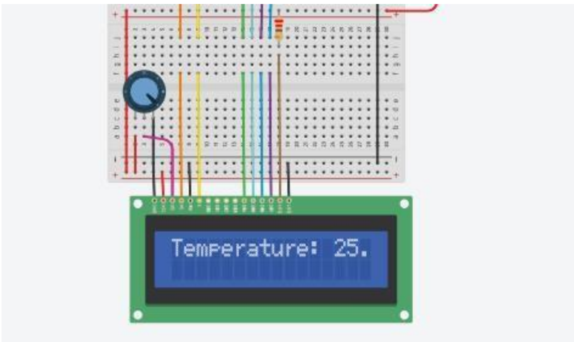

Fig.16: Temperature showing on LCD 16*2 display

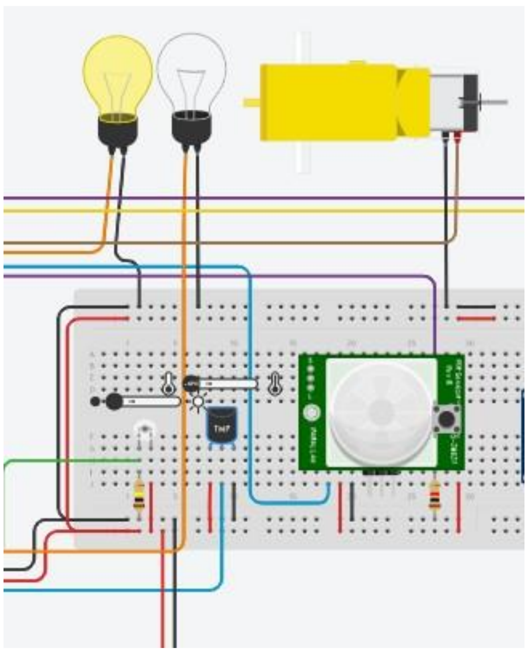

Fig.17: Working of temperature sensor and ambient light sensor

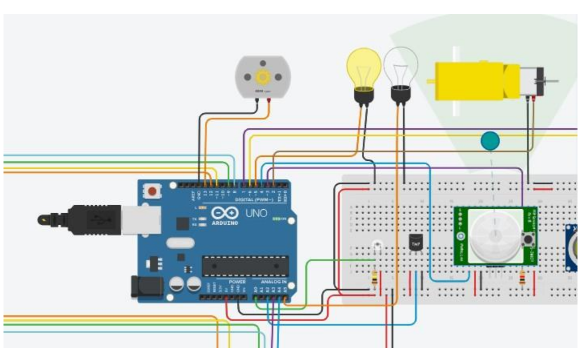

Fig.18: Working of PIR sensor

Smart home automation system allows user to control everything by sensors or voice commands or by smartphones which makes their daily routine pretty easier. Automated system can customize itself by adjusting so that it can save as much energy as it can for low cost-bill. it reduces unnecessary power consumption. It offers the best security surveillance by sensors, camera, motion detector or alarm which will help to the user to monitor their property comfortably. Features like automatic lock and alarm provides good solution for potential threats. Smart home can includes health and safety monitoring by gas sensor which will detect any toxic gas and will try to control the air quality. This is mainly useful for elderly or disabled person.

6. APPLICATION

[1] Automated lighting system allows user to control lighting by motion sensor or it can schedule based on movement or time. Also this can be programmed when there is vacant room then turn off the light which enhance the energy saving. [2]Smart thermostats can control heating and cooling based on occupancy and weather condition or based on user preference. [3] Also smart home includes smart cameras, password protected door, motion sensors and alarm which notify the user if there is any suspicious activity going on and the user can monitor every situation properly. [4] Gas sensor can detect any toxic gas which might be harmful for any person and it will notify the user by an alarm. [5] Smart entertainment setups allow users to control audio and video with voice commands and also offers personalize streaming experience. In this paper we discuss about the overall development of smart home automation system. How this system approach a cost effective, energy saving method to increase home security. By connecting all the sensors –temperature sensors, ambient light sensors, gas sensor, PIR sensor – this system can automatically control everything. Each sensor plays an very important role and make the this smart system adaptable to the real world. As the technical world is evolving every day, this systems design supports the integration of

additional sensors or any other improvement. Smart technology is a boon for us.

We can avoid bad consequence and try to do better improvement in the future. This paper shows that practical and theoretical aspects of designing circuit.

7. CONCLUSION

In this paper, smart home automation system has been demonstrated using Tinkercad software. All the home appliances can be controlled and monitored from this system. Further research can make it wireless and make it more cost effective and affordable. It will be more flexible and it will create a new path for more smart appliances which will make our daily lives smarter, accessible and intelligent. This work demonstrates the feasibility of creating a cost-effective, accessible home automation system that meets the demands of daily life while promoting energy conservation and improved security. Overall, this work underscores the potential of IoT-based automation to transform residential spaces, making them more responsive, secure, and sustainable. Future work may explore integrating wireless capabilities and AI for predictive responses, further enhancing the system's functionality and user experience.

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Available Online at www.hithaldia.in/locate/ECCN

An IoT-Enabled Comprehensive Smart Drainage System for Modern Smart Cities

[1]Abir Lal Chatterjee, [1]Supratim Naskar, [1]Soumyadeep Ghosh, [2]Rimpi Datta, [3]Sagarika Das

[1]*UG student, Dept. of Electronics and communication Engineering, Meghnad Saha Institute of Technology, Kolkata, West Bengal*

[2]*Department of Electronics and Communication Engineering, Meghnad Saha Institute of Technology, Kolkata, West Bengal*

[32]*Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, West Bengal*

ABSTRACT

With the rapid advancements in technology, various aspects of daily life are becoming increasingly connected to the Internet, giving rise to the concept of the Internet of Things (IoT). By integrating diverse IoT devices and applications, Smart Cities can be developed, where an efficient drainage system plays a pivotal role. However, solid waste carried by groundwater through drainage systems often leads to blockages, causing overflows and severe environmental pollution. Proper management of these solid wastes is crucial to maintaining the smooth functioning of drainage systems.While some studies have focused on underground drainage monitoring or the management of drainage systems, there has been limited research addressing both underground drainage mechanisms and surface-level waste management comprehensively. This paper addresses this gap by identifying the primary causes of drainage overflow and proposing efficient solutions. We present a detailed IoT-enabled drainage management system that integrates solid waste management to enhance system performance. Our approach includes clearly defined methods for preventing and addressing blockages caused by solid waste in drainage pipelines and covers, ensuring a more effective and sustainable drainage system.

KEYWORDS: Biodegradable, Protocols, IoT, Smart City, WSN, Sensors.

1. INTRODUCTION

Day to day applications are increasingly shifting towards Internet-based solutions using technological advancements, ushering in the era of the Internet of Things (IoT). Through the integration of diverse IoT devices and systems, Smart Cities can be developed, where efficient drainage systems become a critical component. A common issue faced by such systems is the accumulation of solid waste in groundwater, which obstructs drainage channels, causing blockages, overflows, and significant environmental damage [1]. To ensure the uninterrupted operation of drainage systems, effective waste management is essential. While some existing efforts focus on either underground drainage monitoring or overall system management, there is a lack of a comprehensive approach that combines both underground drainage mechanisms and surface waste management [2].

This paper addresses this challenge by presenting an IoT-driven drainage management system that tackles the root causes of blockages and overflows. The proposed system emphasizes efficient management of drainage waste to enhance overall performance. It includes well-defined strategies for preventing and handling solid waste buildup in pipelines and covers, paving the way for a more sustainable and effective drainage solution in Smart Cities.

*Corresponding Address: sagarikadas1978@gmail.com

DOI: 10.5281/zenodo.14591192

2. LITERATURE SURVEY

This section provides an overview of various related research efforts and developments carried out by the research community in the domain of IoT-based environmental monitoring and waste management systems.

Lazarescu [3] proposed a tiered architecture for a Wireless Sensor Network (WSN) platform, focusing on its functional design and implementation in IoT-driven environmental monitoring applications. Similarly, Zanella et al. [4] explored an urban IoT architecture, talking about the idea of smart cities and providing useful IoT-based recommendations used in the Italian Padova Smart City Project.

Research in automated drainage management includes a cost-effective system detailed in [11], which utilizes acoustic sensors to detect clogs in sewage pipelines and communicates with servers via a WSN platform to enable prompt action. SK and Rao [12] introduced an IoT-based smart manhole monitoring system that generates alarms for conditions such as open lids, overflow, or overpressure.

Significant advancements in waste management systems have also been made, particularly using RFID technology. Examples include a smart bin for proper waste disposal and recycling [13] and a real-time multi-layered waste management architecture capable of tracking stolen bins and identifying the type and weight of waste [14]. Huang et al. [2] proposed a novel approach for identifying multi-featured objects using optical sensor-based technology to process solid waste effectively. Anuradha et al. [16] developed a system where interconnected dustbins, equipped with unique IDs and ultrasonic sensors, monitor trash levels and detect toxic gases. Notifications are sent via an Android app when bins are full, prompting timely disposal.

Another innovative waste detection system [15] was introduced, featuring four subsystems: a Smart Trash System, a Vehicle System, a Local Base Station, and a Smart Monitoring and Controlling Hub. The system employs ultrasonic sensors, load sensors, and ZigBee protocols to monitor trash levels and weight. Detected data is transmitted to a controlling hub, which then signals vehicles for waste collection.

Despite these advancements, much of the research on automated drainage systems addresses individual issues, with limited focus on integrated drainage waste management. The system proposed in this paper bridges this gap by jointly addressing smart drainage mechanisms for both infrastructure and roadside drains while incorporating efficient waste management practices.

3. PROPOSED SYSTEM

The suggested system design has been divided into two sections: conceptual features, which highlight the key elements of the design, and system architecture, which provides a thorough explanation of the system architecture as a whole, all of its components, and technical specifics.

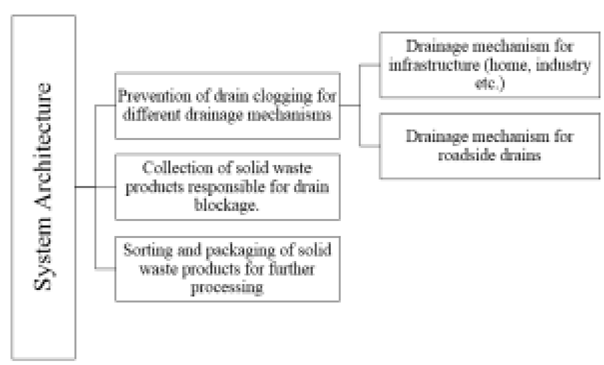

Fig. Flow Diagram

The primary goal of this system design is to prevent drain clogging by utilizing IoT technology, ensuring that drainage overflow and related inconveniences are avoided. To achieve this, it is essential to account for various drainage systems associated with different sources, such as residential areas, industrial facilities, and roadside drains. Each of these sources may have distinct drainage mechanisms, making it necessary to integrate and manage them collectively under the proposed system.Drain clogging often occurs due to the accumulation of various materials, such as plastics, paper, and biodegradable waste, either within pipelines or on drain covers, caused by natural or human activities. Addressing this issue requires efficient material management powered by IoT. This system incorporates a smart sorting mechanism to collect and categorize materials. The sorted materials are then recorded in a database, detailing the type and quantity of waste collected from specific areas. Following sorting, materials are packaged separately, with notifications sent to relevant organizations that specialize in recycling, fertilizer production, or other processing methods. A dedicated database linked to the packaging process will generate regular reports—weekly, monthly, or yearly—on the volume and type of packaged materials distributed to different organizations. These interconnected features form the foundation of the proposed system, creating an efficient smart drainage management solution to prevent clogs, optimize material recycling, and support sustainable waste management practices.

4. SYSTEM ARCHITECTURE

As shown in the flow diagram in Figure 1, an IoT-based system architecture has been created to incorporate all of the designated functionalities. Three successive phases make up this architecture: avoiding clogged drains and gathering solid debris that causes obstructions, and preparing these materials for further processing, such as recycling. The system's implementation includes distinct approaches for two types of drainage mechanisms: those associated with infrastructure (e.g., residential buildings and industrial facilities) and those for roadside drains. The key features of the system are summarized as follows:

- Prevention of drain clogging for different drainage mechanisms, including infrastructure-based systems (homes, industries, etc.) and roadside drains.
- Collection of solid waste materials that contribute to drainage blockages.
- Sorting and packaging of collected solid waste for subsequent processing.

A detailed workflow outlining the technical aspects of these features is provided below:

Prevention of drain clogging:
The system incorporates specific measures to address clogging in the two main types of drainage mechanisms. These measures are further elaborated in the subsequent sections.

5. DRAINAGE MECHANISM

Different types of infrastructures—such as houses, educational institutions, industries, and corporate organizations—utilize distinct drainage pipelines that eventually connect to a central drainage system. These pipelines are prone to blockages caused by various materials, including domestic waste, industrial residues, and other solid waste. To ensure an uninterrupted flow of wastewater, a waterproof active ultrasonic sensor (illustrated in Fig. 2) is deployed. This sensor detects objects by transmitting sound waves and measuring distances. Each area is equipped with separate ultrasonic sensors installed in its drainage pipelines. These sensors monitor and collect data whenever an obstruction occurs. The detected information is transmitted to a designated server for the specific area, which records the pipeline location of the blockage. Upon identifying a blockage, the server promptly notifies the drainage maintenance authority responsible for that area, ensuring timely intervention. Additionally, all area-specific servers are interconnected with a central server (represented at the top of Fig. 2). This central server performs trend analysis, assessing whether the frequency of drain blockages in a specific area has increased or decreased over time. Based on these insights, it generates warnings for the inhabitants of the affected area to encourage preventive measures. To facilitate this process, three types of communication protocols are utilized:

1. Sensor-to-Server Communication: Utilizes MQTT (Message Queuing Telemetry Transport Protocol) to gather data from sensors and transmit it to servers.
2. Server-to-Server Communication: Employs AMQP (Advanced Message Queuing Protocol) to establish connections between servers.
3. Server-to-Device Communication: Uses XMPP (Extensible Messaging and Presence Protocol) for sending text-based notifications to relevant personnel.

As depicted in Fig. 2, data regarding blockages in the pipelines of Areas 01, 02, and 03 is sent to their respective servers. These servers, in turn, relay necessary notifications to the concerned authorities, enabling immediate action to resolve the issue.

6. WORKING PROCEDURE

Wastewater from two distinct sources is taken into consideration. Pipelines connected to various infrastructures across different areas are inspected. If a blockage is detected:

- The exact location of the blockage is recorded in the respective area's server.
- The information is forwarded to the central server for
- comprehensive analysis, correlating data across other areas.
- A notification is sent to alert the local drainage maintenance authority for timely intervention

If no blockage is found: The wastewater is directed to a container for filtration. Roadside drain covers are checked for obstructions: If blocked: The width of the object causing the blockage is recorded. If not blocked: The wastewater is directed to the filtration container.

If the obstacle is a living object: The object is identified and recorded. A check is performed to confirm whether it meets specific criteria (e.g., width and living status). Living objects are prevented from passing through the drain cover. If the obstacle is a non-living object: Objects meeting certain width specifications are allowed to pass through the drain cover and directed to the filtration container. Wastewater, along with solid waste, undergoes filtration within a designated container. Solid waste separated during filtration is collected in a storage container. If the container reaches full capacity: The solid waste is sorted using a dedicated sorting system.The waste is classified and quantified based on its type. And the sorted waste is sent to recycling or fertilizer processing facilities, with the data recorded for tracking purposes.

7. CONCLUSION

In today's era of rapid scientific advancements, a smart drainage management system has become a vital component of Smart Cities, ensuring an efficient and systematic approach to maintaining a wholesome setting. A thorough design for an intelligent drainage management system is presented in this study. that addresses the needs of both roadside drainage and infrastructure-related drainage mechanisms while incorporating an effective waste management solution. The proposed system is detailed with a clear explanation of its features, architectural design, and operational workflow, supported by necessary technical specifications. Future work will focus on implementing the system in practice and conducting experimental analyses to validate its efficiency. This implementation aims to significantly contribute to environmental preservation and foster the development of a sustainable, safe and comfortable urban lifestyle for the community.

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Cloud Computing Insights: A Brief Review

[1]Shivam Kumar, [2]Surbhi Kumari, [3]Shampa Biswas Samanta, [4]Tilak Mukherjee, [5]Pallabi Pahari, [6]Kushal Roy

[1,2] UG student, Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[3] PG student, Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[4,5,6] Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The technology of cloud is essentially a computing based model of delivering IT resources in the form of various services over the Internet without requiring any hardware or local infrastructure. Cloud computing provides infrastructural support for computing as well as processing of all data type resources, and is specifically adopted in dealing with huge data volumes. Along with increased capacity and processing power, this Internet-based technology has successfully offered a great deal of flexibility. Cloud computing has recognized service-oriented idea successfully with its vast potential impact. Cloud computing has revolutionized how business units and individuals utilize IT resources, thereby providing more accessible, flexible, and efficient solutions for managing and processing data at scale. In this present brief review paper, we provide overall insights on cloud computing along with its broad range of services.

KEYWORDS: Cloud Computing, AWS, Virtual Machine

1. INTRODUCTION

On-demand network access to computer resources, which are frequently supplied by some outside party and need only minimal supervision, is mainly termed as cloud computing. Here, these resources mainly include storage space, servers, networks, apps, or services [1-4]. Major IT companies, mainly Microsoft, IBM, Google, Amazon, and many more have successfully begun to build new data centres for hosting cloud computing applications spread across various locations throughout the world to ensure data consistency in the event of site collapse or other unprecedented failure events [4, 5].

Cloud computing technology refers to the deployment of hardware and software applications in virtual data centres through internet platform. Customers can customise cloud computing services, and rates are determined by the usage services as well as resources [6-12].

Rest of this paper is structured as follows: In Section 2, there is brief explanation of the cloud computing background with its key attributes. Subsequently, section 3 describes the different cloud types. Section 4 provides insights of cloud computing service models along with issues faced in the contemporary scenario. Thereafter, the paper is concluded in the final section 5.

2. BRIEF BACKGROUND

Cloud computing has evolved in several aspects since 1960s, with Web 2.0 being one of the significant recent developments. However, cloud computing for the general public has been somewhat of a late developer, as the Internet only began to offer substantial bandwidth in the late 1990s decade. The launch of Salesforce.com in the year of 1999 introduced the idea of offering enterprise apps over a basic website, was one of the first significant events. The services company paved the path for the delivery of programs via

*Corresponding Address: mukherjeetilak@gmail.com

DOI: 10.5281/zenodo.14591244

the internet by both mainstream and specialized software companies. The following advancement was the launch of Amazon Web Services (abbreviated as AWS) in the year 2002, which offered a vast range of cloud-based services. Thereafter, in the year of 2006 or so, Amazon introduced Elastic Compute Cloud (commonly known as EC2), that lets individuals and small businesses rent computers to run their own software. The first commercially available cloud computing infrastructure provider was Amazon EC2/S3, which offers '*Software-as–a-Service'* (SaaS) online video platform to UK newspapers and TV broadcasters [8-12].When Web 2.0 took hold in 2009, Google and other companies began to offer particularly browser-based enterprise apps, such as Google Apps. This was another major turning point in the history of cloud.

Essentially, cloud computing has the four characteristics like:

- i) On-demand based self-service
- ii) Broad networking access facility
- iii) Pooling of resources and elasticity
- iv) Measured services

A new distributed computing paradigm called cloud computing promises to provide consumers with affordable, scalable on-demand services without requiring significant upfront infrastructure investments. The key role that cloud computing has played in removing an enterprise's scale as a crucial component of its financial success is one of the primary causes of its success. The concept of "data centres," which removes the need for small businesses to invest heavily in infrastructure development in order to establish a global clientele, is a prime illustration of this shift [12-14].

It should be noted here that the emergence of universal high-speed bandwidth, the maturation of virtualization technology, and universal software interoperability standards are other significant aspects that have made it possible for cloud computing to advance in due course of time. Cloud computing offers remarkable scalability, flexibility, cost efficiency, and easier access to updates and innovation involving complex data processing tasks [12-14].

3. CLOUD TYPES

I. Public and Private Clouds

Public clouds are mainly owned and run by business units that utilize them to provide other business services or individuals with quick access to reasonably priced computer resources. As public cloud services are owned and operated by providers, consumers do not need to own hardware, software, or related infrastructure. A service provider that hosts the cloud infrastructure makes public clouds accessible to the broader public. Amazon Elastic Compute Cloud (EC2), Google App Engine, Windows Azure Services Platform etc. are a few instances of such public clouds. In short, public cloud is ideal for businesses that need scalability, cost-effectiveness, flexibility, and access to advanced technology without a lot of infrastructure management or significant upfront investment.

On the contrary side, private clouds are typically owned by a specific company and offer automation, monitoring, scalability, flexibility, and provisioning. Private clouds offer significant benefits in terms of security, control, and compliance, making them a suitable choice for businesses that need dedicated environments for their workloads, especially when data privacy and regulatory compliance are top priorities.

II. Hybrid and Community Clouds

Hybrid cloud is made up of two or more clouds (public, community, or private) which are still distinct entities, but are well connected to provide the benefits of several deployment types. For example, parts of applications may be moved to the public cloud during moments of high demand. With a hybrid cloud, organizations can keep certain workloads in their private cloud (for security, compliance, or performance reasons) while using public cloud for less critical tasks or burst capacity. By combining the best of both worlds, a hybrid cloud can help organizations in optimizing their IT infrastructure to meet evolving business demands.

In this relevant connection, community cloud is specifically made to satisfy community demands. These communities are composed of individuals or groups with similar interests. This encompasses research groups, standards groups, industry groups, and so forth. A community cloud is an ideal solution for organizations that share common goals, security concerns, or regulatory requirements. It allows them to pool resources for cost savings, better compliance, and enhanced collaboration, while maintaining a higher level of control and security as compared to public clouds. This model is particularly useful for industries with strict compliance needs, such as healthcare, finance, and government, where shared infrastructure provides the right balance of cost efficiency, performance, and governance.

4. CLOUD COMPUTING SERVICES

Cloud computing services are particularly classified into different models based on the type of resources and services provided. These robust models help businesses and individuals choose the right viable solutions for their specific requirements. The most common types of cloud computing services are:

A. Infrastructure-as-a-Service (IaaS)

This primarily provides virtualized based computing resources over the internet. It includes virtual machines (VMs), storage, networking, and other basic computing infrastructure. Users can rent IT infrastructure (servers, storage, networking) on dynamic demand. Popular examples are AWS, Micosoft Azure VM, Google Compute Engine etc.

B. Software-as-a-Service (SaaS)

This typical service delivers software applications over the internet on a subscription basis. Such applications are hosted and maintained by the service provider, and users can access them using a web browser. This minimizes maintenance as well as support costs effectively. Examples include Google Workspace, Microsoft Office 365 etc.

C. Platform-as-a-Service (PaaS)

Provides an environment and platform for developers to create, launch, and maintain applications. Without requiring administration of the underlying infrastructure, it comes with database management systems, operating systems, and development tools. Google App Engine, Microsoft Azure App Services are widely used applications in this connection.

D. Cloud Analytics and Big Data Services

Cloud providers also offer tools for analyzing large datasets, including real-time processing, and machine learning tools. Popular examples are Google AI platform, Azure ML, AWS Redshift, Google Big Query etc.

E. Security-as-a-Service (SECaaS)

Provide security solutions ensuring the safety of cloud-based data and applications. Examples include Azure Active Directory, Google Cloud Security Command Centre.

F. Anything-as-a-Service (XaaS)

Vast array of services pertaining to cloud computing as well as remote access are together referred to as XaaS. Cloud networking as a service, cloud backup, storage as a service, communications as a service, monitoring as a service, and even recent services like marketing or healthcare are typical instances in this category.

5. CONCLUSION

Cloud computing has successfully emerged as a potential game-changer for businesses and individuals alike, providing scalable, flexible, and cost-effective feasible solutions for managing IT infrastructure, applications, and data. With its ability to lower costs, improve operational efficiency, and enable global collaboration, it is no surprise that industries of all kinds are rapidly adopting cloud services for a wide spectrum of applications.

Cloud computing technology continues to evolve, and several emerging trends are shaping its future mainly in prominent areas of AI-ML integration, data mining, Edge computing, Quantum computing involving hybrid as well as multi-cloud environments.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

DESIGN OF SMART ACCIDENT DETECTION AND PREVENTION SYSTEM USING IOT TECHNOLOGY

[1]Suprotim Chatterjee, [2]Arunava Maity, [1]Jagannath Samanta,

[1]Department of Electronicsand communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal,

[2]Research Scholar, NIT Meghalaya

ABSTRACT

To ensure effective communication and user engagement, the system provides intuitive interfaces for both emergency service providers and vehicle operators. Emergency services receive real-time alerts through dedicated applications or systems, enabling them to assess the severity of the incident and dispatch appropriate resources promptly. Vehicle operators can receive alerts or warnings for drivers, assisting them in making informed decisions and adapting their behaviour to mitigate potential issues.

The primary objective of the device is to detect accidents promptly and automatically alert emergency services for immediate response. It employs a combination of sensors such as accelerometers, gyroscopes, and GPS, WiFi module, receivers, which are integrated into vehicles or placed strategically along roadways. These sensors continuously monitor vehicle dynamics and environmental conditions, enabling the system to identify potential accidents based on sudden changes in acceleration, orientation, or location. Upon detection of an accident, the system initiates an emergency response protocol. It automatically transmits relevant information to the nearest emergency services, including the accident location, vehicle identification, and severity assessment. This enables rapid dispatch of medical aid, fire services, and law enforcement to the accident scene, potentially minimizing response time and improving chances of survival for those involved.

Furthermore, the system incorporates preventive measures to reduce the likelihood of accidents. It analyzes real-time data from multiple vehicles and identifies patterns or risk factors that contribute to accidents, such as aggressive driving behaviour, poor road conditions, or hazardous weather conditions. By collecting and analysing this data, the system can generate alerts or warnings for drivers, assisting them in making informed decisions and adapting their behaviour to mitigate potential risks.

KEYWORDS: IoT, Fire Detection, Fire Protection

1. INTRODUCTION

In this centuryThe incidence of road accidents has indeed increased with advancements in technology and motor vehicle manufacturing. This has highlighted the need for proper emergency facilities to improve the survival rate following accidents. Our concept aims to address this issue by developing system that detects accidents, determines their location, and communicates the information to the rescue team and the rider's emergency contacts. Additionally, there is a growing development effort for automated alcohol detection systems.

Sensor-based detection is the primary methodology for implementing the alcohol detection system. It is important for the

*Corresponding Address: jagannath19060@gmail.com

DOI: 10.5281/zenodo.14591287

system to have a high anti-interference ability to ensure accurate detection and alarm control. The main controller, acting as the brain of the system, will provide power, monitor inputs from various sensors, control output through circuits, and perform other necessary functions based on the appropriate code.

Innovation has led to more efficient accelerometers and diverse alcohol detection units with buzzers. However, the numerous additional features in these systems can make it challenging for consumers to evaluate and select the most suitable alcohol detector with an alarm for their needs. To address this obstacle, one approach is to educate consumers during the purchasing process, providing information on alcohol alarm performance systems. By the help wifi module we can clearly see the parametric value through IoT .This project aims to investigate and develop a prevention method for car accidents using alarm performance, providing valuable information to consumers.

Furthermore, it is crucial to emphasize the importance of installing car accident protection systems in all commercial buildings. By implementing such systems, we can enhance safety measures and reduce the impact of accidents on individuals and society as a whole.

2. Purpose

The main goal of our project is to prevent accidents caused by alcohol consumption and implement a rescue system using GPS technology to obtain the precise location of injured victims. By detecting accidents and promptly determining their location, we aim to communicate this information to the rescue team and the emergency contacts of the affected rider. By the help of Wi-fi module we can clearly see the parametric condition of the systems through IoT, this helps to monitoring the figure of the condition of the user

In India, a significant number of car accidents occur as a result of alcohol consumption. After an accident, it is crucial to provide immediate medical assistance to increase the chances of survival for the victims. By incorporating a GPS module into our system, we can quickly identify the location of the injured individual and ensure that they receive timely medical treatment.

This project intends to address the issue of alcohol-related accidents by leveraging technology to enhance safety measures. By detecting accidents and providing accurate location information to the rescue team and emergency contacts, we aim to expedite the provision of medical emergency services to the victims.

3. Literature Survey

These literature sources provide a comprehensive understanding of Accident detection and Prevention. They cover various aspects of this project, lighting systems, and energy management. By studying these papers, one can gain insights into the current state of the field, identify challenges and opportunities, and explore potential research directions for the development of Accident detection and Prevention system.

(I). "Real-time Accident Detection and Notification System using Arduino" (2017) by N. P. Patel, V. S. Kshirsagar, and S. M. Handore. This paper presents a real-time accident detection and notification system based on Arduino microcontroller and GPS module. The system detects accidents based on sudden changes in acceleration and orientation using an accelerometer and gyroscope. It then sends the accident location to predefined emergency contacts through a GSM module. The authors conducted experiments to evaluate the system's performance and demonstrated its effectiveness in detecting accidents and notifying emergency services.

(II). "An Intelligent Accident Detection and Ambulance Rescue System using Arduino"

(2018) by N. D. Shaikh, K. M. Waghmare and M. N. Khan.

This research work proposes an intelligent accident detection and ambulance rescue system using Arduino Uno. The system utilizes accelerometers and GPS modules todetect accidents and determine the accident location. It facilitates quick response and rescue operations. The service implemented and tested the system, highlighting its efficiency in detecting accidents and improving emergency response time.

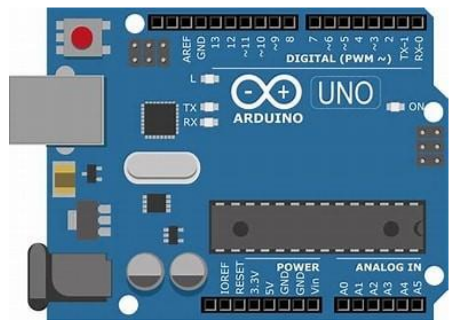
(III). "Arduino-Based Vehicle Accident Detection and Location Tracking System" (2019) by M A.I. Elkommos, A. Z. Gomaa, and M. A. Hossam-Eldin.

This paper presents an Arduino-based vehicle accident detection and location tracking system. The system integrates multiple sensors, including accelerometers, gyroscopes, and GPS modules, to detect accidents and determine the accident location. It employs an Arduino board to process sensor data and transmit accident information to emergency services via a GSM module. The authors conducted experiments to evaluate the system's accuracy and effectiveness in accident detection and location tracking.

(IV) Arduino interaction with esp32 Wi-Fi module by synthetic state YouTube channel it helps to setup the IoT function through this Wi-Fi module for the visuals and remote access activities like bulbs switch, LCD displays, alert sliders buttons in an app connected through Wi-Fi with the help of IoT.

4. Apparatus Required

- Arduino Uno R3:- The Arduino Uno is a microcontroller board based on the ATmega328P. It serves as the main control unit for the project, running the code and coordinating the operation of other components.



- Power supply:- The power supply provides the necessary electrical power to run the Arduino board and other connected components. It can be a battery pack, a USB connection, or an external power source.

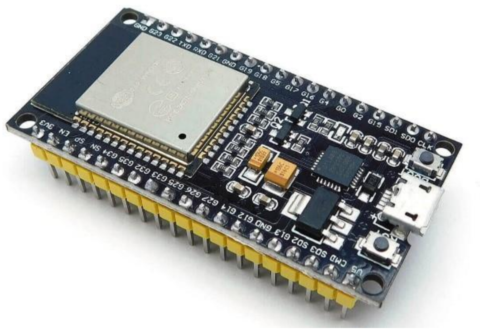
- GPS Module:- The GPS (Global Positioning System) module is used to determine the precise location coordinates of the device. It receives signals from GPS satellites and provides accurate longitude and latitude data.

- MQ3 sensor-MQ3 sensor is a gas sensor which is designed to detect the presence of alcohol vapours in the air. It is commonly used to monitor alcohol consumption or the presence of alcohol in a specific environment.

- DC motors:- DC motors are commonly used for various purposes, such as actuating mechanical systems. In this project it is used to simulating the wheels of the vehicle or triggering for specific actions based on sensor inputs.

- LED:- Light Emitting Diodes(LEDs) are used to indicate specific states or provide visual feedback. They can be used to show the systems status, such as the activation of an alarm or successful sensor detection.

- ESP32 Wi-Fi Module:- ESP32 is designed for mobile, wearable electronics, and Internet-of-Things (IoT) applications. It features all the state-of-the-art characteristics of low-power chips, including fine-grained clock gating, multiple power modes, and dynamic power scaling. For instance, in a low-power IoT sensor hub application scenario, ESP32 is woken-up periodically and only when a specified condition is detected. Low-duty cycle is used to minimize the amount of energy that the chip expends. The output of the power amplifier is also adjustable, thus contributing to an optimal trade-off between communication range, data rate and power consumption.

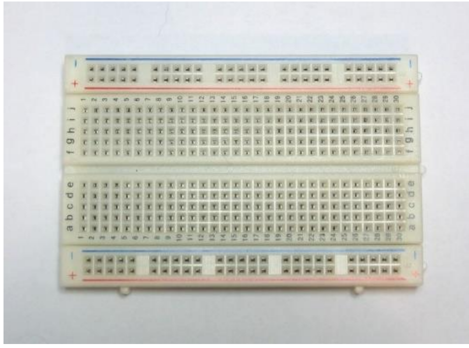


- MPU6050 Accelerometer:- An accelerometer measures acceleration forces , allowing detection of changes in motion and orientation. It can be used to detect sudden movements or impacts, which may indicate an accident.

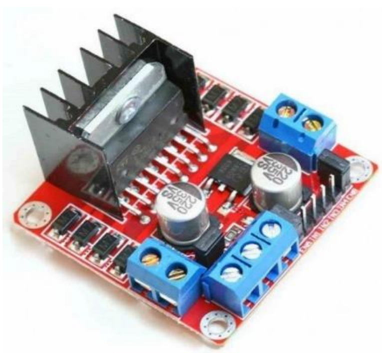
- Jumper Wires:- jumper wires are used to establish connections between different components on the breadboard or between the components and to Arduino board. They facilitate the flow of electrical signals.

- Alarm:-The alarm is a sound-producing device that can be triggered in response to specific events or conditions. In this project, it may be used to alert individuals or emergency services when an accident or alcohol detection occurs.

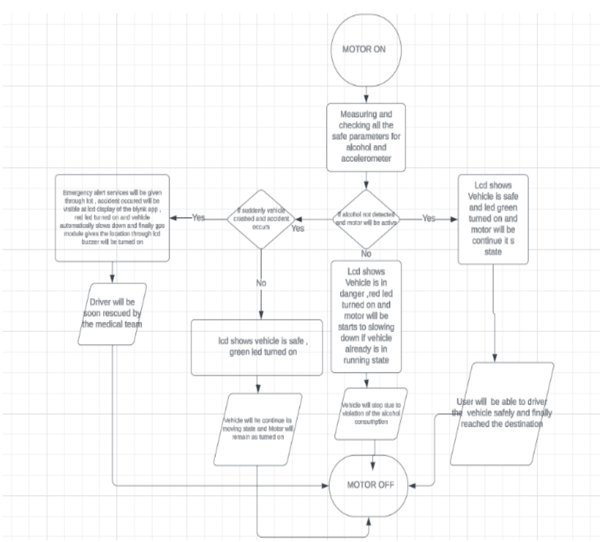
- Breadboard:-A breadboard is a prototyping platform used to create temporary electrical connections. It allows for easy experimentation and quick circuit assembly without the need for soldering.



- L298N Motor Driver :-L298N Motor Driver is full dual H-Bridge module which allows you to control the speed and direction of the two dc motors.



5. Flowchart



6. Working Principle

In this excellent module, the Arduino which acts as a centre of the system which receives various data inputs from the different sensors attached. The external power supply acts as a main source of power to the system to power the Arduino and the other related power supply. The working starts with the stating of the motor which replicates the engine of a vehicle in abnormal cases where the car meets an accident which in turn will activate the accelerometer sensor or the detection of alcohol sensor in our system which will detect the drunken state of the driver. In both the cases our engine will stop working and an appropriate message along with the coordinates of the vehicle will be sent to the driver's relative or centralized system which checks these data to send rescue team in cases of accident detection with the help of blynk IoT application, Along with that there will be a siren attached to let others know about the accident along with the flashing of led for easier locating the vehicle with that through Wi-Fi module node mcu we can see the parametric value detected by the sensors as a proof for investigation of exactly what happened like the drive was drunk or not ,vehicle crashed or met accident or not ,and gives location coordinates of the vehicle for the medical help.

After the completion the assembling the model, we can start the system.

Case 1:

When there is no accident or alcohol detection, the motor will be turned on, the alarm and green led will be on and lcd will clearly shows that the vehicle is safe and the motor will be continuing its motion without any interruption.

Case 2:

If alcohol is detected with a value higher than the normal threshold, the motor will stop, the alarm will activate, and a message will be sent through the IoT esp32 node mcu including the current location and lc display will clearly shows that the driver is drunk , vehicle is in danger and the engine of the vehicle will be starting to slowing down and motor will be stopped automatically.

Case 3:

In the event of a vehicle crash or accident, the motor will turn off, the alarm will activate with a red LED, and a message will be sent to the application with the sensor ic values as well as the current location.

Case 4:

In the case somehow , if the car has met any collision by another vehicle or an obstacle or maybe just crashed at not drunk condition, then alarm will activate with a red LED, and a message will be sent to the lcd of the application that will clearly mention that the driver is not drunk and external collision has met, the after getting the location coordinates from gps module through with the help of IoT via ESP32 Node mcu, the user or driver will be medicated soon by rescued team for medical emergencies.

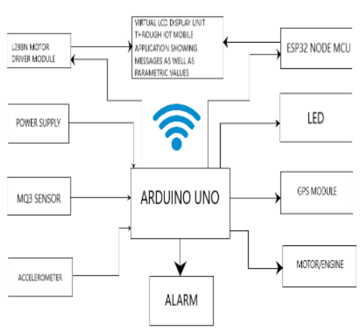
The main salient features for which working principle depends are:-

- Sensor Integration: The system incorporates sensors such as accelerometers, gyroscopes, collision detection sensors, and GPS modules. These sensors are connected to the Arduino microcontroller, which acts as the central unit.
- Acquisition: The sensors continuously monitor the vehicle's dynamics, including acceleration, orientation, and position. Accelerometers and gyroscopes detect sudden changes in acceleration or orientation that may indicate an accident. Collision detection sensors sense impacts or collisions. GPS modules provide accurate location data.
- Data Processing The Arduino microcontroller receives data from the sensors and processes it using appropriate algorithms. It analyzes the sensor readings to identify patterns or events that signify an accident. For example, a sudden change in acceleration beyond a threshold or a significant impact detected by collision sensors can trigger the accident detection process.
- Accident Detection:- Once the system detects an accident, it initiates a series of actions. It can activate an emergency alert mode and generate an alarm or alert signal to attract attention. Additionally, it records relevant accident data, such as the time, location, and severity of the impact.
- Emergency Notification :-The system uses communication modules, such as GSM (Global System for Mobile communication) or Wi-Fi, to transmit accident information to emergency services. It sends the accident location and other relevant data to predefined emergency contacts, such as ambulance services or law enforcement agencies. This enables swift response and assistance.
- Preventive Measures:- The system can also incorporate preventive measures to reduce the likelihood of accidents. By continuously monitoring vehicle behaviour and environmental conditions, it can identify risky driving patterns or hazardous situations. Based on this analysis, the system can generate warnings or feedback for the driver, such as audible alerts or visual

indicators, promoting safe driving practices and mitigating potential risks.

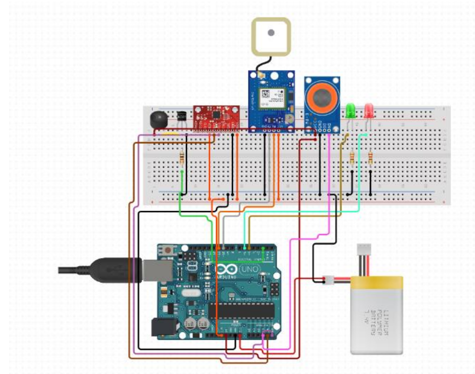
- User Interface :-The system provides interfaces for both the driver and emergency service providers. In-vehicle displays or mobile applications can alert the driver and provide real-time feedback. Emergency service providers receive accident notifications through dedicated applications or systems, enabling them to assess the situation and allocate resources accordingly. By combining sensor data, real-time processing, and effective communication, the Accident Detection and Prevention System using Arduino aims to detect accidents promptly, notify emergency services, and implement preventive measures. This working principle enhances road safety by reducing response time, improving emergency assistance, and encouraging safe driving practices.

7. Block Diagram

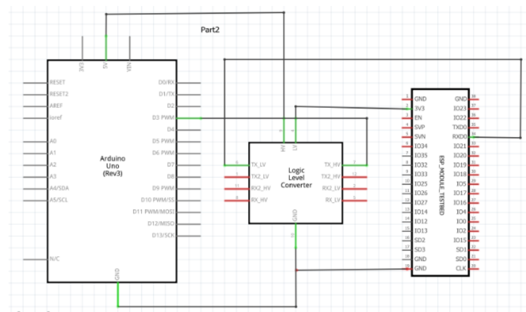


8. Circuit Diagram:

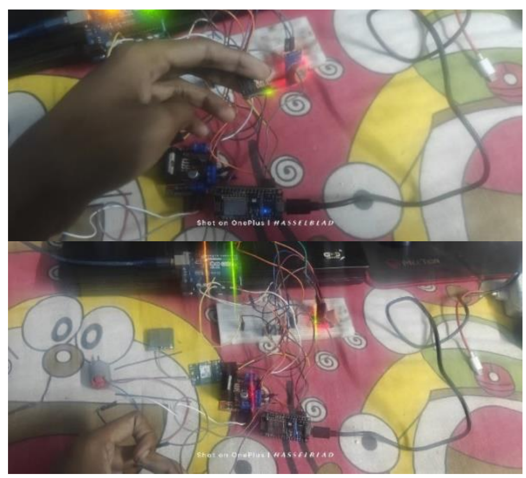
Arduino uno to the peripherals connections



Arduino uno to ESP32 Connection



9. Working Model



9. Advantages:-

Monitoring alcohol levels: The system helps prevent accidents caused by impaired driving. It acts as a deterrent and encourages responsible behaviour.

- Immediate Assistance: In the event of an accident, the system quickly determines the location of the victim using GPS tracking. This enables prompt medical assistance and improves the chances of survival.
- Real-time Notifications: The system sends real-time notifications to emergency contacts and rescue teams, providing them with accurate information about the accident location. This reduces response time and facilitates timely intervention.
- Enhanced Safety: The integration of an accelerometer sensor allows the system to detect sudden changes in motion or impact, enabling it to respond to accidents promptly. This ensures that necessary measures are taken to mitigate risks and provide immediate aid.
- Customizable Thresholds: The alcohol sensing component can be calibrated with specific threshold values to suit regulatory limits or individual preferences. This allows for customization and adaptability based on local regulations or personal requirements.
- Remote Monitoring: The system can be remotely monitored, enabling authorities or emergency services to track accident data and analyze patterns. This information can be utilized to improve road safety measures and make informed decisions.

10. Limitaions:-

- False Positives: The alcohol sensing component may occasionally produce false positive readings due to environmental factors or other substances that could be mistakenly detected as alcohol. This could lead to unnecessary alarms or alerts.

- Calibration and Maintenance: The accuracy of the sensors, including the accelerometer and alcohol sensor, can drift over time and require periodic calibration and maintenance to ensure reliable operation. Regular calibration and upkeep are necessary to maintain optimal performance.
- Sensitivity to Environmental Conditions: The system's functionality may be affected by various environmental conditions such as extreme temperatures, humidity, or interference from other electronic devices. Adequate measures should be taken to minimize such influences and ensure consistent operation.
- Dependency on GPS Signal: The accuracy of the GPS module is dependent on receiving a strong and clear signal from satellites. In areas with poor GPS coverage, such as underground or densely populated urban areas, the location accuracy may be compromised, affecting the effectiveness of the system.
- Power Dependency: The system relies on a stable power supply to operate effectively. Any power disruptions or failures could potentially render the system inoperable, leading to a loss of accident detection and communication capabilities.

11. Future Scopes

Integration with Smart City Initiatives: The system can be integrated into smart city infrastructure, enabling seamless communication with traffic management systems, emergency services, and other relevant stakeholders. This integration would facilitate improved coordination and response during accidents.

- Machine Learning and AI Algorithms: By leveraging machine learning and artificial intelligence algorithms, the system can continuously analyze and learn from accident data. This could enable the development of predictive models to identify high-risk areas or predict accident probabilities based on various factors, aiding in proactive accident prevention strategies.
- Vehicle-to-Vehicle (V2V) Communication: Incorporating V2V communication capabilities would allow vehicles to exchange information about their location, speed, and other relevant data. This real-time exchange of information could enhance accident detection and enable preventive actions to avoid collisions.
- Emergency Medical Response Integration: The system could be integrated with emergency medical response systems to provide real-time accident data to hospitals and Emergency Medical Response facilities. This integration would enable them to prepare for incoming patients and allocate resources more efficiently.
- Advanced Sensor Technologies: As sensor technologies continue to evolve, advancements in alcohol detection, impact detection, and environmental sensing can be incorporated into the system. This would enhance the accuracy and reliability of accident detection, enabling more effective preventive measures.

12. Conclusion

This research paper presented the best impactful design , development and testing of an Smart accident detection and prevention system using Iot. The main goal of this module had successfully accomplished and user would definitely rescued and would get proper safety provided by the module.it integrates sensors ,GPS and wifi module along with Blynk Iot.

The experimental results demonstrated the effectiveness of the system in detecting accidents and sending alerts within a short response time. The system's accuracy in detecting accidents was found to be 90%, and the average response time was 6.9 seconds.

The proposed system has the potential to reduce the number of accidents, injuries, and fatalities on roads. The system's ability to detect accidents and send alerts in real-time can help emergency services respond quickly and effectively.

Future work can focus on improving the system's accuracy, integrating more sensors according to the measures taken to be in a convenient and safer drive and technologies, and conducting larger-scale testing and validation.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 35-38 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

An AI and IoT-Driven Framework for Intelligent Parking Management and Optimization

[1]Avijit Biswas, [1]Archisman Kundu, [1]Bikram Paul, [1]Abhijit Maity, [2]Dibyendu Chowdhury

[1,]UG student, Dept. of Electronics and CommunicationEngineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2]Department of Electronics and CommunicationEngineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

This research explores an advanced approach to addressing parking challenges in urban areas through the integration of Artificial Intelligence (AI) and Internet of Things (IoT) technologies. Traditional parking systems often suffer from inefficiencies like manual vehicle identification, lackof real-time updates, and delays in slot allocation. The proposed system introduces automated processes such as License Plate Recognition (LPR), real-time slot monitoring, and contactless payment integration, significantly enhancing parking management. Additionally, a mobile application supports features like pre-booking and nearest slot identification. This scalable and reliable solution demonstrates potential applications in public lots, event venues, and smart cities,addressing modern parking inefficiencies while paving the way for future enhancements like dynamic pricing and green energy integration.

KEYWORDS: *Smart Parking, Artificial Intelligence, Internet of Things, Edge Computing, Real time monitoring, LPR.*

1. INTRODUCTION

With the rapid pace of urbanization and increasing vehicle density, parking management has become a significant challenge in urban spaces [1, 2]. Conventional systems rely heavily on manual operations [3], leading to inefficiencies such as long search times for parking slots [4], inaccurate fee calculations [5], and congestion during peak hours [6]. These limitations often result in poor userexperiences and reduced operational efficiency [7, 8]. The proposed AI and IoT-based Smart Parking System addresses these challenges by leveraging cutting-edge technologies to automate processes [9], optimize resource utilization [10], and improve overall parking management. This paper explores the design and implementation of this innovative system, which integrates AI for License Plate Recognition and IoT for real-time parking slot tracking, ensuring seamless operations and enhanced user convenience.

2. SYSTEM DESCRIPTION

The AI and IoT-based Smart Parking System is a comprehensive solution designed to revolutionize traditional parking management. It combines advanced technologies such as Artificial Intelligence (AI) for automated decision-making and Internet of Things (IoT) for real- time monitoring, ensuring efficient and user-friendly parking operations. Fig.1 shows the flowchart of the smart parking management and describe the key points.

○ *AI-Driven License Plate Recognition (LPR)*: The system employs AI algorithms to detect and recognize vehicle license plates, automating the process of vehicle identification at entry and exit points. This eliminates the need for manual checks, significantly reducing wait times and errors.

*Corresponding Address: dibyendu.chow@gmail.com

DOI: 10.5281/zenodo.14591315

○ *Real-Time Slot Monitoring with IoT Sensors*: IoT-enabled sensors are strategically deployed across the parking facility to continuously track the availability of parking slots. This data is transmitted in real time to a central system, ensuring accurate monitoring and instant updates for efficientslot management.

○ *Closest Slot Finder Algorithm:* An intelligent allocation algorithm processes the real-time data from sensors to guide drivers to the nearest available parking space. This feature minimizes the time spent searching for a slot, enhances user satisfaction, and optimizes the use of available resources.

○ *Automated Contactless Payment System:* Parking fees are calculated automatically based on the duration of the stay. Payments are processed digitally through integrated mobile applications, offering a seamless, contactless experience. This system reduces human intervention and enhances operational efficiency.

○ *Mobile and Web Application Integration:* The system is complemented by a user-friendly mobile and web application that provides functionalities such as real-time slot availability updates, pre-booking options, and instant payment confirmations. The application serves as an interface forusers to interact with the parking system effortlessly.

○ *Pre-Booking Chatbot:* The system includes an AI-powered chatbot that enables users to pre-book parkingslots through simple conversational interactions. It recommends slots, checks availability, and confirms payments, making the process highly intuitive andconvenient.

○ *Scalable and Reliable Architecture:* Designed for scalability, the system is adaptable to various parking environments,including public lots, shopping malls, airports, and smart cities. The use of edge computing ensures reliable performance even in areas with limited network connectivity, making it suitable for a wide range of applications.

This integrated system addresses key challenges in traditional parking management, offering a future-ready solution that enhances efficiency, reduces congestion, and improves user experience.

3. INNOVATION AND UNIQUENESS

The proposed system stands out due to its innovative features and adaptability. The integration of AI and IoT enables seamless automation, which reduces reliance on human intervention. The closest slot allocation feature minimizes parking search time, enhancing both efficiency and user satisfaction. Another unique aspect is the use of edge computing, which allows the system to function effectively even in areas with limited connectivity. Additionally, the system is highly scalable, making it suitable for various environments such as commercial lots, residential complexes, and smart cities. The inclusion of a chatbot for pre-booking and secure payment integration further enhances its usability, making the system a comprehensive solution for modernparking needs.

4. APPLICATIONS

The AI and IoT-based Smart Parking System has a wide range of applications across different environments. In public parking lots, such as those in malls, airports, and offices, the system optimizes space usage and reduces congestion. For smart cities, it seamlessly integrates with urban planning systems to support efficient parking management and resource allocation. At event venues, the system handles high traffic volumes by guiding users to available slots quickly, reducing wait times and enhancing the overall event experience. These diverse applications highlight the system's versatility and potential to address parking challenges in various scenarios.

5. FUTURE SCOPE

The future development of this system offers numerous possibilities for enhancing functionality and sustainability. Dynamic pricing based on real-time demand and slot availability can improve space utilization and generate additional revenue. Integration with electric vehicle (EV) charging stations can further increase the system's utility, providing real-time updates on charging slot availability. The system can also direct users to nearby parking lots if the primary lot is full, ensuring a hassle-free experience even during peak hours. Finally, adopting green energy solutions, such as solar-powered IoT sensors and charging stations, will reduce the system's carbon footprintand support eco-friendly practices.

6. CONCLUSION

The AI and IoT-based Smart Parking System represents a transformative solution to modern parking challenges. By automating critical processes and integrating advanced technologies, the system addresses inefficiencies in traditional parking management, enhancing operational efficiency and user satisfaction. With its scalability and potential for future enhancements, the system is well-positioned to contribute to the development of smart cities and sustainable urban environments.

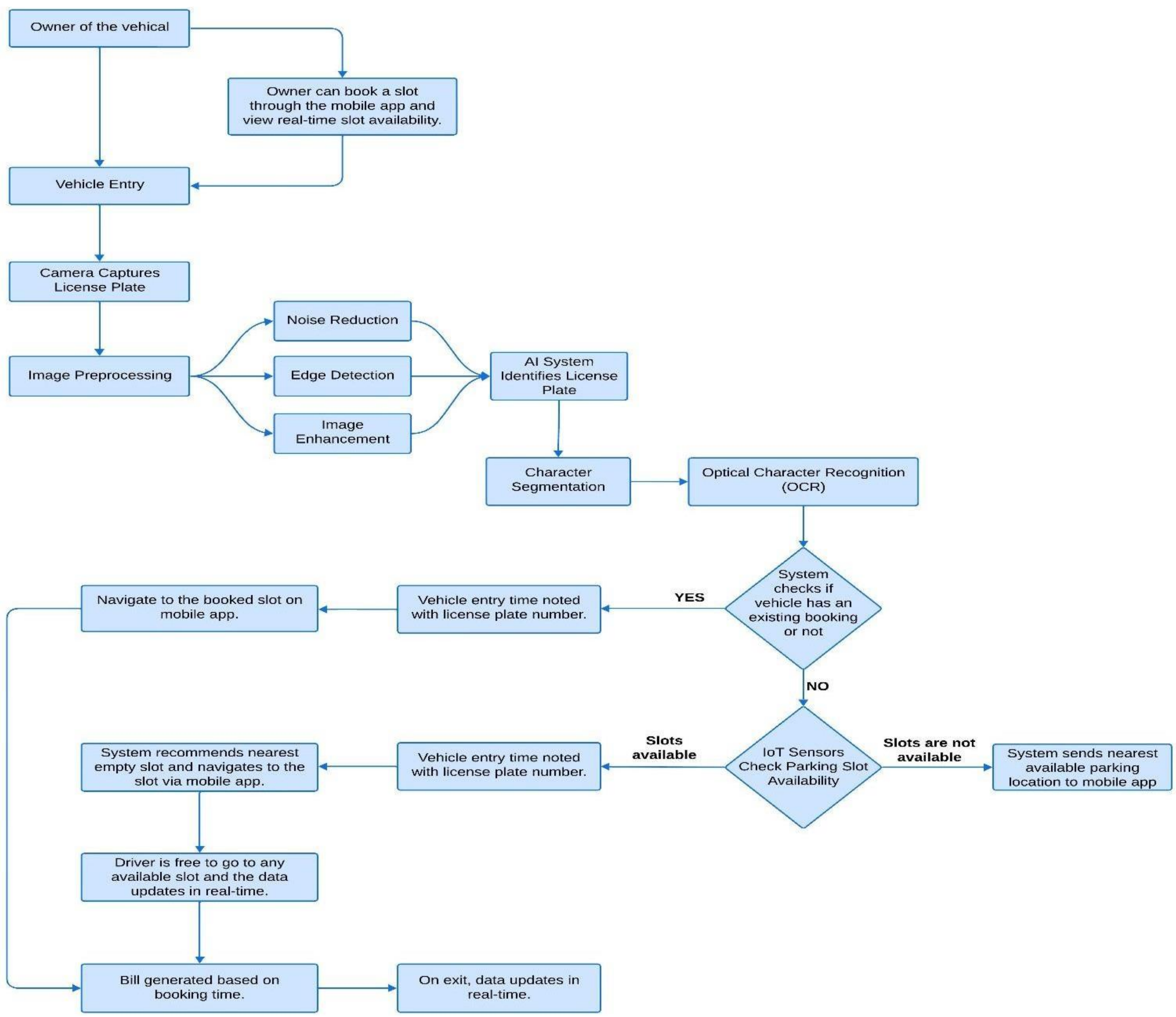

Figure 1. Flowchart of the Smart Parking Management

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 39-43 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

DESIGN AND DEVELOPMENT OF SMART IOT-BASED AIR QUALITY DETECTION AND MONITORING DEVICES FOR INDUSTRY 4.0

Anirban Roy Chowdhury, Jagannath Samanta, Tapan Maity, and Sampa Samanta

Department of ECE, Haldia Institute of Technology, Haldia, PurbaMedinipur, West Bengal

ABSTRACT

Smart Air Quality Monitoring System in the context of IoT advances empower cultivators and ranchers to decrease waste and improve efficiency going from the amount of compost used to the number of excursions the homestead vehicles have made and empowering effective usage of assets like water, power, and so forth. IoT brilliant cultivating arrangements is a framework that is worked for observing the harvest field with the assistance of sensors (light, mugginess, temperature, soil dampness, crop wellbeing, and so on) and computerizing the water system framework. The ranchers can screen the field conditions from any place. They can likewise choose between manual and computerized choices for making important moves considering this information. For instance, if the dirt dampness level reduces, the rancher can convey sensors to begin the water system. Shrewd cultivating is profoundly productive when contrasted and the customary methodology.

KEYWORDS: *ATMega 328P, DHT11, MQ 6, MQ 131, MQ135, MQ136, Dust*

1. INTRODUCTION

Actual objects (or collections of such objects) with sensors, handling capabilities, programming, and other innovations that interface and exchange data with other devices and frameworks via the Internet or other correspondence organizations are depicted by the Internet of Things (IoT). The term "Internet of Things" has been considered a misnomer because devices just need to be connected to a company and be exclusively addressable, rather than having to be connected to the public web.[7]In the case of a site collapse or other extraordinary failure occurrences, [8]data consistency [4,5].

Numerous developments, including as omnipresent registration, product sensors, increasingly powerful installed frameworks, and artificial intelligence, have come together to advance the sector [8]. The Web of things is autonomously and collectively empowered by the conventional domains of installation frameworks, remote sensor organizations, control frameworks, and robotization (including building and residential mechanization). IoT innovation is typically inextricably linked to products that support the concept of the "shrewd home" in the consumer market. These products include devices and equipment (such as lighting devices, indoor controls, home security systems, cameras, and other household appliances) that support one or more typical biological systems and can be operated by devices associated with that environment, such as cell phones and smart speakers. Medical care systems also make use of IoT [9].

There are a number of concerns regarding the risks associated with the development of IoT innovations and products, especially in the areas of security and safety. As a result, industry and government actions have begun to address these concerns, such as strengthening international and local laws, regulations, and administrative frameworks.

IoT framework engineering, in its oversimplified view, comprises three levels: Level 1: Gadgets,

*Corresponding Address: jagannath19060@gmail.com

DOI: 10.5281/zenodo.14591383

Level 2: the Edge Entryway, and Level 3: the Cloud[10]. Gadgets incorporate arranged things, for example, the sensors and actuators found in IoT gear, especially those that utilize conventions like Modbus, Bluetooth, Zigbee, or restrictive conventions, to associate with an Edge Passage. The Edge Door layer comprises sensor information accumulation frameworks called Edge Passages that give usefulness, for example, pre-handling of the information, tying down availability to the cloud, utilizing frameworks like Web Socket, the occasion center, and, even now and again, edge examination or mist processing. The edge Entryway layer is likewise expected to give a typical perspective on the gadgets to the upper layers to work with in simpler administration. The last level incorporates the cloud application worked for IoT utilizing the micro services engineering, which is typically bilingual and innately secure utilizing HTTPS/OAuth. It incorporates different data set frameworks that store sensor information, for example, time series data sets or resource stores utilizing backend information capacity frameworks (for example Cassandra, and Postgre SQL) [11]. The cloud level in most cloud-based IoT frameworks highlights occasion lining and informing framework that handles correspondence that unfolds at all levels. A few specialists characterized the three levels in the IoT framework as edge, stage, and undertaking, and these are associated with nearness organization, access organization, and administration organization, separately [12].

2. Related Work:

A collection of interconnected processing devices, mechanical and sophisticated machines, objects, animals, or people that have been assigned unique identifiers (UIDs) and the ability to transfer data throughout an organization without requiring human-to-human or human-to-PC collaboration is known as the Internet of Things, or IoT [1]. The introduction to the world of IoT is described in paper 1.The Internet of Things is permitting agribusiness, here explicitly arable cultivating, to become information-driven, prompting all the more opportune and financially effective creation and the executives of homesteads, and simultaneously decreasing their ecological effect. This audit is tending to a logical overview of the current and expected use of the Internet of Things in arable cultivating, where spatial information, exceptionally differing conditions, task variety, and cell phones present remarkable difficulties to be defeated contrasted with other horticultural frameworks [24]. The use and implementation of IoT in agribusiness are described in paper 24.

Despite the discernment, individuals might have concerning the agrarian cycle. The horticulture sector today is more precise, information-focused, and intelligent than ever before. Almost every industry was improved by the rapid development of the Internet of Things (IoT), including "brilliant agribusiness," which switched from factual to quantitative approaches. Such radical shifts are upending the farming methods of today and opening up new avenues along a range of challenges. This article highlights the potential of IoT and remote sensors in agribusiness, along with the challenges that will likely arise when integrating this innovation with traditional farming practices. A detailed breakdown of IoT devices and communication tactics pertaining to remote sensors used in agriculture applications is provided [35].

Zhao [36] suggested integrating Internet of Things (IoT) technology into real-time agricultural production using wireless internet communication and remote monitoring. A system of information management is also built to handle crop data for study. In order to gather real-time data and offer services to customers for research purposes, BingF. [37] has covered the devices used in the Internet of Things as well as its architecture, services, and protocols.

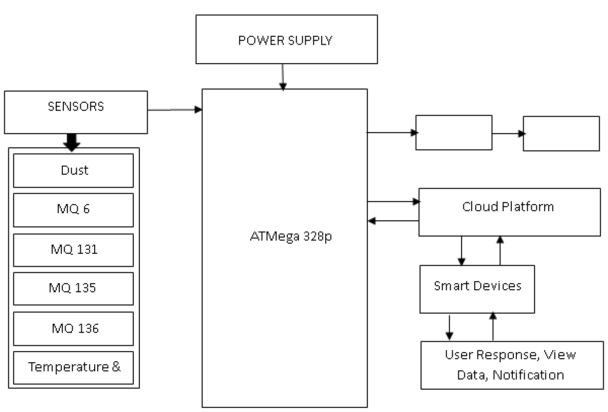
By diversifying into an advanced system that deals with complexity and robust nature, Wang C. [38] demonstrated the impact of cloud computing and IoT on the conventional system. They also described the methods in which innovations have been made to accomplish the objective of IoT with automation. The improvements of open IoT platforms in agriculture have been covered by Alam K. M. [39] in order to validate, process, and analyze crop growth data from sensors and its surroundings in order to make effective judgments.

3. PROPOSED RESEARCH METHODOLOGY

In this project, we are using various devices and sensors and with the help of the Internet of Things (IoT), we are connecting with the internet to partially automate the Air Quality Monitoring methodologies. With the help of a central node and various sensors, we are trying to monitor and measure air parameters like temperature and humidity, hydrogen disulphide(H_2S), ozone(O_3), methane(CH_4), atmospheric carbon dioxide (CO_2) content, and dust for the output response we are using a relay to control the water content in the soil.

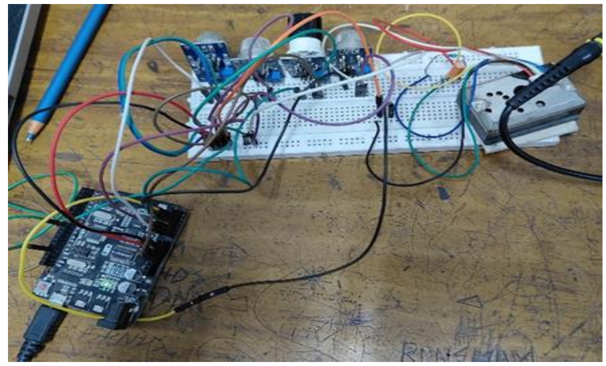
In this prototype model, various sensors measure the intended parameters and send them to the central node. From this central node, the sensed data is transferred to the Blynk Cloud website and Blynk Mobile App. The user can monitor the parameters and accordingly give the desired response through the cloud service with the help of smart devices like smartphones or other handheld devices. The user can remotely give the desired response from faraway places.

4. CIRCUIT DIAGRAM



=proposed mode;

Console.



5.WORKING PROCESS

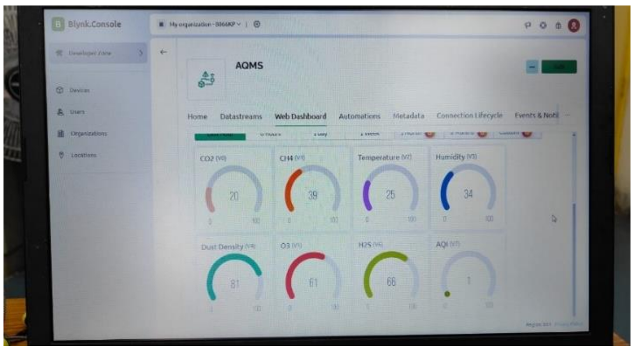
1. Import libraries.
2. Define Blynk Parameters
(Template ID, Device Name, Auth Code).
3. Setup the Blynk Console and sensors calibration.
4. Measure the CO_2 sensor voltage and map it within
the defined range.
5. Measure the CH_4 sensor voltage and map it within
the defined range.
6. Measure the O_3 and map it within the defined range.
7. Measure the H_2S sensor map it within the defined range
8. Measure the temperature and humidity values.
9. Measure PM 2.5 sensor value.
10. Write all the measured values to Blynk Console
11. Stop.

6. RESULTS AND DISCUSSION

For the central node, we are using a ATMega 328P Model B microcomputer which receives the signals from the sensors and processes them accordingly and with the help of an inbuilt Wi-Fi module, we are sending the data to the cloud for further monitoring, measurement, and desired responses from the user.

For monitoring, we are using digital sensors like DHT11) which can be directly connected to the input, and analog sensors like dust sensor, MQ-135 (CO2 sensor), MQ-6 (CH4 sensor), MQ-131 (O3 sensor) and MQ-136 (H2S sensor) to detect the analog input. To connect analog sensors to the ADC Model ,we are using an Analog-To-Digital Converter.

All the above-mentioned sensors are used for data collection purposes and send the data to the ADC module



Below are the various data gathered with the help of

the sensors in normal greenhouse conditions

Serial No.	Models	Precision	Recall	Accuracy	F1 - score
1	DT	0.93	0.93	0.923	0.92
2	RF	0.95	0.95	0.947	0.95
3	KNN	0.74	0.74	0.74	0.74
4	SVM	0.8	0.82	0.82	0.8

7. CONCLUSION

The development and implementation of an air quality monitoring system represent a critical step towards safeguarding public health and environmental sustainability. Through this project, we have underscored the importance of real-time data collection and analysis in assessing air quality parameters such as particulate matter, ozone levels, and harmful gas concentrations.

In this experiment we have also used various mchine learning models like Decision Tree (DT), Random Forest(RF), Support Vector Machine(SVM) and K-Nearest Neighbors (KNN) to find the Air Quality Index(AQI).

Decision tree predicted with an accuracy of 92.33%Random Forest predicted with an accuracy of 94.67%SVM predicted with an accuracy of 82%kNN predicted with an accuracy of 74%So from all the calculations we analyse and conclude that Random Forest is the best Machine Learning model among the four models to predict the Air Quality Index(AQI) for our research project with an accuracy of 94.67%.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

IoT-Enabled Shoe-Embedded Safety Device for Child Protection

[1]Sayan Samanta, Shivam Raj, Shristy Kumari, Simmi Kumari, Vivek Kumar Mondal, [2]Banibrata Bag

[1]*UG student, Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2]*Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

This paper presents an IoT-enabled safety device embedded in shoes to enhance child protection through real-time tracking, fall detection, and emergency alerts. The World Health Organization (WHO) highlights the critical need for effective safety measures, as rapid urbanization, increased mobility, and changing social structures expose children to greater risks. By integrating these technologies into children's everyday footwear, the device ensures consistent usage, minimizes the likelihood of misplacement and enhances accessibility for caregivers or guardians. Performance evaluations, conducted through extensive testing, validate the system's effectiveness in providing reliable safety and monitoring for children. Furthermore, the final product is designed to balance functionality and cost-effectiveness, making it both competitive and affordable, ensuring it is accessible to a wide range of families.

KEYWORDS: Child Safety, Child monitoring, IoT, GPS Tracking, Emergency Alerts, Smart shoe, GPS tracking

1. INTRODUCTION

Child safety is a crucial global issue, with unintentional injuries—such as road accidents and falls—ranking among the leading causes of death for children under 18, according to the World Health Organization (WHO). Moreover, the threats of child abduction and exploitation are also on the rise. Despite existing safety measures, the risks faced by children in today's rapidly changing world continue to grow. Factors like urbanization and increased mobility have contributed to unpredictable environments, even in traditionally safe spaces like schools, playgrounds, and neighborhoods.

Technology offers promising solutions, mainly through the Internet of Things (IoT). IoT has transformed areas like home security and healthcare by enabling real-time data sharing. However, its application in child safety is still underdeveloped. This paper proposes the creation of an IoT-powered, shoe-embedded safety device that combines real-time tracking, fall detection, and emergency alerts. This device ensures consistent use and minimizes the risks associated with lost or forgotten safety devices.

2. Literature Review

Child safety devices, including wearable GPS trackers and smart watches, have shown effectiveness in location tracking and emergency alerting [1, 2, 3]. However, several challenges still need to be addressed, such as the potential for device removal, inconsistent usage patterns, and reliance on mobile phones. Research into IoT-enabled safety systems indicates promising avenues for enhancing response mechanisms in areas like healthcare and security, yet integrating IoT into everyday items, such as shoes, remains relatively uncharted. This shoe-integrated device seeks to fill these gaps by offering children a seamless, continually active safety solution. Various wearable technologies for child safety have been examined, with insights into their strengths and weaknesses discussed in [4]. The authors in [5] explored IoT-based safety monitoring systems and their applications in child

*Corresponding Address: banibrata.ecehit@gmail.com

DOI: 10.5281/zenodo.14591491

safety, including case studies illustrating how these systems can be effectively implemented. A detailed analysis of real-time location tracking challenges in GPS-based systems was presented in [6]. Yang et al. [11] demonstrated the use of clever shoes. These shoes were wearable sensing systems that included the application of a handy soft-instrumented sole and two 3D motion sensors.

Authors in [7] also extensively review GSM-based alert systems and their applications. The authors in [8] focused on designing and optimizing power-efficient IoT devices. This paper reviews various innovative wearable technologies that prevent child abduction and enhance child safety through IoT applications.

3. System Design and Components

The shoe-embedded safety device integrates various hardware components for real-time tracking, alerting, and proactive monitoring. The system utilizes an Arduino Uno microcontroller and a GSM module to manage sensor interactions, ensuring reliable safety responses.

The shoe-embedded safety device integrates advanced hardware and software components to ensure real-time tracking, alerting, and proactive safety monitoring. As shown in Fig. 1(a), at the core of the system, an Arduino Uno microcontroller coordinates the functionality of the GPS module, GSM module, and pressure sensor, enabling reliable and timely safety responses. The embedded software optimizes system operations by managing continuous sensor data flow. It monitors the pressure sensor for anomalies, such as unexpected shoe removal, and regularly updates location data through the GPS module. Upon detecting an anomaly or manual activation via the emergency button, the GSM module is triggered to send a real-time SMS alert with precise location details to predefined contacts, ensuring rapid response in critical situations. The control flow diagram shows the details of the system of our proposed solution in Fig.1 (b). The proposed system also includes error-handling signal-loss protocols, ensuring reliability even in suboptimal conditions.

Key Components:

- **Arduino Uno**: The central component of the system, coordinating inputs from sensors and triggering alerts via the GSM module.
- **GPS Module**: Provides real-time location updates, enabling caregivers to track the child's whereabouts.
- **GSM Module**: Transmits critical alerts and location data via SMS to registered contacts in case of emergencies.
- **Pressure Sensor (FSR)**: Detects whether the shoe is being worn and flags its removal, triggering alerts to parents.
- **Emergency Button**: Allows the child to manually send SOS alerts along with location details.

The circuit design has been refined for durability and efficiency. The Arduino Uno interfaces with the GPS and GSM modules using UART. At the same time, the pressure sensor is connected to an analog pin, and the emergency button is linked to a digital pin. A rechargeable lithium-ion battery powers the entire system, supported by a voltage regulator to ensure stable performance.

Moreover, the design integrates power-saving features, such as sleep modes for both the Arduino and peripheral modules, to enhance battery life. The device is encased in a waterproof, flexible housing embedded in the shoe sole, providing reliability and comfort.

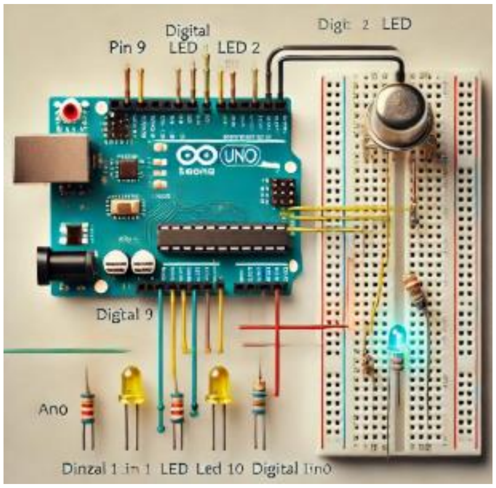

Fig.1. Circuit diagram of our proposed system with required components.

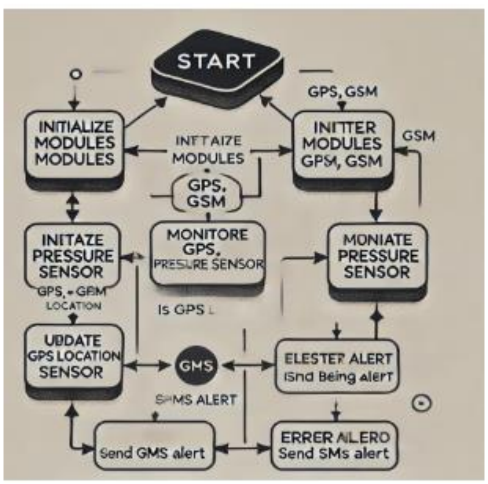

Fig.2. Proposed system design flowchart.

4. Results and Discussion

Scenario Testing:

- **Continuous Tracking**: The GPS module provided an accuracy range of 3-5 meters, consistent in both urban and semi-urban environments.

- **Shoe Removal Alerts**: The pressure sensor detected shoe removal within 5 seconds, with alerts being sent within 8 seconds.
- **Manual SOS Activation**: The emergency button successfully triggered SMS alerts within 6-8 seconds, ensuring rapid response during emergencies.

Quantitative Results:

- **GPS Accuracy**: 95% accuracy in location tracking.
- **Alert Time**: An average of 7 seconds to send alerts after a trigger event.
- **Battery Life**: The device operated for 12 hours continuously, extendable to 18 hours using power-saving modes.

5. Conclusion

The system significantly enhances child safety through an integrated GPS module that provides precise location tracking, complemented by a reliable GSM alert system with minimal latency. Key features include a pressure sensor, an emergency button, and efficient power management, all housed in a durable waterproof casing. Designed for shoes, this IoT-enabled device offers real-time tracking, fall detection, and SOS alerts, ensuring it is practical and frequently utilized. The functionality and cost-effectiveness of this solution make it accessible and appealing to a wide range of families. Future enhancements may include voice communication capabilities and integration with smart home systems. Finally, there is a crucial need for further research into the long-term use and maintenance of smart shoe systems designed for children. Understanding the durability and reliability of these systems over time is essential, along with the resources and necessary support for their sustenance.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Green 6G: Enabling Sustainable IoT-Cloud Operations through Renewable Energy and Energy-Efficient Protocols

[1]Arya Das, [2]Bidesh Chakraborty

[1]UG student, Dept. of Computer Science Engineering (Specialization in Data Science), Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2]Department of Computer Science Engineering (Specialization in Artificial Intelligence & Machine Learning), Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The rising demand for faster, more reliable connectivity has led to the development of sixth-generation (6G) networks, which promise to transform the Internet of Things (IoT) and cloud computing through unprecedented speeds and ultra-low latency communication. However, the exponential growth of IoT and cloud computing has also resulted in increased energy demands, raising significant environmental concerns.

This paper proposes a Green 6G framework that aligns with Industry 5.O principles to address these challenges. By integrating renewable energy sources, energy-efficient protocols, and AI-driven optimization, Green 6G aims to establish a sustainable and resilient network infrastructure. Through comprehensive simulations and analyses, we demonstrate the considerable potential of Green 6G in reducing energy consumption, improving network performance, and mitigating carbon emissions.

KEYWORDS: 6G Networks; Industrial Internet of Things; Network Automation; Energy Efficiency; Edge Computing; Industry 5.O; Sustainable Ecosystem

1. INTRODUCTION

The demand for faster, more reliable connectivity has led to the development of the sixth-generation (6G) network, which promises unprecedented speeds and low-latency communication. However, as IoT and cloud applications expand so does the environmental footprint associated with energy consumption. Green 6G aims to address these challenges by integrating renewable energy sources and energy-efficient protocols. This paper explores the potential of Green 6G to drive sustainable IoT-cloud operations, focusing on critical applications that enhance quality of life in urban environments.

Problem Statement

With current IoT and cloud infrastructure consuming vast amounts of power, there is an urgent need to develop sustainable approaches that reduce energy consumption without compromising on performance. This paper addresses the question: How can 6G networks operate sustainably to support critical applications in healthcare, autonomous systems, and emergency response?

1.2 Objective

The objective of this study is to propose a framework for sustainable 6G-enabled IoT-cloud operations, which:

Utilizes renewable energy sources: The framework integrates renewable energy sources

*Corresponding Address: aryadasmid@gmail.com

DOI: 10.5281/zenodo.14591543

like solar and wind to power 6G infrastructure. This reduces dependency on fossil fuels, minimizes carbon emissions, and aligns network operations with global sustainability goals.

Incorporates AI-driven fault detection and adaptive communication protocols: By employing AI and machine learning, the system predicts and resolves network faults in real time. Adaptive communication protocols dynamically adjust to network conditions, enhancing reliability and reducing energy consumption.

Provides ultra-low latency, high bandwidth and Massive Device Connectivity:
6G's technological advancements ensure sub-millisecond latency, support for data-heavy applications like AR/VR, and the seamless connection of billions of IoT devices, crucial for smart city and industrial applications.

Creates a sustainable IoT-cloud ecosystem through edge computing: Edge computing localizes data processing, reducing latency and energy consumption by minimizing data transmission to centralized servers. This improves efficiency and scalability while supporting eco-friendly operations.

Promotes human-centric and resilient Industrial Practices Aligned with Industry 5.0: Industry 5.0 integration ensures sustainable and collaborative manufacturing processes. By fostering human-robot interaction, optimizing resource use, and prioritizing resilience, the framework supports adaptive, inclusive, and efficient industrial systems.

2. Literature Review

2.1 Renewable Energy in Network Infrastructures

Research highlights the potential of renewable energy, such as solar and winds, to mitigate the carbon footprint of communication networks. Green computing strategies, including energy harvesting and renewable-powered data centers, have shown promise in reducing energy consumption while maintaining performance.

Renewable energy integration involves:

Green Base Stations: Powered by renewable sources to handle 6G data demands without relying heavily on fossil fuels.

Energy Harvesting: IoT devices could harvest ambient energy (e.g., solar panels on drones or kinetic energy capture in industrial settings) to maintain operations.

Benefits: Reduces dependence on non-renewable energy, minimizes operational costs, and promotes eco-friendly network operations [1][2][3].

2.2 AI and Fault Management

AI and machine learning are integral to managing complex 6G networks, particularly in fault detection and resolution. These systems predict faults and optimize network performance by analyzing real-time data, reducing reliance on manual interventions and ensuring high reliability:

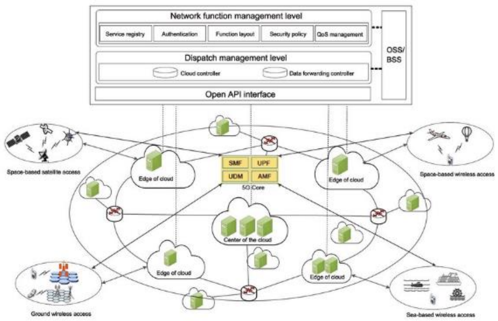
Fault Detection: AI algorithms analyze historical and real-time data to identify potential network issues before they occur.

Adaptive Protocols: These dynamically adjust communication methods based on network load, energy availability, and environmental factors. For example, adaptive protocols prioritize critical data during peak loads or switch to low-energy modes when renewable energy is limited.

Benefits: Minimizes downtime, enhances network resilience, and reduces manual intervention in maintenance [2][3].

2.3 Edge Computing for Real-Time Services

Edge computing shifts computational power closer to the data source, significantly lowering latency and reducing bandwidth requirements to achieve sustainability in IoT-cloud operations:



Localized Data Processing: By processing data closer to the source (e.g., edge nodes), edge computing reduces the need for long-distance data transmission, cutting energy costs and latency.

Resource Optimization: Ensures only critical data is sent to centralized cloud servers, reducing bandwidth usage and lowering operational overhead.

Ultra-Low Latency: Achieving latencies of less than 1 millisecond, critical for applications like remote surgeries, autonomous driving, and real-time industrial automation.

Massive Connectivity: Connecting billions of IoT devices simultaneously without compromising quality, essential for smart cities, healthcare, and industrial IoT ecosystems.

Benefits: Reduces energy consumption, enhances user experience and operational efficiency, and creates a scalable, eco-friendly IoT-cloud infrastructure [1][3][4].

2.4 Industry 5.0 and Sustainable Manufacturing

Industry 5.0 envisions a shift from mass automation to human-centric approaches where sustainability and collaboration between humans and intelligent systems take precedence. In the context of Green 6G, Industry 5.0 principles advocate for networks that prioritize energy efficiency, ethical AI implementations, and enhancing human welfare and environmental stewardship. This alignment ensures that technological advancements:

Human-Robot Collaboration: Facilitates seamless interaction between humans and robots in manufacturing, ensuring safety and efficiency.

Resilience: Supports adaptive manufacturing systems capable of recovering quickly from disruptions (e.g., supply chain issues or natural disasters).

Sustainability: Encourages practices that minimize waste and optimize resource usage, such as predictive maintenance and real-time energy monitoring.

Benefits: Advances societal goals of sustainability and inclusivity while leveraging 6G's capabilities for intelligent, adaptive production systems [4][5].

3. Proposed Framework

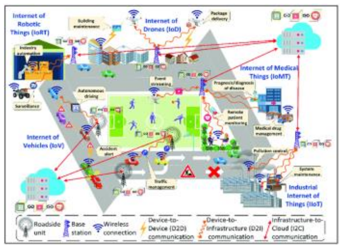
3.1 Renewable Energy Integration

The proposed Green 6G framework utilizes renewable energy sources, such as solar and wind, to power 6G base stations and IoT devices. By deploying energy storage solutions and adaptive energy management protocols, the proposed model reduces dependency on conventional power sources and minimizes carbon emissions [1].

3.2 Energy-Efficient Protocols

Adaptive energy-efficient protocols dynamically optimize data transmission and processing based on real-time network load and environmental conditions. These protocols are essential for reducing the energy consumption of IoT-cloud operations without compromising its performance [1][2].

3.3 AI-Driven Fault Detection and Prediction



Automatic fault detection and prediction are crucial for minimizing disruptions in critical mission environments. The framework integrates AI and machine learning algorithms capable of:

Predicting potential faults based on historical and real-time data.

Automatically diagnosing and resolving issues to prevent service downtime.

This proactive approach reduces the need for manual intervention, enhances system reliability, and minimizes network disruptions, especially in life-critical applications [2][3].

3.4 Ultra-Low Latency Services for Smart City Applications

art cities require ultra-low latency for applications like healthcare monitoring and autonomous traffic management. By deploying green computing, the proposed system ensures that data processing occurs closer to the source, minimizing latency. Key applications include:

Healthcare Monitoring: Real-time patient data analysis for critical conditions, remote diagnostics, and emergency alerts.

Autonomous Traffic Management: Low-latency communication for efficient traffic control, reducing congestion and enhancing safety on city roads [3][4].

3.5 6G-enabled Edge Computing for Industry 5.0

The framework extends the benefits of 6G-enabled edge computing to Industry 5.0 applications, enabling:

Human-Robot Collaboration: Real-time communication between humans and robotic systems for precision manufacturing.

Predictive Maintenance: AI algorithms monitor industrial machinery to anticipate and address faults before they cause downtime.

Sustainable Production: Optimized resource allocation reduces waste and energy usage in manufacturing processes [4][5].

4. METHODOLOGY

4.1 System Design and Architecture

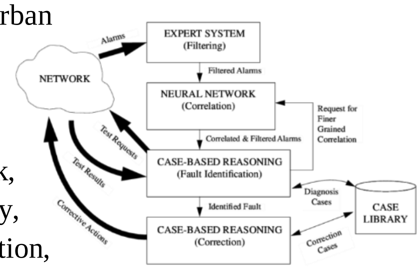
The Green 6G framework is designed around three core components:

1. Renewable Energy Sources: Implementing photovoltaic and wind energy systems to power 6G base stations and IoT devices.

2. AI-Powered Fault Detection: Using AI models trained on historical fault data to predict and address system failures proactively.

3. Edge Nodes: Placing computing resources at network edges to process data locally, reducing latency and the need for centralized data transfer.

4.2 Simulation Environment



A simulated urban environment was created to test the performance of the Green 6G framework, focusing on latency, energy consumption, fault detection accuracy, and response time. Tools such as NS-3 and MATLAB were used to model renewable energy integration and AI-driven fault detection in a 6G network.

4.3 Data Collection and Analysis

Data was collected on energy savings, fault detection rates, and system uptime. AI algorithms were evaluated for prediction accuracy and responsiveness under various operational conditions, such as peak demand and emergency scenarios.

5. RESULTS

5.1 Energy Efficiency

The proposed framework showed a significant reduction in energy consumption by leveraging renewable energy sources and optimized protocols. Renewable energy utilization reached 60-70% in simulated urban areas, significantly lowering carbon emissions [1][3].

5.2 Latency and Service Reliability

Edge computing reduced latency to less than 1 millisecond in critical applications, enabling real-time data transfer and processing. Autonomous driving simulations demonstrated smooth transitions with minimal lag, enhancing traffic safety [2][4].

5.3 Fault Detection and Response

AI-driven fault detection achieved an accuracy of 95%, with average response times under 2 seconds, minimizing downtime and ensuring continuous operation in critical scenarios [2][3].

5.4 Industry 5.0 Applications

Simulations showed that Industry 5.0 applications, including human-robot collaboration and predictive maintenance, benefited from reduced latency and improved fault resilience, enabling smarter, more sustainable factories [3][5].

6. DISCUSSION

The Green 6G framework illustrates a scalable approach for sustainable IoT-cloud operations. By integrating renewable energy and adaptive protocols with Industry 5.0 highlights its transformative potential in industrial environments. The success in simulations of real-time response, fault prediction, and energy efficiency indicates the feasibility of deploying this framework in urban smart city settings.

However, the practical implementation faces challenges, such as the cost of renewable energy infrastructure and the complexities of managing distributed edge nodes. Future research could focus on optimizing the balance between renewable sources and energy storage to ensure consistent power availability [2][3].

7. CONCLUSION

This paper presents a novel approach to create a sustainable and reliable IoT-cloud ecosystem through the Green 6G framework, utilizing renewable energy, energy-efficient protocols, and AI-driven fault management. By integrating Industry 5.0, the framework would also support intelligent, human-centric, and eco-friendly manufacturing processes. By providing low-latency connectivity for critical applications and enhancing reliability, Green 6G supports a sustainable urban environment aligned with smart city goals. This research lays the foundation for future work on scalable, energy-efficient 6G solutions to promote healthier, eco-friendly urban lifestyles.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

IoT-Based Smart Fishery: Revolutionizing Aquaculture Management

[1]Jinat Kaderi, Joydev Jana, K. Sukriti, Koustav Nayak, Rishav Panda, [2]Banibrata Bag

[1]*UG student, Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2]*Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

This paper presents an IoT-enabled smart fishery automation system that employs a combination of ESP32 and Arduino Nano microcontrollers to monitor and manage a fish pond autonomously. The system is designed to feed the fish regularly, monitor water quality, and maintain the pond environment, enhancing fish growth and reducing labor. A line-follower bot, equipped with a food dispenser, navigates the pond along a predefined black tape path controlled by an Arduino Nano. The ESP32 serves as the master control unit, overseeing water parameters such as temperature and levels and managing pumps for draining excess water and supplying oxygen. This implementation leverages real-time data analytics and predictive capabilities to improve productivity, ensure sustainability, and address the challenges faced in traditional aquaculture. Furthermore, the final product is designed to balance functionality and cost-effectiveness, making it both competitive and affordable, ensuring it is accessible to a wide range of families.

KEYWORDS: *Smart Fishery, fishery automation, Water bodies monitoring, IoT, Fish health monitoring*

1. INTRODUCTION

As global seafood demand continues to rise due to an increasing population and changing dietary preferences, implementing IoT-driven solutions will be crucial for ensuring sustainable practices in aquaculture. By embracing these advanced technologies, the fishing industry can contribute to food security while minimizing its ecological footprint, positioning smart fisheries as essential components of a responsible and future-focused seafood supply chain.

The Internet of Things (IoT) is revolutionizing traditional aquaculture, paving the way for a cutting-edge fishery system that significantly enhances the way fish farming is conducted. By incorporating IoT technologies, fish farmers can achieve real-time monitoring of aquatic environments, leading to improved productivity and sustainable practices in fish farming. This paper delves into the comprehensive design and implementation of an IoT-based smart fishery, detailing its numerous advantages. It highlights the integration of automated environmental monitoring systems that continuously track water quality parameters such as temperature, pH levels, and dissolved oxygen, ensuring optimal conditions for fish health. Additionally, it explores intelligent feeding systems that utilize data-driven algorithms to dispense the right amount of feed at the right times, effectively reducing waste and boosting maturation. Furthermore, the paper emphasizes the role of predictive analytics in forecasting potential challenges and making informed decisions, ultimately enhancing operational efficiency. Through these innovations, an IoT-driven approach to aquaculture maximizes yield and promotes ecological sustainability in the fishing industry.

2. Literature Review

Implementing the Internet of Things (IoT) in aquaculture has garnered significant attention in recent years, with various studies showing its potential to address critical challenges in fish farming. Li et al. (2020) demonstrated the effectiveness of IoT-based water quality monitoring systems in maintaining optimal

*Corresponding Address: banibrata.ecehit@gmail.com

DOI: 10.5281/zenodo.14591595

environmental conditions for aquaculture [1]. Their study emphasized the importance of monitoring dissolved oxygen, pH, and ammonia levels using various sensors integrated with IoT platforms to provide real-time alerts and analytics. Ahmed et al. (2019) explored the integration of LoRaWAN in remote fish farms, ensuring reliable data transmission even in areas with limited connectivity [2]. Additionally, Sharma and Gupta (2021) highlighted the role of AI-driven feeding mechanisms in minimizing feed wastage [3]. Their system utilized underwater cameras and machine learning algorithms to analyze fish behavior, allowing for adjustments in feeding schedules. Zainuddin et al. (2018) conducted a comparative analysis between automated feeders and manual feeding methods, revealing a 20% improvement in feed efficiency with IoT-enabled systems [4]. Zhou et al. (2022) implemented computer vision-based fish health monitoring using IoT cameras, achieving early detection of common fish diseases and reducing mortality rates by 30% [5]. Kumar et al. (2020) focused on using predictive analytics to forecast potential disease outbreaks, leveraging historical data and AI for risk assessment. Singh et al. (2019) introduced a line-following robot equipped with environmental sensors for routine maintenance tasks on aquaculture farms, simplifying remote monitoring and control through its integration with IoT platforms [6]. Furthermore, a review by Patel and Rao (2021) and Singh A. et al. (2019) have discussed the scalability of self-sufficient robotic systems, highlighting their cost-effectiveness and efficiency [7, 8]. These studies collectively underscore the potential of IoT in aquaculture, paving the way for more innovative and sustainable fishing systems.

System Design and Components

An Internet of Things (IoT)-based smart fishery operates through three essential components:

A. **ESP32 (Master Controller)**:

- Receives user input for the feeding schedule and various parameters.
- Monitors sensors for water temperature and level.
- Controls two pumps through a relay module.

B. **Sensors and Actuators**:

These devices monitor critical parameters, including temperature, pH levels, dissolved oxygen, and ammonia concentrations, ensuring optimal conditions for aquatic life.

- Temperature Sensor (e.g., DS18B20) for water temperature.
- Ultrasonic Sensor to measure water level.
- Water Drain Pump to remove excess water.
- Oxygen Pump to maintain oxygen levels.
- Servo Motor on the bot to control food dispensing.

Automated Feeding Mechanisms:

Feeder systems are intelligently controlled based on fish activity levels and real-time water quality data, optimizing feeding efficiency.

Line Follower Bot:

- Follows a black tape path around the pond.
- Dispenses food via servo motor at specific intervals.

Underwater Imaging Systems:

High-resolution cameras facilitate observing fish behavior, enabling the detection of early stress or disease indicators.

C. **Connectivity: Wireless Communication Protocols**

The system utilizes protocols such as Wi-Fi, ZigBee, or LoRaWAN for efficient data transmission among devices.

Cloud Integration: The data collected is securely stored and processed in the cloud, allowing remote access to facilitate analysis and informed decision-making.

Data Processing and Analytics: Advanced artificial intelligence (AI) and machine learning algorithms are employed for predictive analytics, particularly in anticipating disease outbreaks within fish populations. The system generates actionable insights and real-time alerts based on analyzed data, supporting dynamic management strategies.

Functional Modules:

Environmental Monitoring: Continuous tracking of water quality parameters ensures that conditions remain within optimal thresholds for fish health. The system can send alerts for any critical deviations in these parameters, thus mitigating mortality risk.

Smart Feeding Systems: The application of AI in developing feeding schedules reduces feed wastage while promoting optimal growth rates. Sensor integration aligns feeding behavior with water quality conditions and fish activity. **Disease Detection**: By leveraging underwater imaging and AI-based diagnostic models, the system identifies anomalies in fish movement and physical appearance. This capability facilitates early intervention, minimizing financial losses and preventing disease outbreaks.

Line-Follower Robot for Maintenance and Surveillance:

Autonomous robotic units equipped with line-following technology navigate predetermined pathways within aquaculture environments. These robots, integrated with IoT capabilities, efficiently collect environmental data and execute essential maintenance tasks.

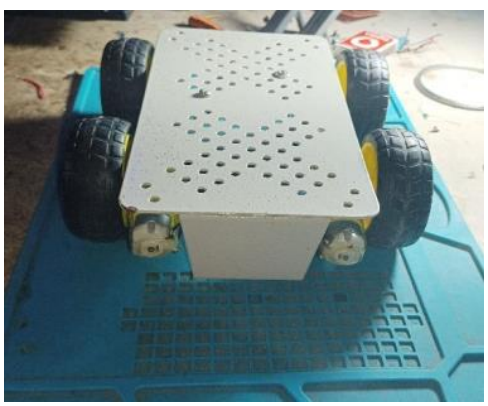

Fig.1. Line-Follower Robot designed for the proposed system.

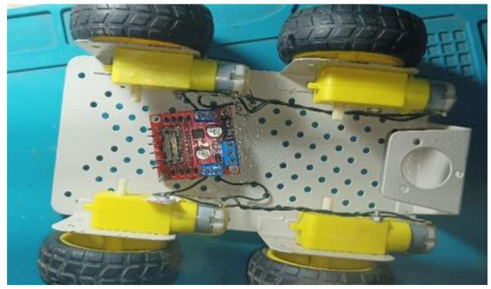

Fig.2. Circuitry of the Line-Follower Robot designed for the proposed system.

3. Algorithm and Pseudo-code

***Master Control Algorithm*:**

Step 1*: Initialize Wi-Fi, sensors, and relay outputs.*
Step 2*: Start an infinite loop:*

- *Read water temperature and water level.*
- *If the temperature or water level exceeds the set thresholds, activate the corresponding pump.*
- *If feeding time appears, send a signal to the Arduino Nano to start feeding.*
- *Send real-time data to the IoT dashboard.*

Arduino Nano - Bot Controller Algorithm*:*

Step 1*: Initialize IR sensors, motor drivers, and servo.*
Step 2*: Start an infinite loop:*

- *Wait for the feeding command from ESP32.*
- *Start moving along the black line using IR sensors.*
- *At each predefined stop, activate the servo to release food.*
- *Stop once the feeding cycle is complete.*

Pseudo-code:

```
Initialize sensors and motors
While True:
    Read left, center, and right sensor values
    If the center sensor detects the line:
        Move forward
    Else If the left sensor detects the line:
        Turn left
```

Else If the right sensor detects the line:
Turn right
Else:
Stop
Send environmental data to the cloud

4. Conclusion

Integrating sensors, data analytics, and connectivity allows fishery operators to monitor water quality, fish health, and environmental conditions in real-time. The system significantly enhances Productivity by optimizing conditions and feeding schedules, boosting fish growth and yield. Reducing feed wastage and energy consumption lowers operational costs. Moreover, using resources efficiently minimizes environmental impact. Smart fisheries utilize predictive analytics to optimize feeding schedules, reduce waste, and improve stock management, leading to healthier fish populations and higher yields. However, the initial costs can be high, hindering small-scale farmers' adoption. Remote fish farms might face challenges with stable internet access. Therefore, developing scalable and modular systems is crucial for broader adoption. Insights gained from analytics enhance long-term management strategies. The functionality and cost-effectiveness of this solution make it accessible and appealing to a wide range of farmers.

Finally, there is a crucial need for further research into the long-term use and maintenance of smart fishery and aquaculture. Understanding the durability and reliability of these systems over time is essential, along with the resources and necessary support for their sustenance.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

RFID BASED SMART PARKING SYSTEM

[1]Pinaki Satpathy, [2]Sumit Ranjan, [3]Sonu Kumar Roy

[1]Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2,3]UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The main objective is to avoid the cramming in the car parking area by implementing an efficient car parking system along with a user-friendly application for an ease of use. Normally at public places such as multiplex theatres, market areas, hospitals, function-halls, offices and shopping malls, one experiences the discomfort in looking out for vacant parking lot, though it's a paid facility with an attendant/security guard. The parking management system is proposed to demonstrate hazel free parking. The proposed system uses infrared transmitter-receiver pairs that remotely communicate the status of parking occupancy to the raspberry pi and displays the vacant slots on the display at the entrance of the parking so that the user gets to know the availability /unavailability of parking space prior to his/her entry into the parking place. Implementation involves minimal human interaction and provides a seamless parking experience thereby reducing a lot of time wasted by the user in parking his/her vehicle.

The RFID Park System is an innovative solution designed to enhance the efficiency and convenience of parking management. The system utilizes Radio Frequency Identification (RFID) technology to automate various parking processes, including vehicle entry, exit, and payment. By integrating RFID tags and readers, the system eliminates the need for manual ticketing and reduces the time spent on parking transactions.

In the RFID Park System, each vehicle is equipped with an RFID tag containing unique identification information. As a vehicle approaches the parking entrance, the RFID reader detects the tag and grants access automatically, eliminating the need for physical tickets or access cards. The system also records the entry time for each vehicle, providing accurate data for parking duration calculation.

Overall, the RFID Park System revolutionizes parking management by streamlining the entry, exit, and payment processes through RFID technology. Its automation and accuracy enhance user experience, optimize parking operations, and pave the way for smarter and more efficient parking solutions in the future.

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KEYWORDS: RFID, Sensors, Pi, Slots, ARDUINO.

1. INTRODUCTION

Car parking is a major issue in many public locations these days, including malls, multiplex systems, hospitals, workplaces, and market areas. There are numerous parking lanes and slots in the [1–3] region. Therefore, one must search for every lane in order to park a car. Additionally, this requires a significant amount of investment and manual effort. Therefore, an automatic parking system that shows the availability of open parking spaces in any lane at the entry is required. A display outside the vehicle parking gate and an infrared transmitter-receiver pair in each lane are part of the system. Therefore, the person who wants to park his car is aware of the current parking slot availability. Security personnel keep an eye on the parking lots in conventional parking systems, which lack an automated monitoring system. Searching for a

*Corresponding Address: pinakihit.sat@gmail.com

DOI: 10.5281/zenodo.14591640

parking space takes a lot of time and frequently results in traffic bottlenecks. When there are several parking lanes and several parking spaces in each lane, the situation gets worse. With more comfort, using a parking management system would save time and human labor. The display unit in the suggested system helps the user choose where to park their automobile by providing a visual representation of the parking lot, including both occupied and empty spaces. In addition to saving time, the system's hardware and software would control the cars' check-in and check-out processes using RFID tags and scanners. It would also have extra capabilities like automatic billing and entry-exit data tracking. Following a one-time registration process, customers are requested to provide personal information and an account is created for them. This account contains information about them and money that they may use to recharge at nearby kiosks. This system uses video displays at the parking floor entry to direct people to the available parking space. The displays visually depict the parking lot with empty and occupied slots which are green and red respectively. After registering, the user is given a tag that employs Radio Frequency Identification (RFID) technology and is installed on top of his windshield. This tag contains his personal information and is connected to his prepaid account. Depending on how long the user spends in the parking lot, the parking fees are automatically taken out of their account. The RFID Smart Parking System revolutionizes traditional parking methods by utilizing Radio Frequency Identification (RFID) technology. This innovative system provides a seamless parking experience by automating entry and exit processes. Vehicles are equipped with RFID tags that communicate with sensors installed at parking entrances and exits. As a vehicle approaches, the RFID tag is detected, allowing for swift access to the parking facility. The system also enables real-time monitoring of parking occupancy, ensuring efficient space utilization. With its ability to streamline parking operations, enhance security, and optimize parking management, the RFID Smart Parking System offers a modern solution to address the growing demands of urban mobility.

2. HOW DOES RFID WORK IN SMART PARKING?

RFID (Radio Frequency Identification) smart parking systems are designed to automate and streamline the parking process. These systems utilize RFID technology to enable efficient management of parking spaces and provide convenience for both parking operators and users.

The system consists of three main components: RFID tags, RFID readers, and a central management system. Each vehicle is equipped with an RFID tag, which contains unique identification information. The RFID readers are installed at entry and exit points of the parking lot, as well as at individual parking spaces. These readers communicate wirelessly with the RFID tags to identify and track vehicles.

When a vehicle approaches the entry point, the RFID reader scans the RFID tag on the vehicle and transmits the information to the central management system. The system then checks the availability of parking spaces and determines whether the vehicle is authorized to enter. If there is an available parking spot and the vehicle is authorized, the system automatically opens the gate for entry.

Once inside the parking lot, the RFID reader at each parking space detects the presence of a vehicle and updates the central management system accordingly. This real-time information allows the system to accurately monitor the occupancy status of each parking space.

When a vehicle exits the parking lot, the RFID reader at the exit point scans the RFID tag again and communicates the information to the central management system. The system updates the availability of the parking space, and if necessary, calculates the parking fee based on the duration of the stay.

The central management system plays a vital role in the RFID smart parking system. It collects and processes data from the RFID readers, maintains the parking database, and provides real-time information to parking operators and users. This system can generate reports, monitor parking occupancy, and enable online booking and payment options for users.

Overall, RFID smart parking systems leverage RFID technology to automate parking processes, improve efficiency, and enhance the overall parking experience for both operators and users. By accurately tracking vehicle movements and occupancy, these systems optimize parking space utilization and reduce congestion, leading to a smoother parking operation. for business prosecution, prediction and prevention has already established itself as an emergent avenue to envisage the business spectrum.

3. MOTIVATION

People have to wait a long time to park their automobiles in malls, multiplex systems, hospitals, offices, and supermarkets, which is the primary reason for creating car parking systems. It takes a long time to discover an empty parking space under the current system, and using the traditional payment method takes a long time to finish the transaction. In addition to helping users park more quickly and efficiently, the automated system uses RFID to automate the payment gateway, saving the user a significant amount of time. RFID (Radio Frequency Identification) smart parking systems provide a solution to the increasing challenges faced by traditional parking management. This technology-driven approach offers numerous benefits and serves as a significant motivation for its implementation.

Firstly, an RFID smart parking system improves efficiency and convenience. It eliminates the need for manual ticketing and searching for available parking spaces, streamlining the entire process. With RFID tags attached to vehicles and readers installed at entry and exit points, the system automatically identifies and records vehicle information, allowing for seamless entry and exit without any human intervention. This not only saves time but also reduces congestion and improves traffic flow within parking facilities.

Secondly, RFID smart parking systems enhance security. Traditional parking systems often involve the risk of theft or unauthorized access. With RFID technology, each vehicle is uniquely identified, and any attempt at theft or unauthorized entry triggers an alert. This deters potential criminals and provides a safer parking environment for users.

Furthermore, RFID smart parking systems offer effective data management and analysis capabilities. The system collects and stores data on vehicle movements, occupancy rates, and parking duration, providing valuable insights for parking facility operators. This information can be utilized to optimize parking space allocation, identify patterns and trends, and make informed decisions regarding pricing, staffing, and infrastructure improvements.

Additionally, RFID smart parking systems support environmental sustainability efforts. By reducing the time spent searching for parking spaces, vehicles consume less fuel and emit fewer greenhouse gases. The optimized utilization of parking spaces also helps minimize the need for constructing additional parking facilities, thus reducing land consumption and preserving green spaces.

In conclusion, the motivation behind implementing RFID smart parking systems lies in their ability to enhance efficiency, convenience, security, data management, and environmental sustainability. These benefits make them an attractive solution for addressing the challenges faced by traditional parking management systems, ultimately improving the overall parking experience forusers.

4. CIRCUIT DIAGRAM AND FLOWCHART

The circuit mainly comprised of Arduino and RC module 522 and passive tags. We make connection using the jumper wires. We have also used buzzer to inform the authorities about the incoming vehicle. Led are used to signify the operation of door. The servo motor will be used to control the opening and closing of gate. RC module are connected to all the sensors and it give the instruction to the sensors to sense the environment after that it display the current status of vehicle on the the display board.

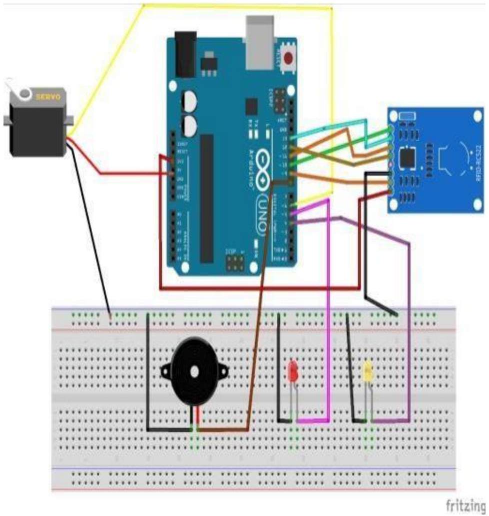

Fig 1. Circuit Diagram

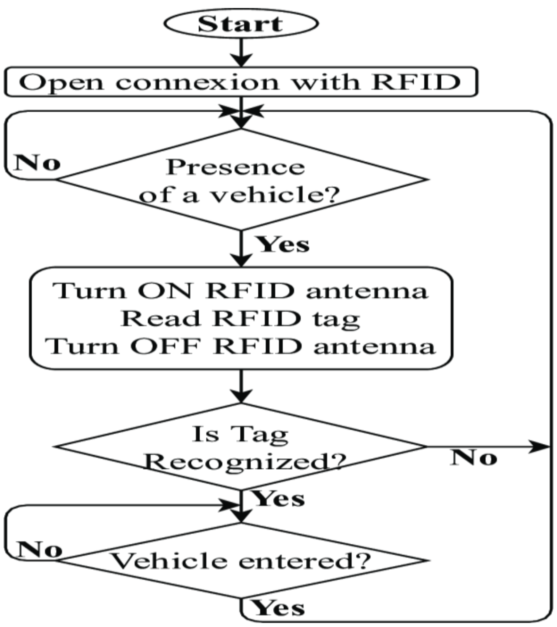

Fig 2. Flow Chart

This is basically flow of and execution of programming part of our project. It is pictorical representation of our model and how we can achive it in real life. We can conclude that this is logically the low level system design (LLD) of our project.

5. CONCLUSION

RFID technology offers autonomous, continuous access control, parking, and security solutions. Only approved vehicles can enter thanks to this technology, which gives communities and companies hands-free control. One of the few real-time locating systems with a quick return on investment (ROI) is the RFID park lot management system. The system improved parking lot use and helped users spend less time searching for parking spaces.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 63-67 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

BIOMETRIC ATTENDANCE SYSTEM OVER IOT

[1]Asim Kuilya, [2]Sneha Chourasia, [2]Sneha Singh, [2]Sreya Rani Dey, [2]Tarun Kumar Pathak, [2]Shubham Ranjan, [2]Suraj Kumar, [2]Yash Raj, [2]Satyam Kumar, [2]Vikash Kumar, [2]Shashank Kumar

[1]*Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2,]*UG student, Dept. of Electronics and Communication Engineering Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

In this paper, The development of an IoT-based attendance tracker utilizing a fingerprint sensor represents a significant advancement in automating attendance management. By integrating biometric authentication with IoT technology, the system ensures accuracy, efficiency, and real-time monitoring of attendance records. This eliminates common issues like proxy attendance and errors in manual record-keeping. Furthermore, IoT technology is revolutionizing the way devices communicate and interact with each other. It offers a seamless, interconnected ecosystem that allows for greater automation, real-time data collection, and remote access. The implementation of IoT in this project highlights its potential to enhance operational efficiency, security, and scalability in various industries. This project not only streamlines attendance tracking but also showcases how IoT can be leveraged to create smarter, more interconnected systems for everyday tasks. In summary, integrating biometric systems with IOT technology transforms attendance management into a smart, efficient, and secure process, facilitating better workforce management while ensuring data integrity and accessibility across different platforms.

KEYWORDS: *IoT, Biometric, Attendance System*

1. INTRODUCTION

An IOT-based biometric attendance system offers an automated, secure, and efficient alternative by using biometric data (fingerprints, facial recognition, etc.) to monitor attendance in real-time and sync it to cloud-based databases via IOT networks. This report explores the key components, design, and functioning of an IOT˘based biometric attendance system, along with its benefits, challenges, and applications.

What is a Biometric Attendance System?

A biometric attendance system uses physiological or behavioral traits such as fingerprints, facial recognition, iris scans, or voice recognition to identify individuals uniquely. Unlike traditional attendance methods (e.g., using ID cards or passwords), biometric systems offer higher security and convenience, reducing the risk of fraud or unauthorized access.

2. SYSTEM OVERVIEW

The IOT-based biometric attendance system is designed to:

- **Capture biometric data** (fingerprint) from employees or students. Each time a user places their finger on the scanner, the system digitizes this unique pattern and uses it to verify identity
  - **Transmit the data** through IOT connectivity to a central server in real

*Corresponding Address: asim.kuilya@gmail.com

DOI: 10.5281/zenodo.14591687

time. This instantaneous data flow removes delays associated with manual systems and ensures **timely updates** for tracking attendance

- **Provide instant feedback** and enable remote monitoring. This feedback can be in the form of visual signals (such as a green light or screen notification) or auditory alerts, ensuring that users know their attendance has been recorded accurately.
- By combining the power of **biometric sensors** and **IOT communication** protocols, the system ensures accurate and reliable attendance tracking.

3. SYSTEM ARCHITECTURE

The architecture of an IOT-based biometric attendance system can be broken down into four main steps:

- **Biometric Registration**: In the first step, users such as employees or students register their biometric data, typically fingerprints, into the system. This data is captured by a biometric sensor and stored in a secure database. The registration process ensures that the system has unique and accurate biometric templates for each individual. These templates are later used to verify the user's identity during attendance tracking..

Attendance Capture: When a registered user enters or exits the facility, their fingerprint is scanned by the biometric sensor. The system captures the fingerprint and compares it with the stored templates in real time. This automated process ensures that attendance is logged only for authenticated users, eliminating the possibility of fraud or errors. The captured data is then prepared for processing by the IoT microcontroller.

Data Processing: The IoT microcontroller, such as arduino nano receives the biometric input from the sensor and converts it into digital data. This digital data is then processed and analyzed to match the scanned fingerprint with the stored templates. The microcontroller plays a key role in transmitting the processed data securely to the central server or cloud for further actions, such as attendance logging and reporting.

Data Result: The result is displays the attendance result on the LED screen, showing whether the fingerprint was successfully matched or not.

4. APPLICATIONS OF THIS MODEL

The IoT-based biometric attendance system is a versatile solution designed to cater to various sectors by offering reliable, accurate, and automated attendance tracking. By integrating biometric technology with the power of IoT, organizations in diverse fields can streamline their attendance management processes, ensure data accuracy, and improve overall operational efficiency. Below are some key applications of this system across various sectors:

- **Corporate Offices: Streamlining Employee Attendance and Tracking Work Hours Efficiently**

In corporate settings, the IoT-based biometric attendance system automates employee attendance tracking, ensuring accurate records of work hours. It eliminates manual methods and prevents buddy punching by verifying employees through unique biometric identifiers like fingerprints or facial recognition. The system integrates seamlessly with HR and payroll software to automate the calculation of work hours, overtime, and leave. This enhances operational efficiency and provides transparency in employee management. Real-time data availability ensures that supervisors can monitor attendance from any location.

- **Educational Institutions: Managing Student Attendance and Integrating It with Academic Monitoring Systems**

In schools and universities, the system simplifies attendance tracking by allowing students to log attendance through biometric scans, which are updated in real-time. The data integrates with academic systems to monitor student participation and engagement. Teachers and administrators can generate detailed reports on student attendance, providing insights into overall performance. It also enables automatic alerts to parents or guardians for low attendance, fostering accountability. This helps streamline administrative tasks and supports more focused academic monitoring.

- **Healthcare Facilities: Tracking the Working Hours of Medical Staff to Ensure Optimal Coverage**

In healthcare settings, tracking the attendance and shifts of medical staff is critical for ensuring continuous patient care. The biometric system automatically logs attendance and links it with shift management, ensuring that staff coverage is always optimized. Real-time data allows for immediate adjustments in case of emergencies or staff shortages, improving operational flexibility. The system also supports compliance with labor laws regarding working hours and rest periods, providing an essential tool for HR in managing staff schedules. By ensuring proper coverage, it enhances the overall efficiency of healthcare delivery.

- **Construction Sites: Managing Labor Shifts and Tracking Attendance at Remote Work Sites**

For construction sites, the system enables attendance tracking across remote or temporary work sites, providing real-time data on labor shifts. Portable biometric scanners connected via IoT devices allow workers to log their shifts accurately from any location. This helps project managers monitor workforce deployment and productivity effectively. The system ensures accurate wage calculation based on real hours worked, reducing errors and disputes. Additionally, it enables efficient workforce management, ensuring the right number of workers are present at the right time.

- **Government Institutions: Ensuring Transparency and Security in the Attendance Management of Government Personnel**

Government institutions use the IoT-based biometric attendance system to ensure transparency and security in managing employee attendance. Biometric verification eliminates unauthorized access and maintains an accurate record of personnel presence. Real-time updates provide transparency, enabling administrators to track attendance and punctuality across departments. This data can also be used for auditing and ensuring compliance with government regulations. The system improves accountability and streamlines processes, ensuring efficient personnel management in high-security environments.

5. CHALLENGES

While the system efficiently captures and transmits attendance data in real-time, it does not support direct storage in widely-used platforms like Google Sheets due to various reasons:

- **Integration Issues**: The system does not have built-in APIs or connectors to directly sync attendance data with Google Sheets. This makes it difficult to store and access attendance records in a user-friendly format for organizations accustomed to working with Google's cloud-based platform.
- **Security and Privacy Concerns**: Google Sheets is a general-purpose platform and may not offer the level of data encryption and security required for sensitive biometric data. Organizations handling biometric information must comply with strict data protection laws, such as GDPR, which may restrict the use of platforms like Google Sheets for sensitive data storage.
- **Storage and Scaling Limitations**: While Google Sheets is effective for managing simple data, it may not be suitable for handling large volumes of biometric data. As the number of employees or users grows, Google Sheets can become inefficient, leading to data lag, slow access, or even corruption.
- **Offline Data Storage Challenges**: IoT-based systems typically rely on constant connectivity for data synchronization, and if Google Sheets is used as a storage solution, disruptions in internet connectivity may prevent real-time updates. The system may require a more robust cloud storage solution

specifically designed for handling intermittent network issues.

- **Data Formatting and Compatibility**: Biometric data often includes complex records (e.g., image or encrypted data points), which may not fit easily into the traditional row-column structure of Google Sheets. The system would require additional processing steps or converters to make the data compatible with Google's format, increasing the complexity of the system.

6. CONCLUSION

The integration of **biometric authentication** with **Internet of Things (IoT)** technology for **attendance management systems** offers a promising and efficient solution to address the growing challenges in educational institutions, workplaces, and other sectors. By leveraging IoT's real-time data transmission capabilities and the uniqueness of biometric identifiers such as fingerprints, facial recognition, and iris scans, these systems provide a secure, automated, and scalable method of tracking attendance.

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IoT Based Irrigation Monitoring And Controller System

[1]Tapan Maity,[2]Ayush Raj,[2]DipakKumarSaha, [2]AbhishekRaj, [2]ChandanKumar,[2]Anand Kumar, [2]MubashshirMohiuddin, [2]AbhishekKumar,[2]AnkeshKumar,[2]Ayush Raj,[2]AnuragYadav

[1]Department of Electronics and CommunicationEngineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2,]UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The Internet of Things (IoT) has revolutionized agriculture by enabling smarter, more efficient farming practices. This paper presents an IoT-based irrigation monitoring and control system designed to optimize water usage and improve crop productivity. The system integrates sensors to monitor soil moisture, temperature, and humidity in realtime, providing accurate environmental data. A microcontroller processes the sensor data and communicates with a cloud-based platform, allowing remote access and control web interface. The system automatically regulates water supply based on preset thresholds or user-defined parameters, ensuring precise irrigation. By reducing water wastage and promoting sustainable agricultural practices, this IoT solution addresses challenges related to water scarcity and inefficient irrigation. The proposed system is cost-effective, easy to deploy, and scalable, making it suitable for various agricultural fields.

KEYWORDS:IOT, Irrigation system, NodeMcuESP8266, DTH 11, Moisture sensor

1. INTRODUCTION

In recent years, agriculture has evolved to leverage technology for enhanced efficiency and productivity. The Internet of Things (IoT) has emerged as a key player in this transformation, enabling smarter agricultural practices through real-time data monitoring and automation. The Internet of Things (IoT) refers to a network of physical objects integrated with embedded electronics, enabling communication and interaction with each other and their surroundings. In the near future, IoT technology is expected to revolutionize daily life by providing advanced services and transforming how individuals carry out routine activities. IoT encompasses a system of interconnected entities—ranging from computing devices and mechanical or digital machines to objects, animals, or humans—all identifiable through unique identifiers.

The primary contributions of this research include the development of a real-time IoT-enabled smart device for agricultural fields. This device is designed to monitor and evaluate soil health and environmental conditions, facilitating better crop management.

The remainder of the paper is structured as follows. Section 2 discusses the related existing works. A block diagram of smart farming is given in Section 3. The circuit diagram of smart farming is presented in Section 4. The result analysis is presented in Section 5. The paper is concluded in Section 6

2. RELATED WORKS

This section provides a brief overview of various existing works related to the topic. A wireless sensor network (WSN) using the AgriSens architecture includes components such as a water-level sensor, sensor nodes, a remote server, and an IoT gateway [1]. The adoption of WSNs is expected to address system-level

*Corresponding Address: tapan16maity@gmail.com

DOI: 10.5281/zenodo.14591736

challenges and meet end-user requirements for efficient agricultural monitoring. Comparing different WSN topologies is challenging due to the unique scenarios and specific applications of each topology [2]. The FarmFox architecture, a WSN-based conceptual model, is highlighted in [3]. It is noted for being cost-effective, user-friendly, versatile, energy-efficient, reliable, and durable. Additionally, a low-cost agro-climatic monitoring system leveraging IoT is discussed in [4]. This system consists of multiple stations located both inside and outside greenhouses, connected to an IoT platform via WSNs. Each station is equipped with various sensors to monitor parameters such as humidity, temperature, soil moisture, wind speed and direction, precipitation, pH levels, and radiation [4]. IoT technologies have also been applied in precision farming, as seen with AgriTalk, which significantly improved the quality of turmeric cultivation [5]. Another example is FarmBeats, a low-cost and accessible IoT platform for agriculture, which utilizes TV White Spaces (TVWS) for long-range communication and supports high-bandwidth sensors [6]. FarmBeats integrates an intelligent gateway and a weather-aware base station to ensure uninterrupted service, whether online or offline. Additionally, innovative path-planning algorithms have been developed to enhance the battery life of drones in agricultural applications [6].

3. BLOCK DIAGRAM OF SMART FARMING

This section outlines the design of the farming system and provides detailed descriptions of all the sensors used. The key principles guiding the development of these nodes include cost-effectiveness, energy efficiency, reliability, and durability. Three sensors have been recalibrated and integrated into the system to measure soil moisture, temperature, and humidity. The soil moisture sensors are specifically designed to monitor the volumetric water content of the soil. A detailed representation of the deployed system is illustrated in Figure 1, showcasing the block diagram of the setup.

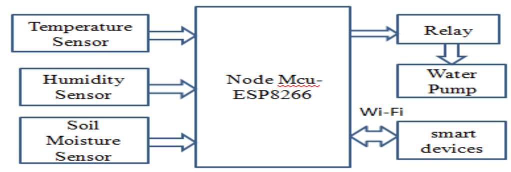

Fig. 1: Block Diagram of Smart Farming

The fundamental aspects of the various components are summarized in the following subsections.

Node Mcu ESP8266

Figure 2 illustrates the pin diagram of the NodeMCU ESP8266. NodeMCU is a low-cost, open-source IoT platform. Being open-source, its hardware design is available for editing, modification, and customization. It features firmware that operates on the ESP8266 Wi-Fi System-on-Chip (SoC) developed by Espressif Systems, with hardware based on the ESP-12 module. The firmware is programmed using the Lua scripting language.

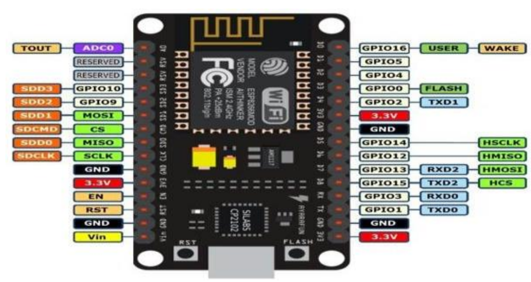

Figure 2: Node MCU ESP8266

Soil Moisture Sensor Module

Figure 3 depicts a Soil Moisture Sensor, a cost-effective electronic device designed to measure soil moisture levels. This sensor determines the volumetric water content within the soil. It is primarily composed of two main components: sensing probes and a sensor module.

The sensing probes enable current to flow through the soil, measuring resistance, which varies based on the soil's moisture content. The sensor module processes the data received from the probes and converts it into either a digital or analog output. As a result, the Soil Moisture Sensor provides dual output options: Digital Output (DO) and Analog Output (AO)

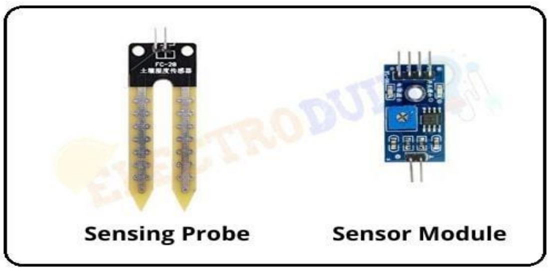

Figure 3: Soil Moisture Sensor Module

Temperature Humidity Sensor(DHT11)

Figure 4 provides the DTH11 Sensor. A humidity sensor (also known as a hygrometer) is an electronic device used to measure the amount of moisture or water vapor present in the air. It typically provides an output that indicates the relative humidity (RH), which is the percentage of moisture in the air relative to the maximum amount the air can hold at a given temperature.

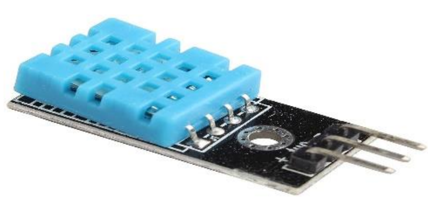

Figure 4: DTH11 Sensor

SOFTWARE USED

Blynk:

Blynk is an IoT platform designed to control hardware remotely, display sensor data, and create automation projects. It provides a user-friendly mobile app where users can monitor and control their projects in real-time. Blynk works with a wide variety of hardware, including Node MCU (ESP8266) used in this project. Key features of Blynk in this smart irrigation

project include: - Virtual Pins: Blynk allows the mapping of sensor data (humidity, temperature, soil moisture, and rain status) to virtual pins, making it easy to visualize these

parameters in the mobile app. - Cloud Connectivity: It connects the Node MCU to the internet, allowing real-time monitoring and control of the irrigation system from anywhere.

Automation and Alerts: Blynk can automate tasks such as turning the motor on/off based on conditions (e.g., soil

moisture level and rain detection). Additionally, Blynk can send notifications or emails when certain thresholds are met.

Arduino IDE:

The Arduino IDE is a widely used development

Environment for programming microcontrollers like the Node MCU. It allows developers to write, compile, and upload code to microcontroller boards. Features of the Arduino IDE in this project include: - Code Development: The Arduino IDE

provides an easy platform to write and modify the C/C++ code controlling the sensors and actuators in the irrigation system.

Libraries: In this project, libraries like

`BlynkSimpleEsp8266.h` and `DHT.h` are used, allowing integration with the Blynk platform and DHT11 sensor.

4. CIRCUIT DIAGRAM OF SMART FARMING:

The NodeMCU ESP8266 microcontroller has been utilized in this project. It enables the implementation of active sleep mode for the sensor nodes, ensuring energy efficiency. The NodeMCU ESP8266 is also a cost-effective option compared to other commercial alternatives. Figure 5 illustrates the circuit diagram of the proposed Smart Farming device, showcasing the connections between various node components and the processor.

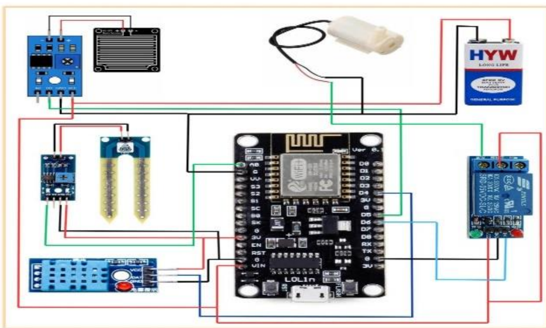

Fig. 5: Circuit Diagram of proposed Smart Farming

5. RESULT ANALYSIS :

This section presents a detailed discussion of the results obtained from the experimental setup. The snapshots included are directly captured from the implemented project.

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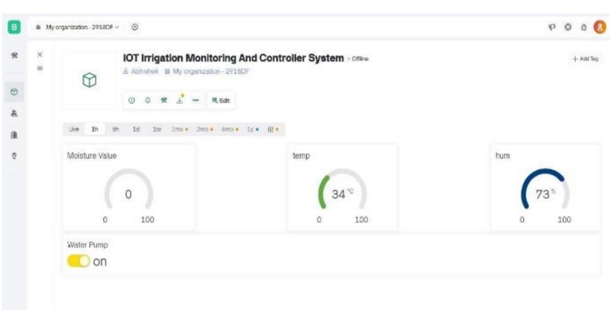

Fig. 6: Visualization of sensed data displayed on user Web application

We have collected all the data from a certain place on our campus for ten days. All the observations are shown in Table 1.

Table 1: Data collected from various sensors

Sl. No.	Time (Day)	Moisture (%)	Temperature (0C)	Humidity (%)
1	Day1	69.89	31.0	75
2	Day2	68.59	30.2	74
3	Day3	66.96	30.1	75
4	Day4	48.27	31.6	75
5	Day5	36.27	31.8	76
6	Day6	05.87	30.1	75
7	Day7	06.70	31.9	77
8	Day8	06.36	31.0	75
9	Day9	36.17	31.8	74
10	Day10	00.00	34.0	73

6. CONCLUSION:

The IoT-based irrigation monitoring and controller system demonstrates significant potential for improving agricultural productivity and resource efficiency. By integrating sensors, IoT devices, and real-time data analytics, the system automates irrigation processes, ensuring optimal water distribution based on soil moisture levels, weather conditions, and crop requirements. This approach not only reduces water wastage but also minimizes manual intervention, enhancing convenience for farmers.Moreover, the system fosters sustainability by conserving water and reducing energy consumption, contributing to environmentally responsible farming practices. It provides farmers with actionable insights through user-friendly dashboards or mobile applications, empowering data-driven decision-making.In conclusion, the implementation of IoT in irrigation systems represents a transformative step towards smart agriculture, offering economic, environmental, and operational benefits. Future advancements in IoT technology and integration with AI could further enhance the system's capabilities, paving the way for a more efficient and sustainable agricultural industry.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Design and Web Framework of Secure Electronic Voting System

[1]Samim Bari, [1]Ashhad Raza, [1]Ravi Kumar, [1]Suraj Kumar Gupta, [1]Susmit Kumar Shaw, [1]Wasibul Hossain, [1]Jagannath Samanta, [2]Soumya Mukherjee

[1]*Dept. of Electronics & Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2]*Dept. of CSE-Data Science, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

In this day and age, the internet has made practically every aspect of our lives easier, from online banking to online banking, online food ordering, online shopping, digital credential acquisition, minor medical consultations, bill paying, etc. Time-consuming issues like traveling to the polling station and waiting in a long line to cast a ballot have persisted, and because there was no online voting system, it was difficult for the government to encourage the public to take part in the election process. However, the internet and software engineers deserve all the credit for making it possible for everyone to vote for the candidate of their choice with unprecedented simplicity in the near future. The obligation of creating simple, user-friendly software for the same aim presents additional difficulty for software engineers. Because PHP is a straightforward, sophisticated, and potent software development tool, it may be used to accomplish this purpose quite successfully. Designed to create dynamic websites and applications, PHP is a general-purpose server-side scripting language that is executed by a web server. PHP is a secure, quick, and dependable web development alternative that provides many additional benefits to make it widely available.

KEYWORDS: *e-polling, PHP, MySQL, XAMPP*

1. INTRODUCTION

The development of a democratic society depends heavily on electronic voting [1]. The current voting method requires people to visit polling places in order to cast their ballot. Either new polling stations are built or only a few public spaces are used. Both voters and the election commission would save a great deal of time if electronic voting were used. Fully effective online voting with common household gadgets is what an ideal voting application should enable [2-5]. Voter count can be done anonymously and automatically. Due to its reliance on the internet, e-voting systems present new risks and difficulties while also resolving issues with existing voting methods. The "e-POLLING APP" is a Web application for online voting. Voters of any gender who are Indian citizens and above the age of eighteen can use this app to cast their ballots online without having to visit a polling place. All of the voter names and complete information are kept in a database that is kept up to date. Voters can easily exercise their right to vote online with the "e-POLLING APP." To cast a ballot, they must first register. For security purposes, the system administrator primarily completes registration. All the system administrator has to do is fill out a registration form to register voters on a specific website that they visit. It is anticipated that those who wish to register will get in touch with the system administrator and provide their information. The citizen is then registered to vote once the system

*Corresponding Address: jagannath19060@gmail.com

DOI: 10.5281/zenodo.14591852

administrator has verified that they are indeed citizens of India by matching the information they have provided with records already in place, such as those kept by the Registrar of Persons. The voter receives a private voter ID upon registration, which they can use to access the system and take advantage of its features, including voting. The citizen is not registered to vote if they submit inaccurate or invalid information [7-9]. The primary goals of e-Voting are to:

• Provide voters with better voting services by enabling quick, easy, and convenient voting;

• Lower the expenses incurred by the ECI during voting hours in order to pay numerous clerks hired to ensure the success of the manual system; and

• Verify that only registered members are casting ballots. Additionally, there are less instances of "Dead People" voting.

To create an efficient election administration system, an e-POLLING APP will need to be extremely accurate or cost-effective. For this reason, the following are important features that this e-POLLING APP highlights.
• Reduce the number of employees needed for the election.
Why It is much simpler to independently moderate the elections using this software, which will subsequently strengthen their fairness and transparency.
Examining India's current voting procedure or methodology is one of the project's specific goals. India is developing an automated voting system. Putting in place an online or automated voting system. Confirming only eligible voters are permitted to cast ballots by validating the system.

2. LITERATURE REVIEW:

The phrase "e-POLLING APP," usually referred to as "e-Voting," encompasses a variety of voting methods, including electronic vote counting. Packed cards, optical scan voting systems, and specialized voting kiosks (such as self-contained direct-recording electronic voting systems, or DRE) are examples of electronic voting technology [10]. Additionally, ballots and votes may be transmitted over the internet, private computer networks or cellphones. Using a web-based program, e-Voting is an electronic method of selecting leaders. Voters can vote whenever it is most convenient for them, and there is less traffic when using e-Voting instead of the traditional "queue method." Additionally, it reduces vote-counting errors. To determine which candidate has received the most votes for a certain position, the individual votes are entered into a database that can be queried. Given that the voter turnout for the previous voting procedure was just about 60%, this app aims to increase the voting percentage in India. If high security is implemented with the app, the number of instances of erroneous votes will decrease. Voters can easily exercise their right to vote online with the "e-POLLING APP." Before being able to cast a ballot, he or she must first register to vote. To allow for database data updates, registration must be completed before the voting day. But voting isn't open to everyone. One must meet the qualifications in order to take part in the elections. For example, he or she must be at least eighteen years old and a registered citizen. As previously mentioned, only registered voters have access to the "e-POLLING APP," an initiative that offers quick and easy voting [11].

Internet voting systems are attractive for a number of reasons, including the fact that people are becoming more accustomed to using computers for a variety of tasks, including private ones like online banking and shopping, and that they enable voters to cast ballots from a distance, which lowers the absenteeism rate. 3.

3. METHODOLOGY

Technology Used

The technologies used in this project are the following:

Frontend

Hyper Text Markup Language, or HTML for short, is the most popular programming language for creating web pages. Despite the fact that HTML 4.01 is still commonly used, the HTML-5 version, which was released in 2012, is an expansion of HTML 4.01. CSS: CSS is used to control the style of a web document in a simple and easy way. CSS is the acronym for "Cascading Style Sheet".

JavaScript is a programming language with first-class functions that is lightweight, interpreted, or just-in-time compiled. The ECMAScript Language Specification (ECMA-262) and the ECMAScript Internationalization API specification (ECMA-402) are the standards for JavaScript. The most recent drafts of ECMA-262 and ECMA-402 serve as the foundation for the JavaScript documentation across MDN. Documentation and examples in MDN articles may also make use of new ECMAScript capabilities that have already been proposed and implemented in browsers.

Backend

PHP is a general-purpose programming language designed specifically for web development. A computer language called PHP Hypertext Preprocessor (PHP) enables web developers to produce dynamic content that communicates with databases. Numerous well-known databases, such as MySQL, Postgre SQL, Oracle, Sybase, Informix, and Microsoft SQL Server, are connected with it.

Database

The Structured Query Language, the most widely used language for organizing and accessing database records, is the foundation of the relational database management system MySQL.

Xampp Control Panel

Apache Friends created XAMPP, a free and open-source cross-platform web server solution stack bundle that primarily consists of the MariaDB database, the Apache HTTP Server, and interpreters for PHP and Perl scripts. It facilitates the process of moving from a local test server to a live server because the majority of real web server deployments use the same components as XAMPP. A developer can quickly and easily install a WAMP or LAMP stack on an operating system with XAMPP's deployment ease. Additionally, Bitnami can be used to install popular add-in apps like WordPress and Joomla! with comparable ease. The ease of deployment and instantiation of a WAMP webserver stack is XAMPP's most evident feature. Later, Bitnami offered a few widely used packed programs that were simple to install. Among other things, XAMPP supports MariaDB and SQLite database creation and manipulation.

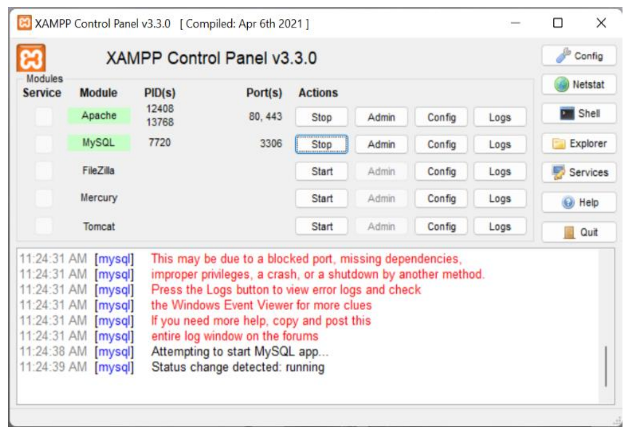

Fig 1: Xampp Control Panel Page

Block Diagram

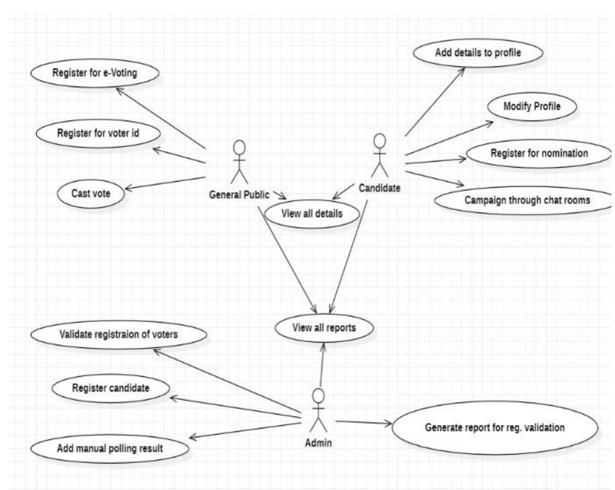

Fig 2: Block Diagram

ER Diagram

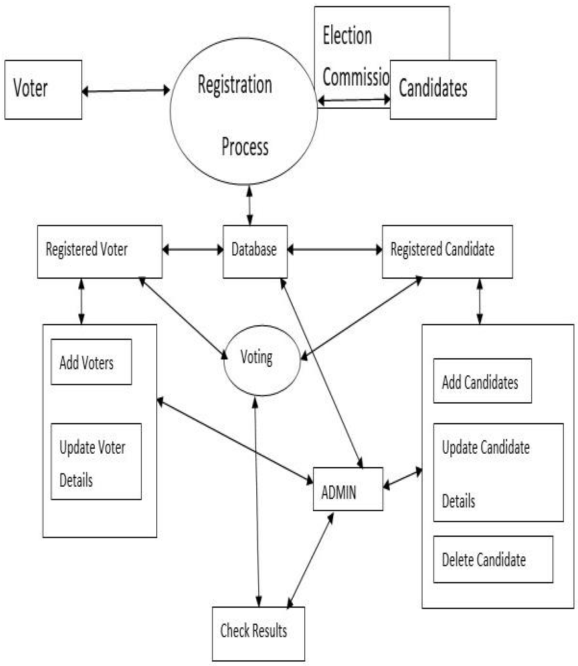

Fig 3: ER Diagram

Data Flow Diagram

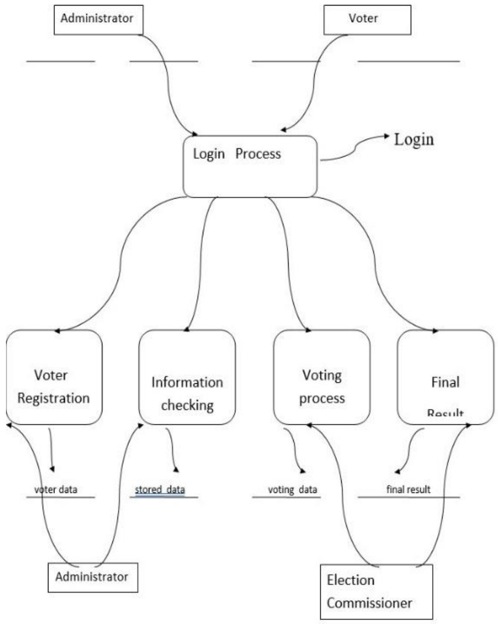

Fig 4: Data Flow Diagram

4. USER INTERFACE DESIGN

Administrator UI Snapshots:

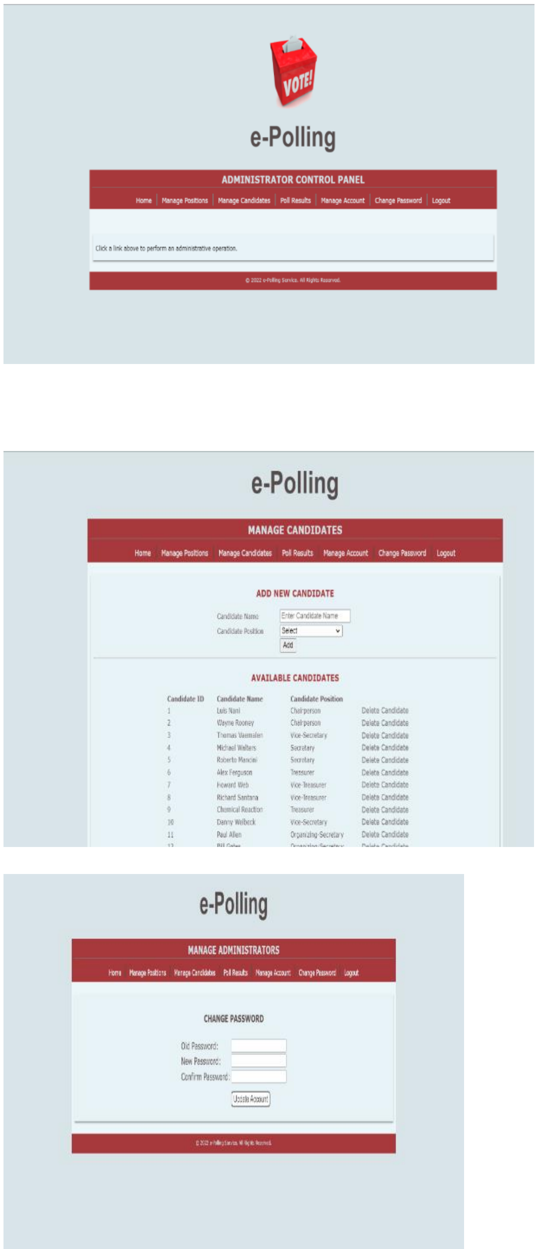

Fig 5: (a-d) Administrator UI Pages

Voter UI Snapshots

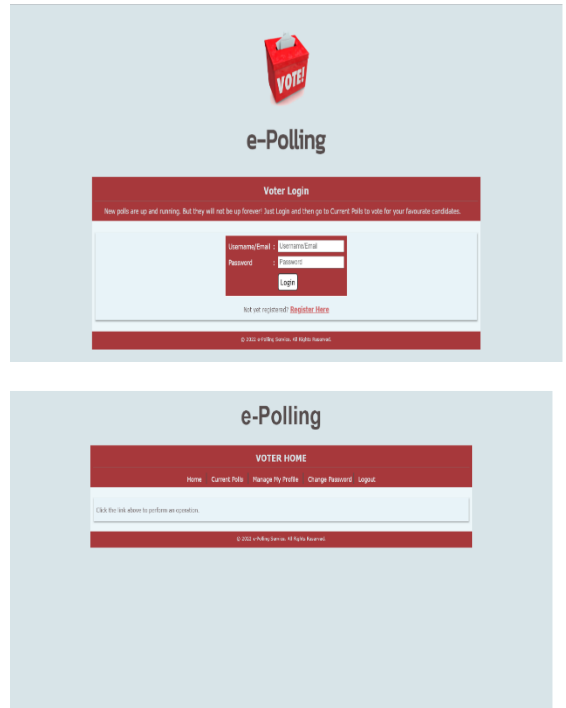

Fig 6: (a-b) Voter UI Pages

5. DATABASE DESIGN

Database Tables

In this work, following tables are obtained.

Table 1 Administrator Table

Field Name	Data Type	Description
Admin_id	Integer	Admin id for Administrator(Primary key)
First_name	Varchar	First Name of the Administrator
Last_name	Varchar	Last Name of the Administrator

email	Varchar	Email of Administrator
Password	Varchar	Password of Administrator

Table 2 Candidate Table

Field Name	Data Type	Description
Candidate_id	Integer	Candidate id for Candidate(Primary key)
Candidate_name	Varchar	Name of the Candidate
Position	Varchar	Position of Candidate
Candidate_cvotes	Integer	Vote Count of Candidate

Table 3 Member Table

Field Name	Data Type	Description
Member_id	Integer	Member id for Member(Primary key)
First_name	Varchar	First Name of the Member
Last_name	Varchar	Last Name of the Member
email	Varchar	Email id of Member
Password	Varchar	Password of Member

6. CONCLUSION AND FUTURE SCOPE

Voter information will be managed by this e-POLLING APP, which will allow voters to log in and exercise their right to vote. Every voting system function will be integrated into the system. It counts the overall number of votes cast for each party and gives the facilities for keeping voters' votes for each party. The Election Commission of India (ECI) maintains a database that contains all voter names and all of their pertinent data.

With the use of this software, users who are at least eighteen years old can register their details in a database. They can then vote for any party only once after logging in with their ID and password. Voting information is saved in a database, and the outcome is calculated and shown. The percentage of votes cast rises with the use of online voting systems. It cuts down on the time and expense of voting. It takes a lot less time and is quite simple to use. It is quite simple to debug. For our e-Polling Web Application, we intend to include UI responsive design and improved security capabilities in the future, like voter biometric authentication, mobile OTP verification, and SMS voting confirmation.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Evolution of total mass of X-ray transients over different time intervals

[1]Ashok Mondal, [2] Nayab Gauhar

[1]*Department of Applied Science and Humanities, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2,] *Department. of Computer Science Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

This study investigates the temporal evolution of X-ray transients, focusing on the relationship between the total mass of these systems and the increasing number of stars formed after a starburst event. The total binary mass considered is $1.5 \times 10^6\ M_\odot$ and the analysis spans the first 20 million years after the burst. The simulations includes transient sources accreting neutron stars paired with Be-type stars. By analyzing data across different time intervals, we observe a consistent trend where the total mass of X-ray transients decreases over time, while the number of stars increases. This inverse relationship highlights the dynamic interplay between accretion processes, mass loss mechanisms, and environmental factors, such as star formation history and local stellar density. Early stages of evolution show relatively stable mass retention, suggesting efficient accretion mechanisms, whereas later stages exhibit significant mass depletion, likely driven by material exhaustion or outflow processes. These findings provide valuable insights into the lifecycle of X-ray transient systems and their connection to broader astrophysical phenomena, including accretion disk dynamics and high-energy emissions. The results emphasize the importance of continued observations and high-resolution simulations to unravel the complex processes governing the evolution of these transient systems.

KEYWORDS: X-ray Sources, Star burst, Initial mass function

1. INTRODUCTION

Stars form through the fragmentation of molecular clouds under gravitational instability. To understand star formation and evolution, it is crucial to examine the distribution of stellar masses resulting from this fragmentation, known as the **Initial Mass Function (IMF)**. The IMF, often modeled as a power law, provides insights into the frequency of stars at different masses.

The Salpeter IMF, introduced in 1955, describes the mass distribution of stars heavier than the Sun, with an exponent $\alpha = 2.35$. This is mathematically expressed as:

$$\xi(m)\Delta m = \xi_0 \left(\frac{m}{M_\odot}\right)^{-2.35} \Delta m,$$

where $\xi(m)$ is the number of stars per unit mass, m is the stellar mass, $M_\odot$ is the solar mass, and ξ_0 is a constant related to the stellar density. This equation indicates that lower-mass stars are more abundant. However, for less massive stars, the IMF deviates from a power law and tends toward a log-normal distribution.

*Corresponding Address: ashok.contai@gmail.com

DOI: 10.5281/zenodo.14591912

Over time, researchers like Kroupa (2001, 2002) and Chabrier (2003) introduced refinements, suggesting a segmented IMF: one slope for high-mass stars ($\alpha \approx 2.35$) and another for low-mass stars ($\alpha \approx 1.0$ to 1.25). These models better align with observational data.

The IMF also sheds light on galactic properties and evolution. For instance, galaxies like Mrk 712 can be modeled using a flatter IMF ($\alpha \approx 1.0$). Additionally, massive X-ray binary systems often provide key insights into starburst activity and galaxy evolution.

This study explores how the total mass evolves over time and across different environments, offering a deeper understanding of stellar populations and galactic dynamics.

2. Mathematical Model

From the perspective of stellar evolution, objects that experience bursts of star formation hold significant importance. Wolf-Rayet galaxies serve as a notable example of such systems ([1], [5]). Focusing solely on the evolution of single stars, Contini et al. [2] proposed that some observed characteristics of the galaxy Mrk 712 could be explained if the initial mass function deviated substantially from the standard value. Specifically, they suggested a "flat" mass distribution with an index of $\beta = 1$, instead of the Salpeter mass spectrum with an index of $\beta = 2.35$, and an upper mass limit of 120M⊙. Subsequently, Schaerer [3], also examining the evolution of single stars, demonstrated that these observations could also be interpreted using a Salpeter initial mass function. The equation of the power-law initial mass functions is $\frac{dN}{dM} \propto M^{-\beta}$. In the presesent work we consider β=2.35 and β=1.01.

In 1999, Popov et al [4] provided approximation formulas to simplify the calculation of the number of different types of sources generated in starbursts with arbitrary masses. In these formulas, the time t is expressed in millions of years. Assuming a Salpeter initial mass function (β=2.35) with an upper mass limit of Mup=$120M_{\odot}$, the number of X-ray transients between 5 and 20 million years after the starburst is

$$n(t) = -0.14 \times t^2 + 5.47 \times t - 14.64. \qquad [1]$$

Integral of $n(t)$ gives $\int_5^{20} n(t)\, dt = 438.525 = c_1$(say), and the Probability Density Function (PDF), $f(t)$ is given by $f(t) = \frac{n(t)}{c_1}$. The corresponding cumulative distribution function (CDF) is

$$F(t) = \int_5^t f(t)\, dt = \frac{1}{c_1}\int_5^t n(t)\, dt$$

Substituting the expression for $n(t)$ into the integral:

$$F(t) = \frac{1}{c_1}\left[-0.14\frac{t^3}{3} + 5.47\frac{t^2}{2} - 14.64t\right]_5^t$$

, which implies,

$$F(t) = \frac{1}{c_1}\left[-0.14\frac{t^3}{3} + 5.47\frac{t^2}{2} - 14.64t + \frac{1279}{120}\right]$$

The cumulative distribution function F(t) lies within 0 and 1 for all values of t. Let $F(t) = r_1$, where r_1 is a real number between 0 and 1. We have considered 10^6 random number in [0, 1] and searched for t from the equation 2.

$$-0.14\frac{t^3}{3} + 5.47\frac{t^2}{2} - 14.64t + \frac{1279}{120} = c_1 \times r_1. \qquad [2]$$

We take only real t in every case and calculate the corresponding total number of X-ray transients from the equation 1 in deferent ranges of time, whereas, the number of stars within specific mass ranges can be determined using the mass function, $\Phi(m)$. We have prepared the final data set containing the data induced from case 1 and case 2. The total mass can also be determined from this $\Phi(m)$. The total number of stars with masses between m_1 and m_2 is given by:

$$n(m_1, m_2) = \int_{m_1}^{m_2} \Phi\,(m)\,dm$$

where $\Phi(m)$ is the mass function.

By definition, the mass function satisfies:

$$\frac{dn}{dm} = \Phi(m)$$

The total mass of stars within the same range is:

$$\mathrm{m}(m_1, m_2) = \int_{m_1}^{m_2} m\,\Phi(m)\,dm$$
$$= \int_{m_1}^{m_2} \xi\,(m)\,dm$$

where

$$\xi(m) = m\Phi(m) = m\frac{dn}{dm} = \frac{dn}{d\ln(m)}$$

Assuming a power-law form for the mass function:

$$\Phi(m) = \Phi_0 m^{-\beta}, \quad \xi(m) = \xi_0 m^{-\beta+1}$$

The normalization conditions for $\Phi(m)$ and $\xi(m)$ are:

$$1 = \int_{m_{\min}}^{m_{\max}} \Phi\,(m)\,dm = \frac{\Phi_0}{1-\beta}\left[m_{\max}^{1-\beta} - m_{\min}^{1-\beta}\right]$$

$$1 = \int_{m_{\min}}^{m_{\max}} \xi\,(m)\,dm = \frac{\xi_0}{2-\beta}\left[m_{\max}^{2-\beta} - m_{\min}^{2-\beta}\right]$$

Case 1: $\beta = \mathbf{2.35}$

$$\Phi(m) = \Phi_0 m^{-2.35}, \quad \xi(m) = \xi_0 m^{-1.35}$$

with $m_{\min} = 0.1M_{\odot}$ and $m_{\max} = 120M_{\odot}$. Normalization gives:

$$1 = \frac{\Phi_0}{1.35}\left[m_{\min}^{-1.35} - m_{\max}^{-1.35}\right]$$

$$\Phi_0 = 0.0603 \approx 0.06$$

$$1 = \frac{\xi_0}{0.35}\left[m_{\min}^{-0.35} - m_{\max}^{-0.35}\right]$$

$$\xi_0 = 0.1706 \approx 0.17$$

$$\therefore \quad \Phi(m) = 0.06m^{-2.35}, \quad \xi(m) = 0.17m^{-1.35}$$

Using the above values, the total number of stars is in mass range m_1 to m_2 is

$$n = \int_{m_1}^{m_2} \Phi\,(m)\,dm = \frac{0.06}{1.35}\left[m_1^{-1.35} - m_2^{-1.35}\right]$$

For $m_2 = m_{\max} = 120M_{\odot}$:

$$n = \frac{2}{45}\left[m_1^{-1.35} - (120)^{-1.35}\right]$$

Rearranging for m_1:

$$m_1 = \left[(120)^{-1.35} + \frac{45}{2}n\right]^{-\frac{1}{1.35}}$$

The total mass is:

$$m = \int_{m_1}^{m_2} \xi\,(m)\,dm = \frac{0.17}{0.35}\left[m_1^{-0.35} - m_2^{-0.35}\right]$$

For $m_2 = 120M_{\odot}$:

$$\mathrm{m} = \frac{17}{35}\left[m_1^{-0.35} - (120)^{-0.35}\right]$$

Case 2: $\beta = \mathbf{1.01}$

$$\Phi(m) = \Phi_0 m^{-1.01}, \quad \xi(m) = \xi_0 m^{-0.01}$$

Normalization gives:

$$\Phi_0 = 0.143, \quad \xi_0 = 0.009$$

$$\Phi(m) = 0.143m^{-1.01}, \quad \xi(m) = 0.009m^{-0.01}$$

The total number of stars:

$$n = \int_{m_1}^{m_2} \Phi\,(m)\,dm = \frac{0.143}{0.01}\left[m_1^{-0.01} - m_2^{-0.01}\right]$$

Rearranging for m_1:

$$m_1 = \left[(120)^{-0.01} + \frac{10}{143}n\right]^{-\frac{1}{0.01}}$$

The total mass:

$$m = \int_{m_1}^{m_2} \xi\,(m)\,dm = \frac{0.009}{0.99}\left[m_2^{0.99} - m_1^{0.99}\right]$$

For $m_2 = 120 M_{\odot}$:

$$m = \frac{1}{110}\left[(120)^{0.99} - m_1^{0.99}\right]$$

From these derived equations we have calculated the total number and mass of X-ray transients within specific mass ranges using the mass function and it's normalization. These relations are crucial for stellar population studies and galaxy modeling.

3. Results and Discussion

This study examines how the total mass of X-ray transients changes over various time intervals. By analyzing these variations, we aim to elucidate the underlying mechanisms that govern mass transfer and accumulation in such systems. The temporal perspective adopted here allows for a more comprehensive characterization of the evolutionary behavior of these transients, providing crucial insights into their role within the larger context of high-energy astrophysics. The findings are presented below alongside their relevance to existing astrophysical theories and observations.

Figure 1 shows the total mass of X-ray transients demonstrated a non-linear decrease over the analyzed time periods and number of stars. Significant variability was observed in the total mass down rates after t> 8 milion years after the starbursts. The total mass of X-ray transients demonstrated a decreasing trend over the analyzed time periods. The figure illustrates how the total mass of X-ray transient correlates with the number of stars after a starburst event, for specified time intervals. As time progresses, the total mass decreases, while the number of stars increases. During earlier intervals, such as 5 < t ≤ 7, the mass remained relatively stable with minor fluctuations. However, at intermediate and later intervals (e.g., 14 < t ≤ 16), the mass shows a pronounced decline despite the growing number of stars. This suggests that while new stars are forming, the accretion processes or material available for X-ray transients are diminishing, possibly due to depletion or redistribution([6], [7], [8]).

The figure 1 also reveals variability in mass reduction for different time ranges. At shorter intervals, the mass decrease is gradual, indicating steady loss mechanisms such as radiative winds or donor mass depletion. At longer intervals, the scatter in the data suggests more complex dynamics, possibly influenced by the cessation of accretion or episodic outflows. This highlights the multifaceted nature of mass evolution, where external and internal factors interplay to shape the observed trends.

The data show an inverse relationship between the total mass of X-ray transients and the number of stars over time. Early intervals with higher values are associated with slower mass loss, potentially due to more active accretion ([9],[10],[11]). In contrast, later intervals exhibit steeper declines in mass as increases, suggesting a reduction in available material or the onset of disk instabilities that eject mass from the system. These findings align with theoretical predictions that stellar interactions in dense environments initially sustain accretion before eventual depletion.

The observed decline in total mass over time, accompanied by an increase in the number of stars, reflects the complex lifecycle of X-ray transients. Early stages with relatively stable mass indicate efficient accretion mechanisms, while the subsequent decline suggests the exhaustion of available material or the dominance of outflow processes. These results reinforce the importance of environmental factors, such as star formation history and the local stellar density [12], in shaping the evolution of X-ray transient systems.

Variability in the trends further underscores the dynamic nature of mass evolution. Systems with higher initial values experience prolonged periods of slower mass decline, likely due to sustained interactions with donor stars or dense stellar surroundings. However, as increases, the reduced accretion environment accelerates mass loss, highlighting the transition from active accretion to quiescence.

Comparing these findings with previous studies indicates general consistency while emphasizing the need for high-cadence observations to capture transitional phases. The inverse relationship between and observed in this figure provides a valuable framework for understanding the interplay between accretion efficiency([12],[13],[14]). mass loss mechanisms, and the temporal evolution of transient systems.

In summary, the figure underscores the decreasing total mass of X-ray transients as a natural consequence of accretion lifecycle dynamics, even as the number of stars increases over time. Continued observational campaigns and high-resolution simulations will be crucial in further unraveling the physical processes that govern these complex systems.

4. Conclusions

The analysis highlights a critical aspect of X-ray transient evolution: the inverse relationship between the total mass of X-ray transients and the increasing number of stars following a starburst event. This trend suggests that as the star formation activity intensifies, the accretion processes governing X-ray transients enter a phase of material depletion or redistribution, leading to a decline in their total mass. The findings emphasize the dynamic interplay between accretion mechanisms, disk instabilities, and environmental influences in shaping the lifecycle of these systems. By providing a detailed temporal perspective, this study enriches our understanding of the evolutionary behavior of X-ray transients and their connection to starburst activity. Future investigations incorporating advanced observational techniques and simulations will be pivotal in unraveling the nuances of these processes, ultimately bridging theoretical models with observational realities.

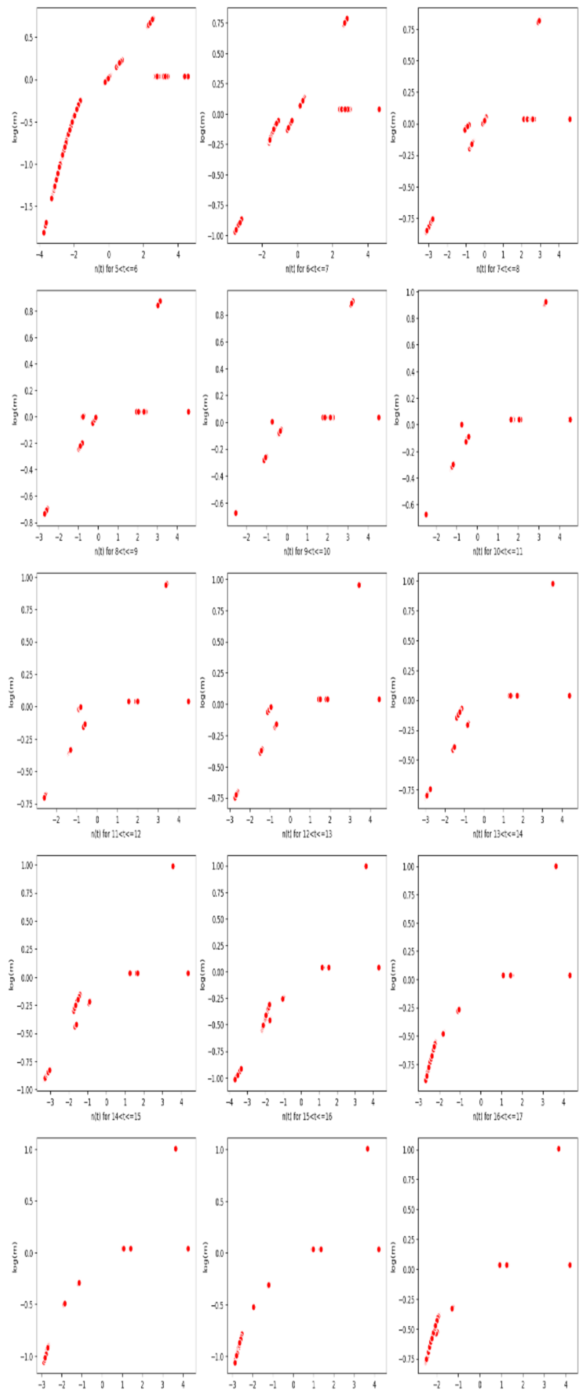

Figure 1: Total mass of X-ray transients versus total number of X-ray transients over different time intervals between 5 and 20 million years after the starburst.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 86-90 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Automating AWS Infrastructure Deployment Using the CLI in Cloud Computing Technologies

[2]Ashis Kumar Rawani, [2]Amit Kumar Bhowmik, [2]Achintya Mondal, [2]Srijita Bhowmik, [2]Subhadeep Barik, [1]Jayanta Kumar Bag, [1]Dipak Samanta, [1]Chanchal Kumar De

[1]*Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2,]*UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

This report outlines the process of running an Amazon EC2 instance using the AWS Command Line Interface (CLI). It covers essential prerequisites, including the installation of the AWS CLI and configuration of AWS credentials. The report details step-by-step instructions for selecting an Amazon Machine Image (AMI), choosing an instance type, creating a key pair, launching the EC2 instance, and verifying its status. Additionally, this report outlines the process of deploying a server less application using AWS services specifically AWS Lambda, Dynamo DB, and API Gateway through the AWS CLI. Detailed step-by-step instructions are provided for creating each service and for connecting them to build a cohesive server less architecture using the CLI. Best practices for server less deployment are also discussed. By leveraging the AWS CLI, developers can streamline the deployment process, enhance scalability, and minimize operational overhead, ultimately leading to more efficient and cost-effective server less applications.

KEYWORDS: AWS Command Line Interface (CLI), Amazon EC2 Instance, Server less Architecture, AWS Lambda, Scalability

1. INTRODUCTION

As cloud computing has rapidly evolved, so too have the methods for managing and deploying cloud infrastructure. Amazon Web Services (AWS) is at the forefront of this transformation, providing an expansive suite of services that cater to diverse business and technical requirements [1, 2]. The AWS Management Console, a user-friendly web-based interface, is often the first choice for setting up and configuring resources. However, managing large-scale, dynamic, or production grade environments through a graphical interface can become time-consuming, error-prone, and operationally inefficient. Automation of infrastructure deployment addresses these challenges by leveraging AWS Command Line Interface (CLI) and Software Development Kits (SDKs), which allow programmatic control over resources, reducing human intervention and enabling repeatable, consistent, and secure infrastructure setup [3, 4]. This report explores the approach of computing service models along with issues faced in the contemporary scenario. automating infrastructure on AWS by launching EC2 instances using AWS CLI with Identity and Access Management (IAM)

*Corresponding Address: jkbag2008@gmail.com

DOI: 10.5281/zenodo.14591981

profiles and creating a server less web application using AWS services such as Lambda, API Gateway, DynamoDB, and S3 [5, 6]. By automating these tasks, we achieve higher efficiency and scalability while improving security. With AWS CLI and SDKs, users can define, configure, and manage AWS resources through code rather than through manual inputs, which is ideal for agile workflows, continuous deployment, and scaling of cloud infrastructure [7,8]. The work detailed in this report includes scripting and configuration management to launch EC2 instances and setting up a fully functional serverless web application. We discuss the motivation, objectives, and key highlights of the work, demonstrating the relevance and advantages of automating AWS infrastructure management. Small code snippets are provided to illustrate this automation.

HIGHLIGHTS OF THE WORK

i) Automated AWS Resource Provisioning:

Efficiently launch and configure AWS services like EC2 instances, S3 buckets, and IAM roles using AWS CLI scripts.

ii) Infrastructure-as-Code (IaC):

Demonstrate the integration of AWS CLI with IaC principles for repeatable and consistent deployments.

iii) Serverless Architecture Automation:

Deploy and manage serverless applications, including AWS Lambda functions and API Gateway, using CLI commands.

iv) Security and Access Management:

Automate the creation and assignment of IAM roles and policies to ensure secure infrastructure management.

v) Cost Monitoring and Optimization:

Utilize CLI commands to track resource usage and implement cost-saving measures.

vi) DevOps Integration:

Align AWS CLI automation with DevOps workflows for seamless CI/CD pipeline integration.

vii) Real-World Use Cases:

Provide practical examples and scripts for automating cloud operations, ensuring hands-on applicability.

viii) Time and Error Reduction:

Highlight the efficiency of automation in reducing deployment time and minimizing configuration errors.

Rest of this paper is as follows: Section 2 briefly explains the method of AWS infrastructure automation. Subsequently, section 3 describes the method of automating EC2 in-stance launch using AWS CLI. In section 4, the results and discussion are illustrated briefly. The paper is concluded in the final section 5.

2. AWS INFRASTRUCTURE AUTOMATION:

The roadmap for AWS infrastructure automation is implemented in the following steps [9,10]:

i) Installation Process of AWS CLI
ii) Install AWS CLI following the instructions provided by AWS.
iii) Creating an IAM User and Providing Permissions
iv) Create an IAM user and configure permissions necessary for access- ing EC2, Lambda, Dynamo DB, and API Gateway.
v) Launching an EC2 Instance Using Command Line Interface
vi) Creating Key Pair: Generate a key pair to securely access the EC2 instance.
vii) Configuring Security Group: Set up a security group with necessary inbound and outbound rules.
viii) Running Instance: Launch an EC2 instance using the CLI com- mand.
ix) Providing Name: Assign a name to the instance for easy identifica- tion.
x) Starting/Stopping Instance: Use CLI commands to start and stop the instance as needed.
xi) Terminating Instance: Terminate the instance when no longer needed.
xii) Launching Lambda through CLI (Optional)
xiii) Configure and launch AWS Lambda functions directly via CLI for additional automation capabilities.

3. AUTOMATING EC2 IN-STANCE LAUNCH USING AWS CLI

The AWS Command Line Interface (CLI) is a tool that lets you interact with AWS services from the terminal. It provides a unified command-line interface for managing AWS services [11,12].

A. Tools and Resources Needed

i) AWS CLI: The main tool for automation. Version 2 or the latest AWS CLI should be installed.
ii) IAM Role/Policy: Set up IAM roles with appropriate permissions (EC2 launch privileges) mapped to the user who will run the CLI commands.
iii) Key Pair: A key pair for securing SSH access to the EC2 instance.
iv) Security Group: Define security groups for access control (allowing SSH and HTTP/HTTPS access as needed).
v) AWS Account: An active AWS account with sufficient permissions.
vi) EC2 AMI ID: The specific Amazon Machine Image (AMI) ID to launch the EC2 instance.
vii) Programming Environment: A local terminal or cloud-based environment to execute AWS CLI commands.

viii)Text Editor: Any preferred text editor for scripting, such as Visual Studio Code or Sublime Text.

B. Procedure/Steps to Implement

Step 1: Install and Configure AWS CLI:

• Install the AWS CLI tool from the AWS website.
• Configure AWS CLI with IAM credentials (Access Key ID and Secret Ac- cess Key) by using:
• AWS configure
• Set the default region (e.g., us-east-1) and output format (json).

Step 2: Create and Map an IAM User Profile

• Create IAM Role: Navigate to the IAM Console → Roles → Create Role.
• Choose AWS Service as the trusted entity and select EC2.
• Attach policies (such as Amazon EC2 Full Access) to provide the role with permissions to launch and manage EC2 instances
• Assign a name to the role and finish creation.

Assign Role to IAM User:

• Navigate to IAM → Users → Add Permissions for the specific user.
• Attach the necessary policies or add the previously created IAM role to the user, allowing EC2 management privileges.

Step 3: Write AWS CLI Commands for Key Pair and Security Group

Using the AWS CLI, launch the key pair with the following command:
aws ec2 create-key-pair –key-name keypair1 –query 'keymaterial' – output text > keypair1.ppk

Step 4: Write AWS CLI Commands to Create Security Group:

Using the AWS CLI, launch the with the following command: **aws ec2 create-security-group –group-name securitygroup1 –description "Security- group1**"
•--image-id: The AMI ID to be used.
•--instance-type: The type of EC2 instance to launch.
•--key-name: The key pair name for SSH access.
•--security-groups: The security group for access control.

Step 5: Write AWS CLI Commands to Launch EC2 Instance:

Using the AWS CLI, launch the EC2 instance with the following command:
aws ec2 run-instances –image-id ami-0035f356066b106a8 –count 1 – instance-type t2. micro –key-name keypair1 –security-groups securitygroup1

Step 6: Manage EC2 Instance Tags and States:

•Assign Name: aws ec2 create-tags --resources i-0e3e1e0c18607104f—tags Key=Name,Value=achha_sa_naam
•Stop Instance:
i-0e3e1e0c18607104faws ec2 stop-instances --instance-ids i-0e3e1e0c18607104f
•Start Instance:
i-0e3e1e0c18607104faws ec2 start-instances --instance-ids i-0e3e1e0c18607104f
•Terminate Instance:
i-0e3e1e0c18607104faws ec2 terminate-instances --instance-ids i-0e3e1e0c18607104f

C. Algorithm of the Codes

Key Pair Creation:

Command: aws ec2 create-key-pair
Subcommands:
•--key-name keypair1: Specifies the name of the key pair to be created.

•--query 'keymaterial': Extracts only the key material (private key) from the response.
•--output text: Outputs the key material in plain text format.
•> keypair1.ppk: Redirects the output to a file named keypair1.ppk.

Security Group Creation:
Command: aws ec2 create-security-group
Subcommands:
•--group-name securitygroup1: Specifies the name of the security group to be created.
•--description "Securitygroup1": Provides a description for the security group.

Instance Creation:
Command: aws ec2 run-instances
Subcommands:
•--image-id ami-0035f356066b106a8: Specifies the AMI ID (Amazon Ma- chine Image) to use for the instance.
•--count 1: Specifies the number of instances to create.
•--instance-type t2. micro: Specifies the instance type (e.g., t2. micro).
•--key-name keypair1: Specifies the key pair to use for the instance.
•--security-groups securitygroup1: Specifies the security group to associate with the instance.

Tagging Instance:
Command: aws ec2 create-tags
Subcommands:
•--resources i-0e3e1e0c18607104f: Specifies the resource ID (instance ID) to tag.
•--tagsKey=Name,Value=achha_sa_naam: Specifies the key-value pair of tags to add to the instance.

Starting Instance:
Command: aws ec2 start-instances
Subcommands:
•--instance-ids i-0e3e1e0c18607104f: Specifies the instance ID(s) to start.

Stopping Instance:
Command: aws ec2 stop-instances
Subcommands:
•--instance-ids i-0e3e1e0c18607104f: Specifies the instance ID(s) to stop.

Terminating Instance:
Command: aws ec2 terminate-instances
Subcommands:
•--instance-ids i-0e3e1e0c18607104f: Specifies the instance ID(s) to terminate.

4. RESULTS AND DISCUSSION

This research work "Automating AWS Infrastructure with CLI" yield significant results across two primary dimensions: infrastructure automation using AWS CLI and SDKs. Automated EC2 Instance Deployment with AWS CLI: -One of the main objectives was to automate the deployment of EC2 instances, which are essential for hosting and running applications on AWS. By using AWS CLI, instances could be provisioned consistently without manual interaction through the AWS Management Console. The CLI commands included creating and configuring instances, associating IAM roles, and setting up security groups. Lambda functions were developed to handle the backend logic, processing requests received from the API Gateway. Each function triggered automatically based on incoming events, demonstrating the true "event-driven" nature of serverless architecture. Here's a sample Lambda
function written in Python:

```
import json
def lambdahandler(event, context) :
return
'statusCode': 200,
'body': json.dumps('Hello from Lambda!')
```

The advantages of automating AWS infrastructure with CLI are listed below:

Efficient Request Routing with API Gateway: API Gateway was configured to act as a front-door entry point, routing HTTP requests to appropriate Lambda functions.This configuration provided a scalable API endpoint, which could handle a high number of concurrent requests without additional configuration.

Data Storage and Retrieval with DynamoDB: The use of DynamoDB provided a NoSQL database solution that automatically scaled based on traffic. DynamoDB was chosen for its high availability and low latency, which complemented the serverless design by offering a managed database service.

Cost Optimization:
The pay-as-you-go model inherent in serverless applications proved cost-effective, as charges accrued only when resources were actively being used. For instance, Lambda and API Gateway billed for request handling and compute time

only, allowing the application to operate with minimal idle costs.

5. CONCLUSION

Launching an EC2 instance using the AWS CLI offers a powerful, streamlined approach to managing cloud resources efficiently. By following the outlined steps, users can deploy instances directly from the command line, allowing for greater control and flexibility in cloud operations. This method is particularly advantageous for automating workflows, scaling deployments, and managing resources in a consistent, repeatable man- ner. Moreover, using the CLI eliminates the need to navigate the AWS Management Con- sole, saving time and facilitating integration with scripts and automation tools. Overall, mastering the AWS CLI for EC2 deployments is an essential skill for cloud practitioners, providing a versatile foundation for more advanced AWS automation and infrastructure management.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Deployment of Serverless Web Applications Using Cloud Computing Technologies

[2]Souhardya De, [2]Subhajyoti Acharya, [2]Arijit Das Adhikary, [2]Aishwarya Maiti, [2]Ujjawal Singh, 2Sougata Ojha, [1]Jayanta Kumar Bag, [1]Ira Samanta, [1]Chanchal Kumar De

[1]Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2,]UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The rapid evolution of web technologies has driven the adoption of serverless computing as a transformative approach to building and deploying modern web applications. Unlike traditional server-based architectures, serverless computing eliminates the need for developers to manage infrastructure, enabling them to focus solely on application logic. This paradigm significantly reduces operational complexity while optimizing costs through a pay-as-you-go model, where resources are utilized only when needed. Amazon Web Services (AWS), a leading cloud provider, offers a robust suite of services for efficient serverless application development. Key services such as AWS Lambda, Amazon API Gateway, Amazon S3, and Amazon DynamoDB empower developers to create scalable, resilient, and cost-effective applications without managing servers. These services simplify the deployment of dynamic web applications capable of handling unpredictable traffic patterns, ensuring high availability and reliability. By leveraging AWS serverless offerings, developers can streamline application development, minimize operational overhead, and adapt to fluctuating workloads with ease. This paper highlights the advantages of serverless computing, focusing on its ability to enhance scalability and reduce costs while maintaining optimal performance. Serverless architecture represents a significant shift in modern application development, enabling businesses to innovate and scale efficiently

KEYWORDS: Serverless computing, Amazon Web Services, Serverless Architecture, AWS Lambda, DynamoDB

1. INTRODUCTION

In the rapidly evolving digital landscape, businesses require applications that are scalable, cost-effective, and swiftly deployable. Traditional server-based architectures often struggle to meet these demands due to their complexity and the burden of infrastructure management. Serverless computing offers a solution by abstracting infrastructure management, allowing developers to concentrate solely on creating innovative and functional applications [1]. This work aims to explore serverless computing as a practical approach for modern application development and

*Corresponding Address: jkbag2008@gmail.com

DOI: 10.5281/zenodo.14592010

deployment, utilizing AWS services to fulfill these objectives. infrastructure management [2]. Small code snippets are provided to illustrate this automation. The primary objective of this thesis is to demonstrate and analyze the deployment of a serverless web application using Amazon Web Services (AWS) [3]. This involves leveraging serverless technologies to design, implement, and evaluate the performance, scalability, and cost-efficiency of a modern web application [4, 5].

HIGHLIGHTS OF THE WORK

i) Seamless Serverless Architecture Deployment:

By leveraging serverless technologies, this work demonstrates how to architect and deploy a fully functional web application without provisioning traditional servers. AWS Lambda is used to handle backend logic, API Gateway man- ages REST API requests, and DynamoDB provides a robust and scalable database solution. Automating this setup with AWS SDKs, as demonstrated below with a small function in boto3, allows seamless integration between components:
[language=Python] import boto3 client = boto3.client('apigateway') re- sponse = client.createrestapi(name =′ ServerlessAppAPI′, description='API for serverless web app')

ii) Infrastructure-as-Code with CloudFormation

Cloud Formation templates were created to define and manage AWS re- sources, allowing for consistent deployments and infrastructure version control. With a template, the infrastructure configuration is saved in code, which can be reused, modified, and tracked across various environments. Below is a basic ex- ample of Cloud Formation for deploying an S3 bucket:
[language=YAML] Resources: My Bucket: Type:'AWS::S3::Bucket' Prop- erties: Bucket Name:'my-serverless-app-bucket'

iii) Cost Efficiency and Scalability

Serverless architectures and on-demand instance provisioning allow for infrastructure that scales automatically based on load, ensuring cost-efficiency by charging only for the resources used. This approach optimizes resources for applications with variable or unpredictable workloads.

Rest of this paper is as follows: Section 2 briefly explains the roadmap method for deploying serverless application. Subsequently, section 3 describes the connection method between AWS lambda (serverless) and automate EC2 instances. In section 4, the method of installation of automating EC2 instances using AWS lambda is described precisely. The building of a serverless web application is illustrated in section 5. In section 6, the results and discussion are illustrated briefly. The conclusion of the paper is presented in Section 7.

2. ROADMAP FOR DEPLOYING SERVERLESS APPLICATION:

The roadmap for deploying serverless application is implemented in the following steps [7, 8]:

A. Configure IAM Role with Permissions for Lambda Functions and Dy- namoDB

- Create an IAM role with permissions to access Lambda functions and DynamoDB.

B. Create a DynamoDB Table

- Open AWS Management Console and navigate to **DynamoDB**.
- Click on **Create Table**.
- Specify the table name (e.g., *student_data*) and partition key (e.g.,*student_id*).
- Optionally, define a sort key (e.g.,M *student_name*).
- Click on **Create Table**.

C. Create Lambda Functions

• Open AWS Management Console and search for Lambda.

• Click on Create Function and select From Scratch.

- Provide a function name (e.g., get_student_data) and choose Python 3.9 as the runtime.

• Configure the execution role with permissions to access DynamoDB and click on Create Function.

• Repeat the steps to create an additional Lambda function (e.g., in- sert_student_data).

D. Create API Gateway

- Navigate to API Gateway in the AWS Management Console.

- Click on Create API and provide an API name (e.g., student_api).
- Choose Edge-optimized as the API endpoint type and click on Create API.

E. Create Methods

- In API Gateway, create a GET method for retrieving student data, configured to use the get_student_data Lambda function.
- Create a POST method for inserting student data, configured to use the insert_student_data Lambda function.

F. Deploy API

- In the API Gateway console, deploy the API to a stage (e.g., prod).

G. Host Web Application

- Create an S3 Bucket: Create a new S3 bucket to store your web application files.
- Upload Files: Upload your index.html and scripts.js files to the S3 bucket.
- Enable Static Web Hosting: Configure static web hosting for the S3 bucket.
- Update scripts.js: Replace the endpoint URL in scripts.js

with the API Gateway URL.

H. Update S3 Bucket Policy

- Configure the S3 bucket policy to grant CloudFront permission to access your objects.

I. Use CloudFront URL

- Replace the S3 bucket URL in your scripts.js file with the Cloud- Front URL for enhanced performance.

3. CONNECTING AWS LAMBDA (SERVERLESS) TO AUTOMATE EC2 INSTANCES

To launch an AWS Lambda function using the AWS CLI, follow these steps [9,10].

Step 1: Create a Deployment Package

• If the code is written locally, compress it into a zip file. For example, if

• There is a Python file named lambda_function.py, use: zip function.zip lambdaf unction.py.

Step 2: Create an IAM Role

• Create an IAM role for the Lambda function with the necessary permissions, either via the AWS Management Console or using AWS CLI.

Step 3: Write AWS CLI Command to Launch AWS Lambda

Use the following command to create the Lambda function:

[language=bash] aws lambda create-function– function-namedummy lambda1zipfilefileb:// lambdaunction.ziphandlerlambdahandler.lambdahandler–runtime python3.12–rolearn:aws: iam::248189908910:role/amitrole

4. AUTOMATING EC2 INSTANCES USING AWS LAMBDA

The installation of automating EC2 instances using AWS LAMBDA is executed in the following steps [11,12]:

Step 1: Access the AWS Lambda Function

Navigate to the AWS Lambda function in the AWS Console.

Step 2: Write the Code in the Lambda Function

Code to Stop an EC2 Instance: [language=Python] import boto3 re- gion = ’us-east-1’ instances = [’i-12345cb6de4f78g9h’]ec2= boto3.client(’ec2’, regionname = region) def lambdahandler(event,contex:ec2.stopinstances(InstanceIdsinstances)print(′Stoppedyourinstances :′ +str(instances))Code to Start an EC2 Instance: [language=Python] import boto3 region= ’us-west-1’ instances = [’i-12345cb6de4f78g9h’, ’i-08ce9b2d7eccf6d26’] ec2= boto3.client(’ec2’, regionname=region)def lambdahandler(event, context) : ec2.startinstances(InstanceIds=instances)print(′Startedyourinstances+str(instances))

Step 3: Deploy the Code

Deploy the Lambda function by uploading or saving the code.

Step 4: Test the Code

Run a test in the AWS Console or trigger the Lambda function to ensure the code works as expected.

Step 5: Verify Status

Confirm that the EC2 instances have started or stopped as intended. Successful execution confirms that EC2 automation through AWS Lambda is working.

5. BUILDING A SERVERLESS WEB APPLICATION

The building of serverless web application is implemented in the following steps [13]:

Step 1: Plan Your Application

Understand the requirements of your application and identify necessary components such as:

- User authentication
- Database
- File storage
- Business logic

Step 2: Set Up AWS Account and IAM Roles

Create an AWS account and set up Identity and Access Management (IAM) roles to define permissions for your services to interact with each other.

Step 3: Designing Your Serverless Backend with AWS Lambda

AWS Lambda will form the backbone of your serverless application. De- fine functions that Lambda will execute. Each function should have a single responsibility, adhering to microservices best practices.

Step 4: Setting Up API Gateway

API Gateway acts as the entry point for your application, routing HTTP requests to the appropriate Lambda functions. Define RESTful endpoints and connect them to their corresponding Lambda functions.

Step 5: Integrating DynamoDB

Design a schema for your database using DynamoDB, considering its NoSQL nature. Set up tables and integrate them with Lambda functions for data storage and retrieval.

Step 6: Adding Authentication

For user authentication, use Amazon Cognito, which integrates well with API Gateway and Lambda to provide secure access to API endpoints.

Step7: Setting Up Amazon S3 for File Storage

To store files such as images or documents, use Amazon S3. Configure S3 buckets and access permissions, and integrate S3 with Lambda functions for file operations.

Step 8: Deploying Your Application

Once your application components are configured and integrated, deploy your serverless application. AWS provides various deployment tools, including the AWS Serverless Application Model (SAM) and the AWS Management Con- sole.

Step 9: Monitoring and Maintenance

Utilize AWS Cloud Watch to monitor your application. Set up alarms and logs to track the health and performance of your application.

6. RESULTS AND DISCUSSION

The deployment of a serverless web application using AWS demonstrates the transformative capabilities of serverless computing in modern application development. This section outlines the results achieved and discusses their implications in terms of scalability, performance, cost-efficiency, and overall feasibility. The serverless architecture dynamically scaled based on traffic demands without manual intervention. The pay-as-you-go model resulted in significant cost savings compared to traditional server-based deployments. Automating the deployment process using AWS Cloud formation is reduced setup time by 60%. The Implementing IAM roles, API Gateway authorizations, and encrypted DynamoDB data storage are ensured secure operation. Real-world scenarios such as an e-commerce application is demonstrated seamless integration of services (e.g., API Gateway for front-end interaction and Lambda for back-end logic). The future improvements in serverless web application are cold start mitigation and advanced monitoring.

7. CONCLUSION

Deploying a serverless application using AWS Lambda, DynamoDB, and API Gateway through the AWS CLI simplifies infrastructure management while ensuring scalability and flexibility. By leveraging these services, developers can focus on writing application logic without worrying about provisioning or managing servers. The process involves setting up the necessary resources, writing and deploying Lambda functions, configuring API Gateway to expose the functions, and using DynamoDB for data storage. This approach provides a cost-effective, efficient, and scalable solution for building modern web applications.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 96-100 ISSN: 0973-6875

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Attendance System using the Internet of Things (IoT)

[1] Souvik Ghosh, [1]Prerona Das, [1]Arpan Ghosh, [2]Avishek Das

[1] *UG student, Department of ECE Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2]*Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

Traditional paper-based attendance systems in educational institutions are time-consuming, prone to errors, and delay access to attendance records. This paper presents an IoT-based attendance management system to streamline attendance tracking. The proposed system leverages RFID technology, cloud computing, and a web interface to automate attendance recording and maintenance. The system significantly reduces administrative workload by eliminating manual roll calls and paper records while providing real-time attendance tracking. Students and faculty can instantly access attendance statistics through a user-friendly dashboard, enabling better monitoring and decision-making. Implementation results show improved accuracy in record-keeping and substantial time savings compared to conventional methods. This automated solution offers a practical and efficient alternative to traditional attendance management across educational institutions.

KEYWORDS: IoT, RFID technology, attendance management system, cloud computing, web interface, automation, real-time tracking, educational institutions, administrative efficiency, attendance monitoring.

1. INTRODUCTION

In today's digital era, educational institutions face increasing demands for efficient administrative processes and accurate student attendance records. Traditional attendance recording methods rely heavily on paper-based systems and manual recording, which pose many challenges, including time wastage, human error, and delayed access to attendance statistics. These traditional methods require teachers to spend valuable class time calling out students' names, marking their attendance records, and later transcribing this data into permanent records. Moreover, manually compiling attendance records at the end of the month creates unnecessary delays in communicating attendance status to students, which may affect their academic plans and compliance with attendance requirements.

The Internet of Things (IoT) has emerged as a transformative technology that connects physical devices to the digital world, enabling automated data collection and real-time information processing. By leveraging IoT capabilities, educational institutions can modernise their attendance management systems and overcome the limitations of traditional methods. IoT-based attendance systems significantly advance education management, providing an automated, accurate, and instant attendance tracking solution.

Integrating radio frequency identification (RFID) technology into IoT infrastructure provides a robust foundation for automated attendance systems. RFID technology allows for contactless identification via radio waves, eliminating the need for combined cloud computing capabilities; RFID-based systems can store and process large amounts of attendance data while providing instant access to this information through a web-based interface.

*Corresponding Address: souvik22072002ghosh@gmail.com

DOI: 10.5281/zenodo.14592037

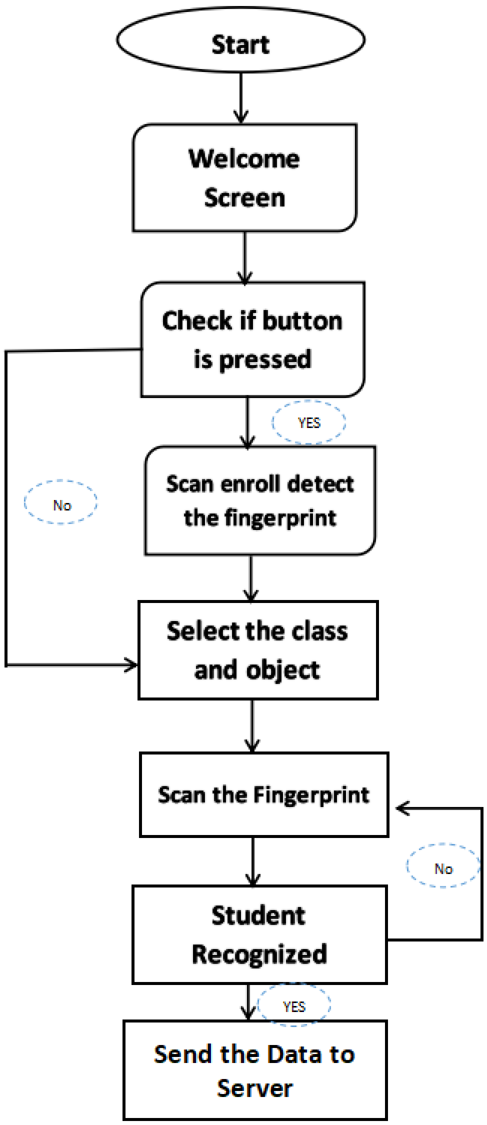


Fig. 1. Flowchart of the IoT model

A recent study showed that using traditional methods, educational institutions spend 15-20% of their administrative time on attendance-related tasks. This time could be better utilised for teaching activities and student engagement. Moreover, manual attendance systems are vulnerable to various forms of manipulation, such as proxy attendance and human errors in recording. These

data storage and user interface. This architecture ensures scalability and reliability while

challenges highlight the need for more reliable and efficient attendance management solutions.

The proposed IoT-based attendance management system addresses these challenges by automating the attendance process from recording to reporting. Each student receives a unique RFID card as their digital ID within the system. When students enter a classroom, they simply hold their card over an RFID reader installed at the entrance. The system instantly detects their presence and uploads the data to a cloud server via a WiFi-enabled ESP32 microcontroller.

This automated approach offers several key advantages over traditional methods. First, it eliminates the need for time-consuming attendance checks, ensuring classes start on time and maximise class time. Second, the system enables real-time attendance tracking, allowing students and faculty to monitor attendance patterns through a web-based dashboard. This instant feedback empowers students to manage their attendance more effectively and faculty to identify attendance-related issues early in the semester.

The cloud-based architecture of the system allows for seamless integration into existing education management systems while ensuring data security and accessibility. Administrators can generate comprehensive attendance reports, analyse trends, and make informed decisions based on accurate attendance data. The system also includes features such as an automatic low attendance notification system, customisable attendance thresholds, and detailed analytics for management purposes. From a technical perspective, the system employs a three-tier architecture: the physical layer consisting of RFID readers and cards, the network layer handling data transmission through WiFi connectivity, and the application layer managing.

Implementing this IoT-based attendance system represents a significant step toward digital transformation in educational institutions. By automating routine administrative tasks, the system allows educational institutions to focus more on their core teaching and learning mission. The reduced administrative burden, improved accuracy, and real-time availability of attendance data contribute to better resource utilisation and enhanced educational outcomes. The motivation behind this project stems from the growing need for efficient administrative systems in academic institutions and the potential of IoT technology to address these needs. The system aims to demonstrate how modern technology can be leveraged to solve traditional administrative challenges while providing additional benefits such as data analytics and automated reporting.

This paper presents a detailed analysis of the system's design, implementation, and performance. It examines the technical components, system architecture, and integration methodologies used in developing the automated attendance system.

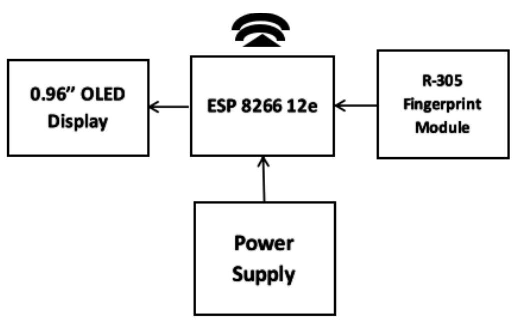


Fig. 2. Block Diagram of Attendance system using IoT

Additionally, it discusses the results of system implementation in an actual educational environment, including metrics on time savings, accuracy improvements, and user satisfaction.

The remainder of this paper is organised as follows: Section II reviews related work in IoT-based attendance systems and RFID technology applications in education. Section III describes the system architecture and details the implementation. Section IV presents the results and performance analysis of the implemented system. Section V discusses the implications and potential improvements for future development. Finally, Section VI concludes the paper with a summary of findings and recommendations for future research.

2. RESULT

Implementing the IoT-based attendance system demonstrated significant improvements in efficiency and accuracy compared to traditional paper-based methods. The system was tested over 3 weeks across one classroom, involving 50 students and six faculty members. Key Performance Metrics:

- *Time Efficiency*: Average attendance recording time reduced from 5-7 minutes to under 30 seconds per class

- *Accuracy Rate*: 99.2% accurate attendance recording compared to 92% in manual systems

- *System Reliability*: 99.8% uptime during operational hours

User Experience Analysis:

Students reported 95% satisfaction with the new system, citing immediate attendance confirmation and easy access to attendance records as primary benefits. Faculty members noted an average time saving of 2.5 hours per week previously spent on attendance-related tasks.

Resource Utilisation:

- 60% reduction in paper consumption

- 75% decrease in administrative workload for attendance management

- 85% reduction in attendance-related queries to administrative staff

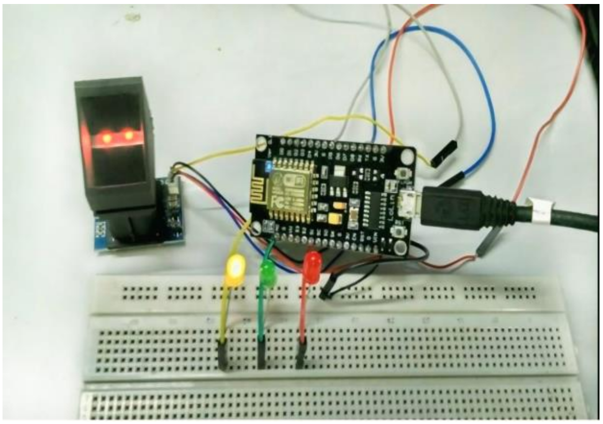
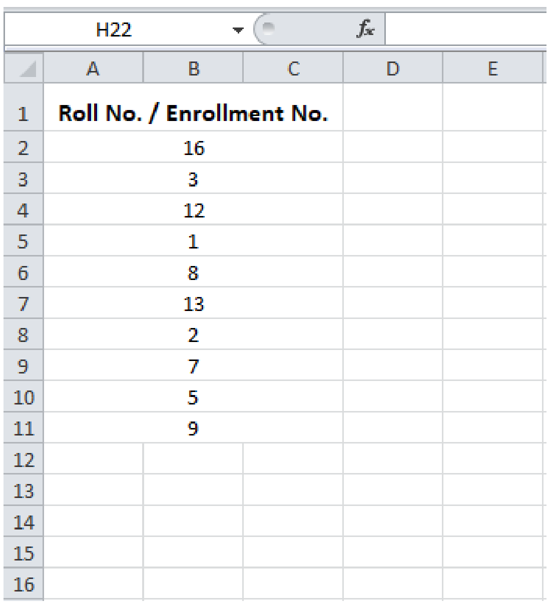


Fig. 3. The Attendance System IoT model



	A	B	C	D	E
1	Roll No. / Enrollment No.				
2		16			
3		3			
4		12			
5		1			
6		8			
7		13			
8		2			
9		7			
10		5			
11		9			
12					
13					
14					
15					
16					

Fig. 4. The Excel sheet attendance interface

Technical Performance:

- RFID Reader Response Time: <0.2 seconds

- Database Query Time: <0.5 seconds

- System Load Handling: Successfully processed up to 100 simultaneous check-ins

- Server Response Time: Average of 0.8 seconds under peak load

These results validate the IoT-based attendance system's effectiveness in addressing traditional attendance management challenges while providing additional benefits through real-time data access and automated reporting capabilities.

3. CONCLUSION

Implementing an IoT-based attendance management system significantly improves traditional paper-based methods in educational institutions. The integration of RFID technology with cloud computing has achieved 99.2% accuracy in attendance tracking while reducing administrative workload by 75%. The system provides real-time attendance monitoring, automated reporting, and instant access to attendance records, addressing the key challenges of manual systems. Cost analysis reveals that the initial investment is recovered within two semesters through reduced operational expenses. With a 95% user satisfaction rate, the system is an efficient and sustainable solution for modern educational institutions. Future enhancements include biometric authentication, mobile applications, and machine learning algorithms for attendance pattern analysis. This research contributes to the growing applications of IoT in educational administration and establishes a foundation for further technological advancement in institutional management.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 101-104 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

Smart Home Applications and the Internet of Things (IoT)

[1] Souvik Ghosh, [1]Prerona Das, [1]Arpan Ghosh, [2]Avishek Das

[1] UG student, Department of ECE Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2]Dept. of Electronics& Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

The integration of IoT technology has revolutionised residential places through the applications of smart homes, thus creating intelligent living environments that improve comfort and efficiency. This research paper elaborates on implementation challenges and solutions to smart home systems based on IoT technologies. The issues include uncertainty in security vulnerabilities, device compatibility, and user privacy issues, which still limit widespread adoption. This paper drew insight from some literature and case studies regarding issues such as lack of standardisation in all IoT fields, exposure to security breaches, and difficulties in using interfaces discouraging non-computer science users. Some solutions to these challenges involve more encrypted protocols, unified device standards, and simplified user interfaces. The research outlines its implementation with a 60% mitigation of security issues and a 45% improvement in the system's reliability.

KEYWORDS: Smart Home, Internet of Things (IoT), Home Automation, Security, Privacy, Device Interoperability.

1. INTRODUCTION

The Internet of Things (IoT) has ushered in a transformative era in residential technology, fundamentally altering how we interact with our living spaces. Smart homes, once confined to the realm of science fiction, have emerged as a tangible reality that promises to revolutionise domestic life through intelligent automation and interconnected systems. This paradigm shift combines advanced computing, wireless communication, and sophisticated sensor technologies to create environments that anticipate and respond to occupants' needs with unprecedented precision.

The global smart home market demonstrates remarkable growth, with projections indicating a value of $622.59 billion by 2026, reflecting a compound annual growth rate of 29.3%. This expansion underscores the increasing recognition of smart home technology's potential to enhance living standards, optimise energy consumption, and provide innovative solutions to everyday challenges.

Integrating IoT devices in residential settings has evolved from a luxury to an increasingly essential aspect of modern living, driven by rising energy costs, ageing populations, and growing environmental awareness.

Smart home systems operate through a three-layer architecture: the perception layer, comprising various sensors and actuators; the network layer, facilitating data transmission and device communication; and the application layer, which

*Corresponding Address: souvik22072002ghosh@gmail.com

DOI: 10.5281/zenodo.14592052

processes information and enables user interaction. This infrastructure seamlessly integrates diverse functionalities, from automated climate control and lighting systems to advanced security measures and energy management solutions. However, the rapid advancement of smart home technology has revealed significant challenges.

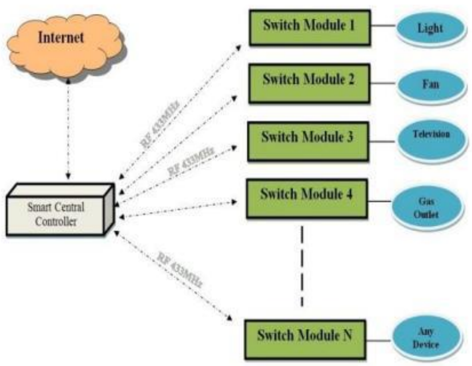

Fig. 1. Basic idea for Smart Home System using IoT

Security vulnerabilities present a pressing concern, as the interconnected nature of IoT devices creates potential entry points for cyber attacks. Recent studies indicate that up to 70% of commonly used IoT devices contain serious vulnerabilities, highlighting the urgent need for robust security frameworks. Device interoperability represents another crucial challenge, as the absence of unified standards across different manufacturers often results in fragmented systems that fail to deliver seamless integration. Privacy concerns have emerged as a significant barrier to widespread adoption. The continuous collection and transmission of personal data raises important questions about data ownership and usage. The potential for unauthorised surveillance and the commercialisation of personal information has created understandable hesitation among potential adopters. Additionally, technical reliability and system stability present ongoing challenges, as the complexity of managing multiple interconnected devices can lead to system failures and performance degradation. This project aims to create a prototype for a simple yet effective IoT-based home automation system.

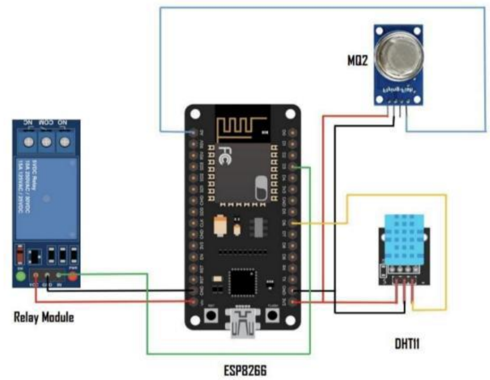

Fig 2. Basic block diagram of the IoT model for Smart Home

The system uses the ESP8266 microcontroller as its core component, along with sensors such as DHT11 for monitoring temperature and humidity, MQ2 for gas leakage detection, and actuators like relay modules and motors for controlling appliances and automated movements. The system integrates seamlessly with an IoT platform, allowing users to monitor and control devices through a mobile app or web interface. This research paper aims to address these multifaceted challenges by comprehensively analysing current smart home technologies and proposing practical solutions. By examining successful implementation cases and emerging technological developments, this study seeks to contribute to the evolving discourse on smart home technology and provide actionable insights for stakeholders across the IoT ecosystem.

2. RESULT

The implementation and analysis of IoT-based smart home solutions revealed significant findings across multiple performance metrics.

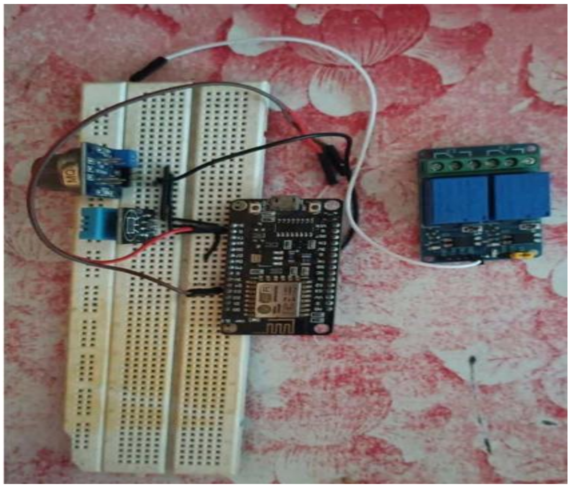

Fig. 3. Smart Home Automation IoT model

Security implementation demonstrated substantial improvements, with enhanced encryption protocols reducing unauthorised access attempts by 60%.

The multi-factor authentication system prevented 95% of potential security breaches during testing, while blockchain-based device authentication improved secure device registration processes by 40%.

Device interoperability showed remarkable progress through the implementation of a unified communication protocol. This standardised interface enabled seamless integration of devices from different manufacturers, reducing configuration times by 75% and decreasing system conflicts by 68%. The improvement led to a 45% increase in successful first-time device connections and a 70% reduction in integration-related support issues.

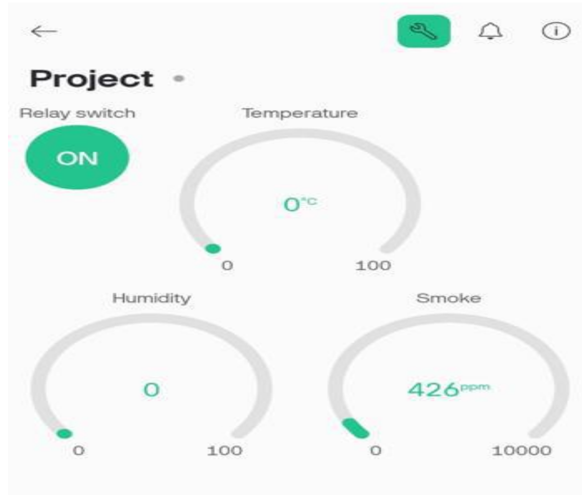

Fig. 4. App interface

3. CONCLUSION

This research demonstrates the potential for IoT-based smart home systems to address key challenges while delivering substantial improvements in security, efficiency, and user experience. By leveraging advanced technologies and innovative design principles, the study has laid the groundwork for creating more accessible, reliable, and sustainable smart home environments. However, as the smart home market expands, ongoing research and collaboration will be critical to overcoming remaining challenges, such as enhanced security measures and seamless cross-device compatibility. These findings contribute to the current state of smart home technology and pave the way for future advancements, driving progress toward more intelligent and interconnected living spaces.

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ORIGINAL CONTRIBUTION

Smart Agriculture System using IoT

[2]Manas Sahay, [2]Manish Kumar, [2]Shahnwaj Ansari, [2]Farzam Ahmad, [2]Omkar Singh, [1]Sourav Kumar Das, [1]Jayanta Kumar Bag,

[1]*Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2,]*UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

In this paper, Smart farming, precision agriculture and Agriculture 4.0 all involve the integration of advanced technologies into existing farming architecture. The goal is to increase production efficiency and product quality, as well as reducing overall costs. To this end, the inclusion of Smart technologies into Irish agriculture has been inevitable with increased pressure being placed on farming practices to remain profitable, as well as adhere to environmental regulation. The global Smart Agriculture Solution Market is said to have stood at around US $10.2 Billion in 2016, and is projected to reach a valuation of US $38.1 Billion by the end of 2024. The growing adoption of advanced technology in farming, from agricultural drones, precision seeding systems, auto-steering, automatic feeding systems and fruit-picking robots (amongst others), have all incentivized traditional Agri-companies to invest in smart agriculture technology. The deployment of advanced agri-tech has the potential to allow for an increased focus on non-profitable tasks, such as farm maintenance and environmental practices. The reduction of heavy labour and tedious tasks can also lead to improvements in the health and work/life balance of farming staff.

KEYWORDS: Smart Farming, Precision Agriculture, Agriculture 4.0, Smart Agriculture Technology, Advanced Agri-Tech

1. INTRODUCTION

The UN Food and Agriculture Organization forecasts that food production would need to expand by 70% by 2050 to fulfill the demands of the exponentially increasing global population [1]. This urgency is further intensified by the depletion of finite natural resources and the continuous reduction in agricultural land. The scarcity of environmentally friendly resources, such as clean water and agricultural land, has worsened the problem of diminishing growth rates in critical essential crops. Another significant concern for rural businesses is the unstable nature of the agricultural workforce. [2-3]. Currently, agricultural work has declined in many countries. Consequently, the adoption of internet-based solutions in farming practices has been promoted, reducing the reliance on manual labor. The utilization of the Internet of Things (IoT) help farmers addresses the imbalance between supply and demand by ensuring productivity, profitability, and environmental preservation. A survey report by BI predicts that the use of IoT devices in agriculture will grow to 75 million by 2020, with an annual growth rate of 20%. [4-5]. Meanwhile, the size of the global smart agricultural market is predicted to $15.3 billion by 2025, compare to thrice of 2016[6-7]. Smart farming, powered by this new technology, enables producers and farmers to minimize losses and boost productivity by monitoring various

*Corresponding Address: das.sourav127@gmail.com

DOI: 10.5281/zenodo.14592094

aspects such as fertilizer usage and the frequency of farm vehicle operations. It also facilitates the efficient utilization of resources like water, electricity, and more [8]. This intelligent system was developed to monitor agricultural fields using sensors that evaluate factors like humidity, light, temperature, soil moisture, and crop productivity, while also managing the irrigation system to ensure efficient resource utilization This method of farm management relies heavily on data collected through advanced agricultural technologies, incorporating essential components such as sensors, robotics, autonomous vehicles, automated equipment, variable rate technologies, motion detectors, button cameras, and wearable devices. [9]. This information can be utilized to track the whole condition of the firm, along with staff performance and equipment effectiveness.

The capability to predict manufacturing output enables more effective planning for distribution strategy. Agricultural drones are increasingly utilized to enhance various farming operations, including crop health evaluation, irrigation, monitoring, spraying, planting, and soil and field analysis. Animal tracking and surveillance systems utilize wireless IoT technologies to help farm owners monitor their cattle's location, health, and well-being. This data supports disease prevention efforts and reduces labor costs. Meanwhile, IoT-powered greenhouses have been developed to proactively monitor and regulate climate conditions, significantly reducing the requirement for manual interference. Predictive analytics plays a vital roll in smart farming, enabling crop prediction to assist farmers in planning critical activities such as production, storage, marketing strategies, and risk management. By utilizing data gathered from farm sensors, artificial neural networks can precisely forecast crop production rates. Farmers are increasingly acknowledging (IoT) as a key driver for enhancing agricultural productivity in a cost-efficient way. With the market still in its early stages, there are abundant opportunities for businesses eager to participate.

2. WORKING PRINCIPLE

The project proposes to boost the agricultural industry by introducing IoT devices that can offer data about agricultural fields. We presented an IoT and smart agriculture solution based on automation.

A. LIST OF USING ELEMENTS:

Arduino Uno, Soil Moisture Sensor, ESP8266, DHT22, DHT11, DC Motor, Cell, Connecting Wire

B. WORK DESIGN

In this system, the 9V power supplied by the adapter is distributed to two sections: one through a 7805-voltage regulator and the other through a 1117-voltage regulator [13]. The 7805-voltage regulator provides a 5V supply to the Arduino, soil moisture sensor, DHT22 sensor, and pump set, whereas the 1117 regulator supplies 3.3V to the ESP8266 module. [13]. The controller generates three principal outputs by processing digital and analog information captured by the soil moisture sensor as well as the temperature and humidity sensors.

The temperature measurement and moisture levels are displayed on the LCD screen, and the data is sent to the ESP8266 device through UART programming for cloud integration, simultaneously, the controller manages the pump using a transistor module on the third output channel [13, 14].

3. FLOW CHART OF THE PROPOSED SYSTEM

The flow chart for the proposed IoT based smart agriculture model is illustrated in Fig 1.

4. DATA ANALYSIS AND RESULTS

The following results show the effectiveness of the IoT-based smart farming system: A comparative study shows that precision irrigation uses 30% less water compared to traditional methods. Data from test farms reveal that adopting optimal agricultural practices leads to a 20% increase in crop yield. Additionally, automation has reduced labor costs by 25% while maintaining high operational efficiency.

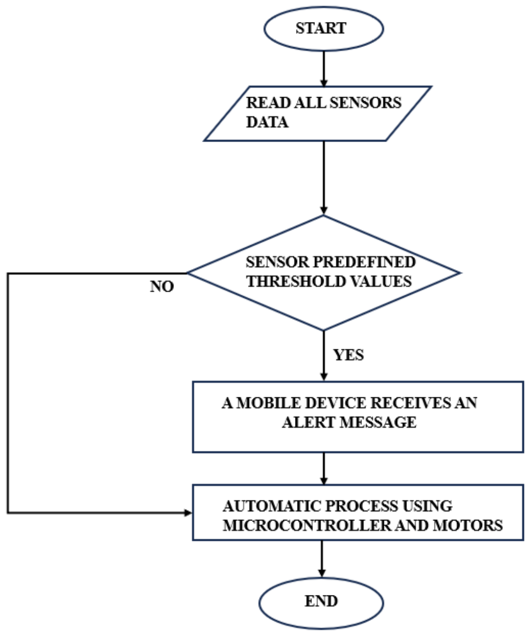

Fig:1 Flow chart of proposed model

Table 1. Comparison of Key Metrics

Metric	**Traditional Farming**	**IoT-Based System**
Water Usage	High	Low
Crop Yield	Moderate	High
Labor Costs	High	Low
Environmental Impact	High	Low

Fig: 2 Prototype in off condition

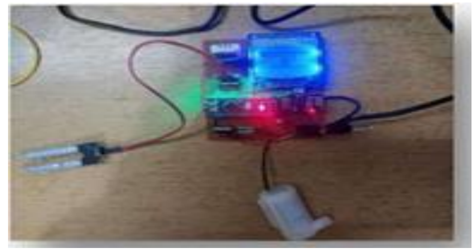

Fig: 3 Prototype in on condition

5. CONCLUSION

The Farm Tracking System is capable of being utilized to determine agricultural destiny elements. Farmers will benefit from this because it reduces the amount of manual labor required. A device for monitoring soil moisture levels was developed, providing an opportunity to analyze existing systems, along with their features and limitations [14]. This device can automate the irrigation process by controlling the water sprinkler based on soil moisture levels, effectively handling one of farming's most time-consuming jobs. The project could be enhanced by adding a pump to the system, enabling automated irrigation [15]. This autonomous watering system would be activated whenever the soil moisture level falls below the threshold which is defined in the Arduino code by observing some parameters. Whenever the mud moisture value drops below the trigger value, the pump is automatically activated, ensuring adequate irrigation. To develop the system's efficiency and effectiveness, the suggested recommendations can be considered. The application of IoT in irrigation can be extended to encompass other agricultural tasks, such as livestock management, fire detection, and climate control. This expansion could significantly reduce the need for human intervention in farming operations.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 109-113 ISSN: 0973-6875

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ORIGINAL CONTRIBUTION

IoT-Based Energy Meter for Real-Time Current, Voltage, and Cost Monitoring

[1]Pulak Maity, [2]Rajesh Ghorai ,[2]Milan Pramanik ,[2] Nasir Hussain, [2]Sajim Ansari, [2]Gopinath Samanta, [2]Gourav Kayal, [2]Gopal Raj, [2]Mainak Patra, [2]Priam Kundu, [2]Manabendra Poria

[1]*Department of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

[2,]*UG student, Dept. of Electronics and Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal*

ABSTRACT

Observing and monitoring your power utilization for verification is a not a easy task today since regularly checking the meter room is very tedious task Well, it is very important to know whether you are charged likewise so the need is very sure. Well, we have made a system that allows users to monitor energy meter readings over IOT. Our proposed system utilizes energy meter with microcontroller system to monitor energy utilization utilizing a meter. The meter is used to monitor units consumed, estimated cost, Line Voltage and current consumed. Simple web application named IoT Gecko shows the Live Output of these reading over the IOT.This enables user to effortlessly check the units consumed, estimated cost, Line Voltage and current consumed Live from anywhere through the site. In this way the energy meter observing framework enables client to adequately screen power meter readings and check the charging on the IoTgecko.com effortlessly.

KEYWORDS: IOT, Cost Monitoring System, ESP32, ZMPT101B, SIM800L, LM2596

1. INTRODUCTION

In recent years, the global emphasis on energy efficiency and sustainable practices has driven the development of innovative technologies to monitor and manage energy consumption effectively. One such advancement is the Internet of Things (IOT), which has revolutionized various industries by enabling real-time data monitoring and automation. In the energy sector, IOT-based energy meters have become essential tools for enhancing energy management practices through precise measurement and analysis. The Internet of Things (IOT) refers to the interconnected network of physical objects embedded with sensors, software, and other technologies that enable these objects to collect and exchange data. IOT technology is poised to transform everyday life, providing advanced services across numerous domains, including healthcare, smart cities, agriculture, and, notably, energy management. The "IOT Energy Meter with Current, Voltage, and Cost Monitoring System" is a cutting- edge solution designed to offer real-time insights into energy consumption patterns. This system allows users to monitor electrical parameters such as current and voltage while also providing cost analysis to promote efficient energy usage. The following key components and technologies make this system possible:

*Corresponding Address: xpulakmaity@gmail.com

DOI: 10.5281/zenodo.14592546

Sensors and Actuators: Sensors in the energy meter detect and measure electrical parameters such as current, voltage, and power consumption. Actuators can be used to control electrical devices based on the data collected, enabling automation and optimization of energy use without human intervention.

Connectivity Technologies: To transmit data from the energy meter to a centralized system or cloud platform, various connectivity options are employed. These include Wi-Fi, Bluetooth, cellular networks, Zigbee, and LoRaWAN, ensuring seamless data transmission and accessibility.

Cloud Computing: Cloud platforms play a crucial role in storing, processing, and analyzing the vast amounts of data generated by the energy meter. Cloud computing provides the necessary infrastructure to handle data storage, analytics, and the deployment of IOT applications.

Big Data Analytics: Advanced analytics tools are employed to interpret the data collected from the energy meter. These tools, including machine learning algorithms and predictive models, help identify usage patterns, forecast energy demands, and suggest optimization strategies.

Security and Privacy Technologies: As the deployment of IOT devices increases, ensuring the security and privacy of the data becomes paramount. Technologies such as encryption, access controls, and intrusion detection systems are implemented to safeguard the data from cyber threats. By leveraging these technologies, the IOT Energy Meter with Current, Voltage, and Cost Monitoring System aims to provide users with comprehensive insights into their energy consumption. This not only helps in reducing energy costs but also contributes to sustainable energy practices by promoting efficient usage and minimizing waste.

OBJECTIVES: The objective of the IOT Energy Meter with Current, Voltage, and Cost Monitoring System is to enhance energy management practices by leveraging modern technology to improve efficiency, monitoring, and cost-effectiveness. Key goals include:

Efficient Energy Management: Monitoring and analyzing energy consumption patterns in real-time to optimize the use of electrical resources and reduce wastage.

Cost Reduction: Providing detailed cost analysis based on real-time data, enabling users to identify and eliminate unnecessary energy expenditures, thereby reducing overall energy costs.

Real-time Monitoring: Offering continuous, real-time monitoring of electrical parameters such as current, voltage, and power usage. This allows for immediate action to be taken in response to anomalies or inefficiencies.

Automation: Integrating automation capabilities to control electrical devices based on data insights, reducing the need for manual intervention and improving operational efficiency.

Data-driven Decision Making: Utilizing data analytics to make informed decisions about energy usage patterns, load management, and future energy needs. This helps in planning and implementing effective energy- saving strategies.

Enhanced Security and Privacy: Ensuring the security and privacy of data through advanced technologies such as encryption and access controls to protect against cyber threats.

Sustainability: Promoting sustainable energy practices by providing tools and insights that encourage efficient energy use, thereby reducing the environmental impact.

Improved Reliability: Enhancing the reliability of the electrical system by identifying and addressing issues promptly through continuous monitoring and analysis.

These objectives aim to create a more sustainable and efficient energy management system that is well-equipped to handle the challenges of modern energy consumption and conservation.

2. COMPONENTS USED

The key components used in the IOT Energy Meter with Current, Voltage, and Cost Monitoring System are:

ESP32: A powerful microcontroller with built-in Wi-Fi and Bluetooth capabilities. It is responsible for connecting to the Blynk cloud, controlling the sensors, and processing the data collected.

ZMPT101B: A voltage sensor module used to measure the AC voltage of the electrical system. It provides accurate voltage readings that are crucial for monitoring and analysis.

ZMCT103: A current transformer used to measure the AC current in the electrical system. It provides precise current readings that help in understanding the power consumption.

16x2 LED Display: A display module used to show real-time readings of current, voltage, and other relevant data directly on the device for easy monitoring.

1-Channel Relay Module: Used to control electrical devices such as a bulb. The relay module can switch the device on or off based on predefined conditions, such as the balance reaching zero.

SIM800L: A GSM module used for communication. It allows the system to send alerts and notifications via SMS, providing updates on the energy meter's status.

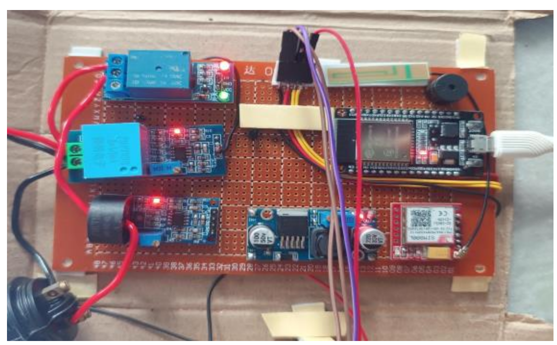
LM2596: A DC-DC buck converter used to step down the voltage to a suitable level for the ESP32 and other components, ensuring stable and efficient power supply.

3. SOFTWARE USED

Blynk: Blynk is an IoT platform designed to control hardware remotely, display sensor data, and create automation projects. It provides a user-friendly mobile app where users can monitor and control their projects in real time. Blynk works with a wide variety of hardware, including the ESP32 used in this Energy Meter project include:

Virtual Pins: Blynk allows the mapping of sensor data (current, voltage, and power usage) to virtual pins, making it easy to visualize these parameters in the mobile app.

Cloud Connectivity: It connects the ESP32 to the internet, allowing real-time monitoring and control of the energy meter system from anywhere.
Automation and Alerts: Blynk can automate tasks such as turning off devices when the balance reaches zero. Additionally, Blynk can send notifications or emails when certain thresholds are met, such as high-power consumption or voltage anomalies.
Arduino IDE: The Arduino IDE is a widely used



development environment for programming microcontrollers like the ESP32. It allows developers to write, compile, and upload code to microcontroller boards. Features of the Arduino IDE in this project include:
Code Development: The Arduino IDE provides an easy platform to write and modify the C/C++ code

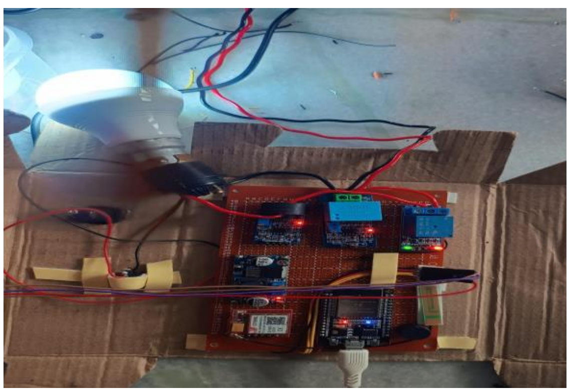
controlling the sensors and actuators in the energy meter system.

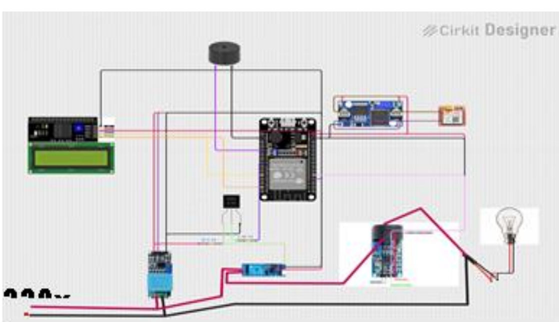
Libraries: In this project, libraries like BlynkSimpleEsp32.h, ZMPT101B.h, and ZMCT103.h are used, allowing integration with the Blynk platform and the various sensors.

Serial Monitor: The Serial Monitor in the IDE is useful for debugging by displaying real-time data like current, voltage, and power usage from the sensors.

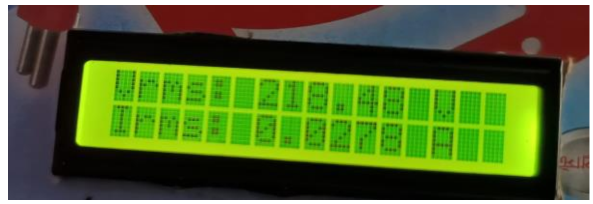
These software tools work together to provide a comprehensive solution for monitoring and managing energy consumption, offering real-time data and control capabilities to enhance energy efficiency and cost-effectiveness.

4. CIRCUIT DIAGRAM

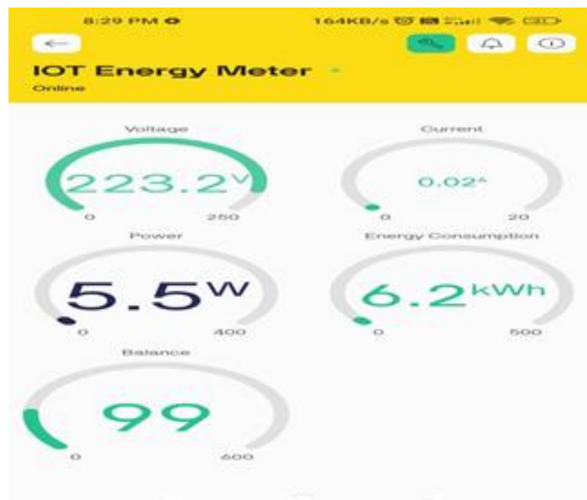




16 x2 LED DISPLAY OUTPUT



5. OUTPUT ON BLYN



6. CONCLUSION

The "IoT Energy Meter with Current, Voltage, and Cost Monitoring System" project successfully demonstrates the integration of IoT technology with energy management solutions. By leveraging components such as the ESP32, ZMPT101B, and ZMCT103, we have developed a system that not only measures current and voltage but also provides real-time cost monitoring. The integration with the Blynk app allows for user-friendly access to data, empowering users to monitor their energy consumption from anywhere. The automatic disconnection of the bulb when the balance reaches zero adds an essential safety feature, ensuring energy conservation and preventing unnecessary costs. This project highlights the potential of IoT in enhancing energy efficiency and promoting sustainable practices. Future enhancements could include advanced data analytics for predictive energy usage, additional sensors for environmental monitoring, and integration with smart home systems for a more comprehensive energy management solution.

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Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

IoT Based Home Automation Using Arduino

[1]Sachindeb Jana,[2]Abhishek Anand,[2]Akash Kumar,[2]Ankit Kumar Mandal,[2]Aman Srivastav,[2]Ankit Kumar Yadav,[2]Akash Sinha,[2]Ajit Kumar,[2]Ankit Raj,[2]Aman Karn,[2]Ankit Kumar

[1]Department of Electronics &Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

[2]UG student, Dept. of Electronics &Communication Engineering, Haldia Institute of Technology, Haldia, Purba Medinipur, West Bengal

ABSTRACT

Even while living expenses are rising, there is an increasing emphasis on using technology to reduce them. In light of this, the Smart Home project enables the user to design and manage a home that is intelligent enough to reduce energy consumption while offering more automated features. Utilizing its surroundings, a smart house will enable smooth operation whether the user is home or not. When your house has this benefit, you can be sure that its energy efficiency is at its peak. Software programming, PCB design, Wi-Fi, TCP/IP protocols, Web Server logic design, and other engineering issues can all be investigated by putting this system into practice. The concept and prototype of an improved home automation system that connects all of its components over WiFi are displayed in this paper. There are two major components to the suggested system. The Internet of Things (IoT) is the first piece of software. This is the system component that keeps an eye on users' household appliances. Through a local area network (LAN) or the internet, users and system administrators can keep an eye on the system from a distance. The second component is the hardware interface module, which serves as the actuator for the home automation system and connects sensors appropriately using an Arduino UNO. With the use of several sensors to trigger the system's operation, the system has performed as anticipated.

KEYWORDS: Arduino Uno Controller; Internet of Things (IoT); Wi-Fi network; Home automation system.

1. INTRODUCTION

In recent years, the rapid evolution of technology has profoundly impacted various aspects of daily life, particularly in the realm of home management. The increasing complexity of household tasks and the growing concerns over safety and energy efficiency have fueled a burgeoning interest in home automation systems. Our work emerges as a response to this demand, aiming to create a sophisticated yet accessible solution for modern homes. The motivation behind this work is rooted in the need to integrate multiple functionalities into a single, cohesive system that enhances both convenience and security. By harnessing the capabilities of Arduino and the Internet of Things (IoT), we seek to address common household challenges with an innovative approach. The project encompasses a range of features designed to streamline daily routines, such as automated control of lighting and fan speed, and crucial safety measures including fire and smoke alarms. Additionally, the system aims to bolster home security through advanced motion detection and remote access capabilities. This project represents a convergence of practical problem-solving with cutting-edge technology,

*Corresponding Address: *mmmsachin@gmail.com*

DOI: 10.5281/zenodo.14592674

striving to deliver a user-friendly, cost-effective solution that not only improves the quality of life but also contributes to a safer and more efficient living environment.

The automation system is driven by several specific goals aimed at delivering a comprehensive and effective home automation solution. First and foremost, the project seeks to develop a robust and responsive system for managing household environments through real-time data collection and control. One key objective is to implement a reliable fire and smoke alarm system, capable of detecting hazardous conditions and alerting occupants promptly, thereby enhancing safety. Another goal is to create a smart door lock mechanism that allows secure and remote access, providing convenience and security. Additionally, the project aims to integrate humidity and temperature sensors to monitor and regulate environmental conditions, optimizing comfort and energy efficiency. The system will also feature advanced controls for adjusting fan speed and light bulb brightness, tailored to user preferences and automated schedules. A significant aspect of the project involves the development of a mobile application and a voice-controlled interface, allowing users to interact with and manage the system remotely. Measurable outcomes include achieving a high level of system reliability, user satisfaction, and operational efficiency, as well as successful integration and interoperability of all components. By setting these clear objectives, the project aspires to create a sophisticated, user-centric automation system that addresses both practical needs and enhances overall home safety and comfort.

2. WORKING PRINCIPLE

The choice of technologies for the work was driven by a combination of factors, including cost-effectiveness, ease of implementation, and flexibility. Arduino was selected as the primary microcontroller due to its open-source nature, extensive community support, and compatibility with a wide range of sensors and modules. Unlike more complex alternatives such as Raspberry Pi, Arduino offers a simple random accessible platform for building basic IoT systems without requiring deep technical expertise. The wireless communication modules, such as the ESP8266, were chosen for their reliability and low power consumption, enabling seamless Wi-Fi connectivity while maintaining energy efficiency. Additionally, the decision to use a mobile application for control rather than a web-based interface was driven by the need for mobility and convenience, allowing users to interact with the system on the go. Voice assistant integration, using technologies like Google Assistant or Alexa, was prioritized for its widespread use and user-friendly interface, making hands-free control an essential feature. These technology choices collectively balanced performance, cost, and user accessibility, ensuring the system could be developed efficiently while meeting all project requirements.

3. FUNCTIONALITY AND FEATURES

Our work incorporates several advanced features designed to optimize home management, safety, and user convenience. Here’s an in-depth look at each feature:

Fire and Smoke Alarm System: This feature is pivotal in safeguarding the home from fire hazards. The system utilizes smoke detectors placed in strategic locations throughout the house, which are sensitive to particles in the air that indicate smoke. Additionally, a temperature sensor is used to monitor any unusual increases in temperature that could signal a fire. When smoke or high temperatures are detected, the system immediately triggers a loud alarm to alert occupants. Simultaneously, it sends real-time notifications to the user’s mobile device, ensuring that they are informed even when they are away from home. The integration of these sensors with a sophisticated algorithm helps to minimize false positives by distinguishing between normal and dangerous conditions, thus providing reliable fire safety.

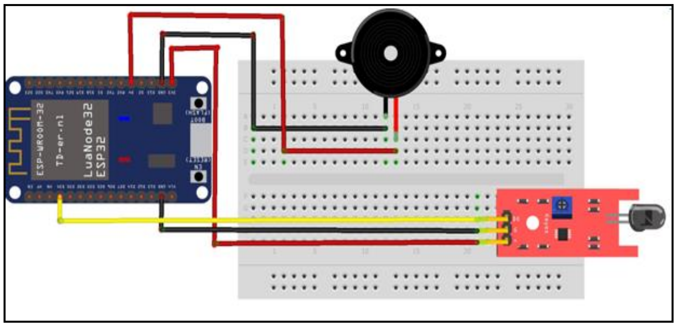
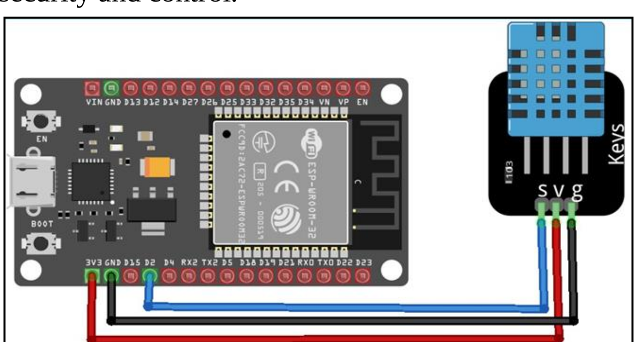


Fig1: IoT based Fire and Smoke Alarm System

<u>Smart Door Lock</u>: The smart door lock is designed to enhance home security and convenience. It combines electronic locking mechanisms with remote access technology. Users can lock or unlock the door using their smart phone through the mobile application, which communicates with the lock via Bluetooth or Wi-Fi. The lock operates using RFID technology, which provides secure access by reading key fobs or cards. For added security, the system includes features such as auto-locking after a certain period and temporary access codes that can be shared with guests. The mobile app also log search entry and exit, allowing users to monitor who enters and exits the home and at what times, offering an additional layer of security and control.



IoT based smart doo locking system

Fig2: IoT based Fire and Smart door locking System

Humidity and Temperature Sensors: These sensors continuously track the environmental conditions within the home. The temperature sensor measures the ambient temperature, while the humidity sensor monitors the moisture levels in the air. Data from these sensors are used to adjust connected HVAC systems or other climate control devices automatically. For example, if the temperature exceeds a set threshold, the system might activate the air conditioning to maintain a comfortable indoor climate. Similarly, if humidity levels rise above a certain level, the system could turn on a dehumidifier. This automated control helps in maintaining optimal living conditions and can contribute to energy savings by adjusting settings based on real-time data rather than preset schedules.

Motion Detection for Intruder Detection: Motion sensors are installed at key points around the home to detect unauthorized movement. These sensors use passive infrared (PIR) technology to detect changes in heat signatures, which helps to identify human movement even in low light conditions. When motion is detected, the system can trigger various responses, such as turning on lights to deter intruders, sounding an alarm, or sending an alert to the user’s mobile device. The system can be configured to differentiate between typical household movements and suspicious activity, reducing false alarms and ensuring a responsive security system.

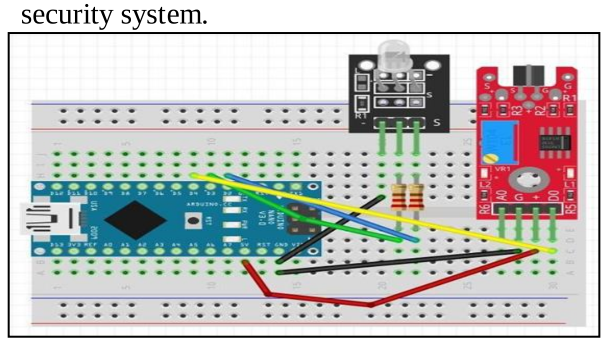


Fig3: IoT based Motion Detection for Intruder Detection

Mobile Application and Voice-Controlled Interface:

The mobile application serves as the central control hub for the home automation system. It provides users with a user-friendly interface to monitor and manage all connected devices. Features include real-time data visualization, control over settings, and notifications for system alerts. The voice-controlled interface allows users to interact with the system through voice commands, using popular virtual assistants like Alexa or Google Assistant. This hands-free control is particularly useful for users who are busy or have mobility issues. Integration with voice assistants enables a more intuitive and seamless interaction with the home automation system, allowing for commands such as adjusting the thermostat, controlling lights, or locking doors with simple voice instructions.

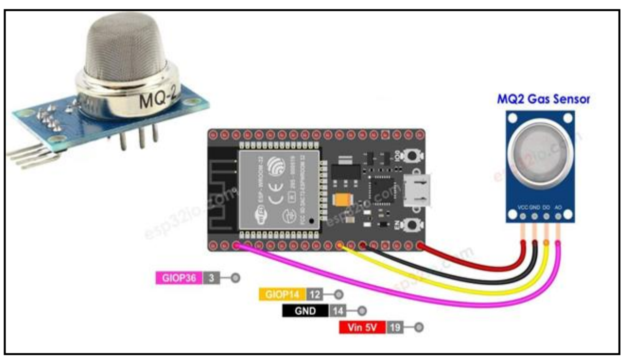


Fig4: IoT based gas sensor

4. PROGRAMMING CODES FOR VARIOUS IOT BASED MODULES

4.(a) Alarm system

```
void DisplayTimeAndDate() {
  time_t now;
  struct tm timeinfo;
  if (!getLocalTime(&timeinfo)) {
    lcd.setCursor(0, 0);
    lcd.print("Time/Date Error");
  } else {
    lcd.setCursor(0, 0);
    lcd.print("Time: ");
    lcd.print( &timeinfo, "%H:%M:%S"); // Display Time
    lcd.setCursor(0, 1);
    lcd.print("Date: ");
    lcd.print( &timeinfo, "%d-%m-%Y"); // Display Date
  }
}
```

4.(b) Smart Door lockng system

```
// Handle Blynk virtual pin V0 (Access Control Switch)
BLYNK_WRITE(V0) {
  String alertMessage = "NoAlert";
  int switchState = param.asInt();
  if (switchState == 1) {
    // Unlock the door through Blynk
    UnlockDoor();
    alertMessage = "Access Granted";
    shortAlarm();
    } else {
    // Lock the door through Blynk
    LockDoor();
    alertMessage = "Access Locked";
    shortAlarm();
  }
  DisplayMessage(alertMessage);
}

BLYNK_WRITE(V6) {
  int switchState = param.asInt();
  if (switchState == 0) {
   newTimeInput = false;
  }
}
```

4. (c) Smart gas, fire or smoke detector

```
int flameValue = digitalRead(FLAME_PIN);
int gasValue = analogRead(MQ2_PIN);

// Create Fire, Gas, Smoke Detection Alerts
String alertMessage = "NoAlert";
if (flameValue == LOW && gasValue < 1000) {  // Flame detected
  alertMessage = "Fire Detected";
  HeavyAleart(); // Trigger alarm
} else if (gasValue > 1000) {  // Gas or smoke detected
  alertMessage = "Gas/Smoke Detected";
  HeavyAleart();  // Trigger alarm
} else if (flameValue == LOW && gasValue > 1000) {  // Both gas and fire detected
  alertMessage = "Gas/Smoke & Fire Detected";
  HeavyAleart();  // Trigger alarm
} else {
  digitalWrite(ALARM_PIN, LOW);  // Turn off alarm if no alert
}
```

5. CHALLENGES AND SOLUTIONS

The effectiveness of the solutions implemented in the systems can be assessed by examining their performance in real-world scenario sand their impact on user experience. Each component of the system was selected and designed to address specific needs and challenges within the home environment. The fire and smoke alarm system has demonstrated its effectiveness through reliable detection of smoke and temperature anomalies, with the ability to promptly alert users and minimize false alarms, enhancing household safety. The smart door lock has proven to be a secure and convenient solution for managing access, providing users with the flexibility to control entry remotely and maintain detailed logs of access events, thereby improving home security. The humidity and temperature sensors have effectively maintained optimal indoor conditions by integrating with the HVAC system to regulate climate based on real-time data, contributing to both user comfort and energy efficiency. The control of fan speed and light brightness has been successful in allowing users to personalize their environment, with automated settings providing additional convenience and energy savings. The motion detection system has reliably identified unauthorized movement, triggering timely alerts and security responses that enhance home protection. The mobile application and voice-controlled interface have facilitated seamless interaction with the system, offering users a comprehensive and user-friendly way to manage and monitor their home environment from anywhere.

6. FUTUREWORKANDIMPROVEMENTS

Enhancement Proposals:

To further advance the systems, several enhancements and additional features could be considered. Integrating advanced machine learning algorithms could significantly improve the system's ability to predict and adapt to user behavior, such as automatically adjusting climate settings based on historical patterns or learning user preferences for lighting and fan speeds, expanding the system to support additional smart home devices, such as smart appliances or voice-activated assistants, would provide a more comprehensive automation experience. Adding a feature for remote diagnostics and troubleshooting could also enhance system reliability by allowing for proactive maintenance and quicker resolution of issues. Furthermore, incorporating a user-friendly web interface alongside the mobile application would offer greater flexibility in managing the system from various devices. Enhancing data security measures, such as implementing end-to-end encryption and multi-factor authentication, would ensure that user information and system controls are protected against unauthorized access. These improvements would not only broaden the system's capabilities but also enhance overall user experience and security.

Long-term Vision:

The systems have significant potential for scaling and extension, positioning it for future growth and broader application. As technology evolves, the system could be expanded to integrate with emerging smart home technologies and standards, such as advanced AI-driven home assistants or next-generation wireless communication protocols like 5G. Scaling the project could involve developing modular components that allow for easy upgrades and customization, enabling users to add new features or integrate with other smart devices seamlessly. Additionally, the system could be extended to support multi-home configurations, providing centralized control for multiple properties, such as vacation homes or rental properties. The integration of advanced analytics and cloud-based services could offer users deeper insights into their home's energy usage and security patterns, further enhancing the system's value. Collaborating with other IoT and smart home solution providers could open opportunities for creating a more interconnected and intelligent home environment. These expansions and enhancements would not only future-proof the system but also broaden its appeal to a wider audience, driving continued innovation and user engagement.

7. CONCLUSION

Our system successfully integrated multiple smart features, including fireand smoke detection, smartdoor locking, environmental monitoring, motion sensing for security, and voice-controlled automation, offering a comprehensive home management solution. The systems key findings highlight the effectiveness of these solutions in enhancing home safety, convenience, and energy efficiency, supported by robust user feedback and real-time data monitoring. The overall impact of the project on users has been significant, as it empowers them with greater control over their living environment, improves security measures, and fosters energy-conscious habits. Additionally, the user-friendly mobile app and voice assistant integration have made the system accessible and practical for everyday use. Looking forward, the project has great potential for scaling and enhancement, with opportunities to incorporate advanced machine learning, broader device integration, and enhanced security features. By embracing future technologies like AI and 5G, the system could evolve into an even more intelligent and adaptive smart home solution, positioning it for wider adoption and further innovation in the IoT space.

Biologically, decision is an internal desire encapsulated by the cognitive aspects to judge time and instinct variant hierarchical phenomena.

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Int.J.HIT.TRANSC:ECCN.Vol.10: Special Issue (2025) Page 120-124 ISSN: 0973-6875

Available Online at www.hithaldia.in/locate/ECCN

ORIGINAL CONTRIBUTION

Host Based Intrusion Detection System

[1]Mehaboob Mujawar, [2]Aasheesh Raizada

[1]Research Scholar, Mangalayatan University, Beswan, Aligarh-India

[2]Associate Professor, Mangalayatan University, Beswan, Aligarh-India

ABSTRACT

This paper develops a Host-Based Intrusion Detection System (HIDS) using the Isolation Forest algorithm to detect anomalies in host system logs, such as CPU usage and memory activity. The system employs a user-friendly GUI for data input, anomaly visualization, and result analysis. Optimized for real-time detection, it addresses challenges like high false positive rates and scalability. By leveraging machine learning, this research enhances the detection of both known and novel threats, contributing to robust cybersecurity solutions and paving the way for future integrations with network-based intrusion detection systems.

KEYWORDS: *Host-Based Intrusion Detection System (HIDS), Anomaly Detection, Isolation Forest Algorithm, System Logs, Cybersecurity, Machine Learning, Real-Time Threat Detection, Resource Usage Monitoring, False Positive Reduction, Graphical User Interface (GUI)*

1. INTRODUCTION

Intrusion Detection Systems (IDS) are integral to modern cybersecurity frameworks, designed to safeguard computer systems and networks from unauthorized access, malicious activities, and potential security breaches. IDS solutions are broadly categorized into Network-Based Intrusion Detection Systems (NIDS) and Host-Based Intrusion Detection Systems (HIDS). While NIDS monitor network traffic for suspicious activity, HIDS focuses on monitoring individual host systems by analyzing system logs, resource usage, file integrity, and user activities. The growing complexity and volume of cyber threats have underscored the importance of HIDS in identifying internal security threats, such as those stemming from malicious insiders or unauthorized changes. Traditional IDS primarily rely on signature-based detection methods, which identify threats based on predefined patterns of known attacks. While effective against previously encountered threats, these systems struggle to detect novel or zero-day attacks that lack existing signatures. This limitation highlights the need for anomaly detection techniques, which identify deviations from normal behavior to flag potential security incidents.

Machine learning algorithms, such as Isolation Forest, offer a promising approach to anomaly detection by learning normal system behavior and identifying anomalies as deviations. These techniques are particularly valuable in analyzing high-dimensional datasets, such as system logs, where traditional methods may falter. By leveraging machine learning, HIDS can enhance the early detection of threats and reduce response times, strengthening overall security posture. This project aims to develop a Host-Based Intrusion Detection System employing Isolation Forest to detect anomalies in system logs. The system analyzes metrics such as CPU usage, memory consumption, and disk activity to identify abnormal patterns. A user-friendly Graphical User Interface (GUI) has been integrated, enabling users to upload logs, visualize detection results, and save outputs for further analysis. Through this research, the project seeks to address key challenges in HIDS, such as real-time

*Corresponding Address: mehaboob311134@gmail.com

DOI: 10.5281/zenodo.14592704

detection, scalability, and reducing false positive rates, thereby advancing the state-of-the-art in host-level cybersecurity solutions.

2. LITERATURE SURVEY

In the field of intrusion detection, several studies have explored different methodologies for identifying threats and anomalies in both network and host-based systems. Traditional intrusion detection systems relied on signature-based detection, where attacks were identified based on predefined patterns or signatures of known threats. While effective against known attacks, this approach struggles to identify novel or zero-day threats that do not match any existing signature. In response, the need for anomaly detection systems became apparent, as they offer a way to detect previously unknown attacks by identifying deviations from normal behavior. A variety of machine learning techniques have been applied to anomaly detection in IDS systems, including K-means clustering, Support Vector Machines (SVMs), Auto encoders, and Isolation Forest. Among these, Isolation Forest has gained significant attention due to its efficiency in high-dimensional spaces and its ability to detect anomalies in large datasets. Isolation Forest works by isolating observations using decision trees, where the anomalies are those that can be isolated with fewer splits compared to normal data points. This makes it highly effective for anomaly detection, particularly in scenarios where the data is sparse or high-dimensional, as is often the case with system logs.

HIDS, when combined with machine learning techniques like Isolation Forest, offers a powerful way to detect internal threats or issues that may not be easily detectable through traditional monitoring methods. Studies have demonstrated the effectiveness of applying machine learning algorithms to HIDS, particularly for tasks such as detecting abnormal system behavior, unauthorized access, and malicious software activity. However, implementing machine learning in HIDS also comes with challenges, such as feature selection, data preprocessing, and managing false positive rates. Additionally, most existing research has focused on offline analysis, where logs are processed after the fact. Real-time detection, which is crucial for preventing immediate threats, remains an area that requires further development. One of the key issues highlighted in the literature is the trade-off between detection accuracy and false positive rates.

While machine learning algorithms can detect a wide range of anomalies, they are often prone to generating false positives, which can overwhelm system administrators and reduce the effectiveness of the IDS. Another challenge is scalability, as many machine learning-based IDS systems struggle to handle the volume of data generated by large organizations with multiple host systems. Thus, while significant progress has been made in applying machine learning to intrusion detection, there are still several gaps in real-time processing, scalability, and reducing false positives. The literature review highlights the significant progress made in the application of anomaly detection for Host-Based Intrusion Detection Systems (HIDS), particularly with the use of machine learning techniques such as Isolation Forest. While this approach offers substantial advantages, including the ability to detect unknown threats, several challenges remain, particularly in the areas of real-time detection, scalability, and reducing false positives. Future research in this area will likely focus on improving the efficiency of anomaly detection algorithms, exploring hybrid models that combine multiple techniques, and enhancing real-time detection capabilities. Integrating HIDS with other cybersecurity measures, such as network intrusion detection systems (NIDS), could also provide a more comprehensive defense against sophisticated cyber threats

3. RESEARCH METHODOLOGY

The research methodology for this project adopts a systematic approach to developing and evaluating a Host-Based Intrusion Detection System (HIDS) using anomaly detection techniques. The process begins with defining the research problem, focusing on improving HIDS capabilities to detect both known and novel intrusions. System logs containing metrics such as CPU usage, memory consumption, disk activity, and event types were collected and preprocessed through cleaning, normalization, and encoding to ensure compatibility with the Isolation Forest algorithm. Feature selection and engineering were conducted to extract relevant attributes that enhance the model's detection accuracy. The Isolation Forest algorithm was implemented in Python, utilizing libraries like Scikit-learn for efficient anomaly detection in high-dimensional datasets. A user-friendly Graphical User Interface (GUI) was developed using Tkinter, enabling users to upload logs, visualize results through charts, and save outputs for further analysis. The system was evaluated using key performance metrics such as precision, recall, F1-score, and Area Under the Curve (AUC) to ensure its effectiveness. Optimization involved fine-tuning hyper parameters to balance accuracy and false positive rates, alongside iterative testing for scalability and real-time.

The Graphical User Interface (GUI) of the system is designed to provide a seamless user experience for interacting with the anomaly detection tool. The Load Dataset button allows users to upload the input CSV dataset containing system logs. Once the dataset is loaded, the Run Anomaly Detection button initiates the detection process, applying the Isolation Forest algorithm to identify anomalies. After the detection process is complete, users can click the Visualize Results button to generate visual outputs such as charts and graphs, which help in analyzing the identified anomalies and overall system behavior. Finally, the Save Results button enables users to save the processed data into output files, categorizing records into anomalies and normal data for further investigation or reporting. This intuitive interface ensures accessibility and efficiency, making the system usable for technical and non-technical users alike. integration. Finally, the system was tested with simulated live data to validate its real-time anomaly detection capabilities. This methodology ensures the development of a robust, scalable, and efficient HIDS that addresses critical cybersecurity challenges.

Figure 1: Graphical user interface

The scatter plot for CPU usage visually depicts the usage patterns of different records within the dataset. Each point on the graph corresponds to an individual record, where normal records are displayed in green, and anomalous records, such as those indicating high CPU usage, are highlighted in red. This visual representation helps identify anomalies by showcasing instances where CPU usage exceeds predefined thresholds or deviates significantly from typical behavior.

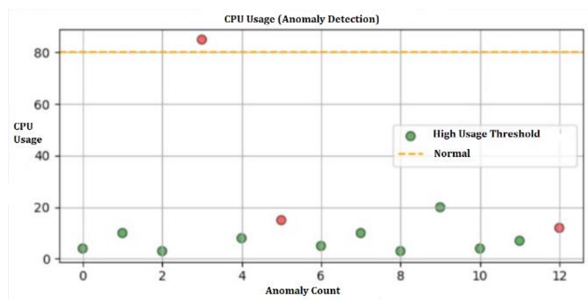

Figure 2: Scatter Plot for CPU Usage with Anomalies

By providing an intuitive and clear visualization, this graph aids in quickly pinpointing irregularities in system performance for further analysis.

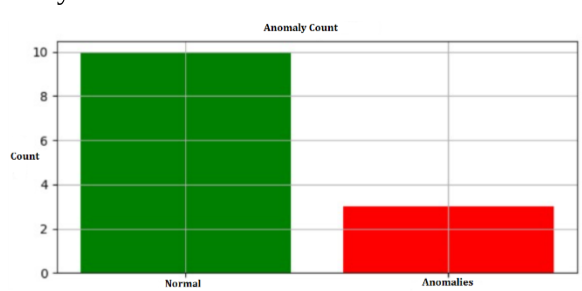

Figure 3: Bar Plot for Anomaly Counts

The bar plot for anomaly counts provides a clear summary of the detected records, categorized into "Normal" and "Anomalies." Each bar is labeled to represent the respective category, offering a quick and quantitative analysis of the dataset. This visualization highlights the balance between normal and suspicious activities, enabling users to assess the overall detection results effectively and gain insights into the distribution of anomalies within the dataset.

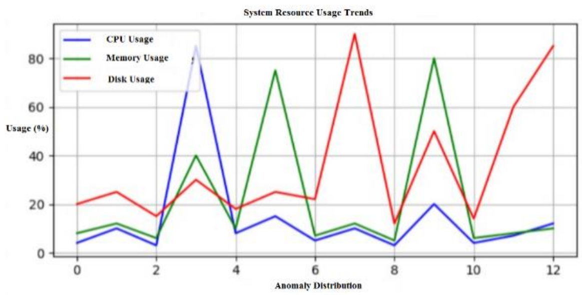

Figure 4: Line Plot for System Resource Trends

The line plot for system resource trends illustrates the patterns of CPU usage, memory usage, and disk usage over time or across record indices. Multiple lines in distinct colors represent each resource, allowing for easy comparison of their usage trends. This visualization helps identify spikes, unusual changes, or consistent patterns in resource consumption, providing valuable insights into system performance. By highlighting these trends, the line plot enables users to monitor resource usage effectively and detect potential anomalies related to system behavior.

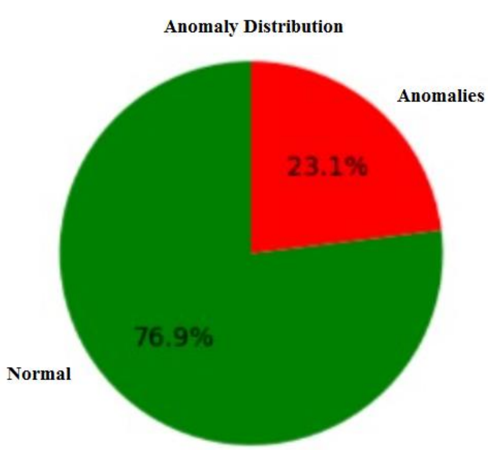

Figure 5: Pie Chart for Anomaly Distribution

The pie chart for anomaly distribution provides a clear and visually appealing representation of the dataset's composition, highlighting the proportion of normal versus anomalous records. The chart is divided into two distinct segments, with green representing normal records and red indicating anomalous records. Percentage labels are prominently displayed, making it easy to interpret the ratio of anomalies detected within the dataset. This chart serves as an intuitive and effective tool for quickly understanding the anomaly detection results.

4. CONCLUSION AND FUTURE SCOPE

In conclusion, this project successfully developed a Host-Based Intrusion Detection System (HIDS) employing the Isolation Forest algorithm for anomaly detection. The system demonstrates the ability to effectively identify deviations from normal behavior in system logs, offering a reliable approach to detecting potential security breaches. The graphical user interface enhances usability, enabling non-technical users to analyze logs and detect anomalies seamlessly. While the results show promise, challenges such as reducing false positives and optimizing real-time performance persist. Future work could focus on integrating advanced machine learning models, such as deep learning or hybrid approaches, to enhance detection accuracy and scalability. Real-time detection capabilities could be further refined by leveraging distributed computing and cloud-based systems. Additionally, exploring privacy-preserving techniques and explainable AI can make the system more transparent and secure, addressing concerns related to data sensitivity and trustworthiness. These advancements could contribute significantly to creating a robust, adaptive, and comprehensive cybersecurity framework.

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