A

Project Implementation Paper

On

"Intelligent Home Automation System Using Gen AI and IoT for Personalized Energy Management to Reduce Carbon Footprint"

Submitted to

Autonomous Institute,

Affiliated to The Rashtrasant Tukadoji Maharaj Nagpur University

Department of Emerging Technologies

Bachelor of Technology (B. Tech)

Submitted By

1. **Vaishnavi Rahamatkar (AM21014)**
2. **Atharva Wakdikar (AM21015)**
3. **Ayush Roy (AM21023)**
4. **Vaishnavi Dhekwar (AM21031)**

Guided By

Prof. Yogesh Narekar

S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT AND RESEARCH, NAGPUR

2024 – 2025

CERTIFICATE

This is to certify that the mini project report entitled **Intelligent Home Automation System Using Gen AI and IoT for Personalized Energy Management to Reduce Carbon Footprint** submittedby **Vaishnavi Rahamatkar, Atharva Wakdikar, Ayush Roy, Vaishnavi Dhekwar** to the **S. B. JAIN INSTITUTE OF TECHNOLOGY, MANAGEMENT AND RESEARCH, NAGPUR** of **B. Tech in (Emerging Technologies)** is a *bona fide* record of mini project work carried out by him/her under my supervision. The contents of this report, in full or in parts, have not been submitted to any other Institution or University for the award of any degree or diploma.

Signature	**Signature**
Vaishnavi Rahamatkar (AM21014)	**Prof. Yogesh Narekar**
Atharva Wakdikar (AM21015)	**Project Guide**
Ayush Roy (AM21023)	
Vaishnavi Dhekwar (AM21031)	

Signature of HOD with seal

DECLARATION

We declare that this mini project report titled **Intelligent Home Automation System Using Gen AI and IoT for Personalized Energy Management to Reduce Carbon Footprint** of **B. Tech in (Emerging Technologies)** is a record of original work carried out by us under the supervision of **Prof. Yogesh Narekar** , and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements havebeen made wherever the findings of others have been cited.

Signature

Vaishnavi Rahamatkar AM21014]

Atharva Wakdikar AM21015]

Ayush Roy AM21023]

Vaishnavi Dhekwar AM21031]

Date

INDEX

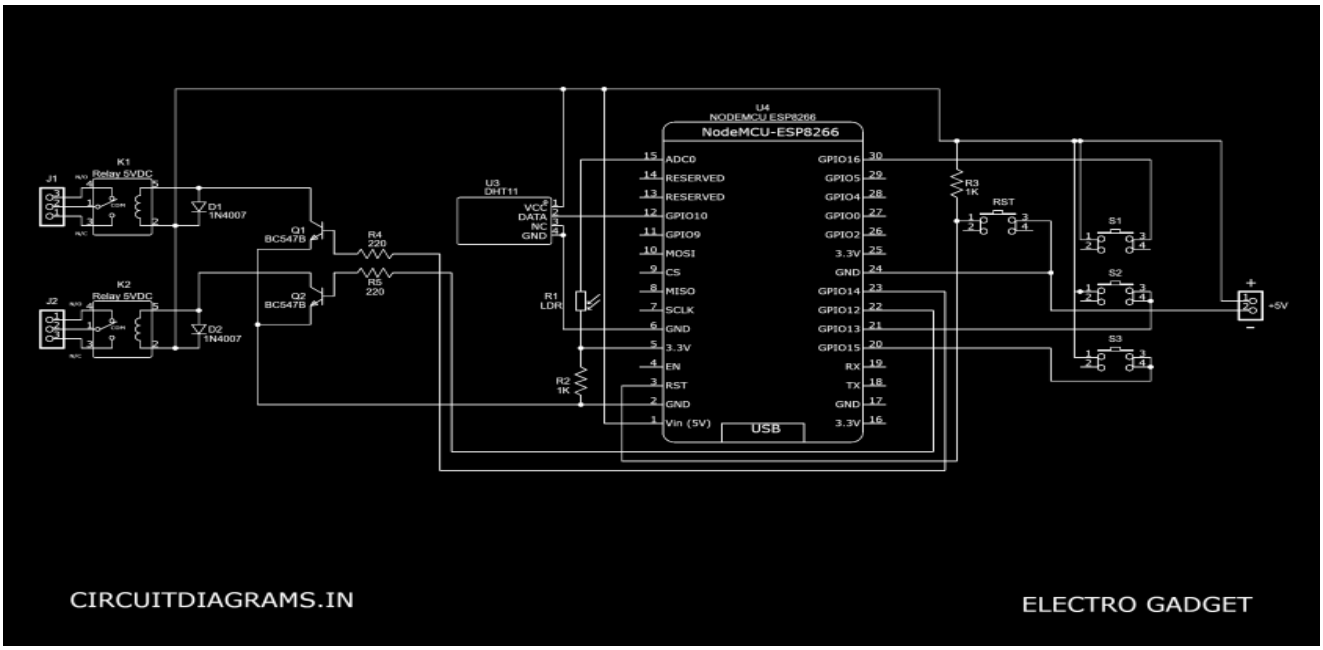
ABSTRACT

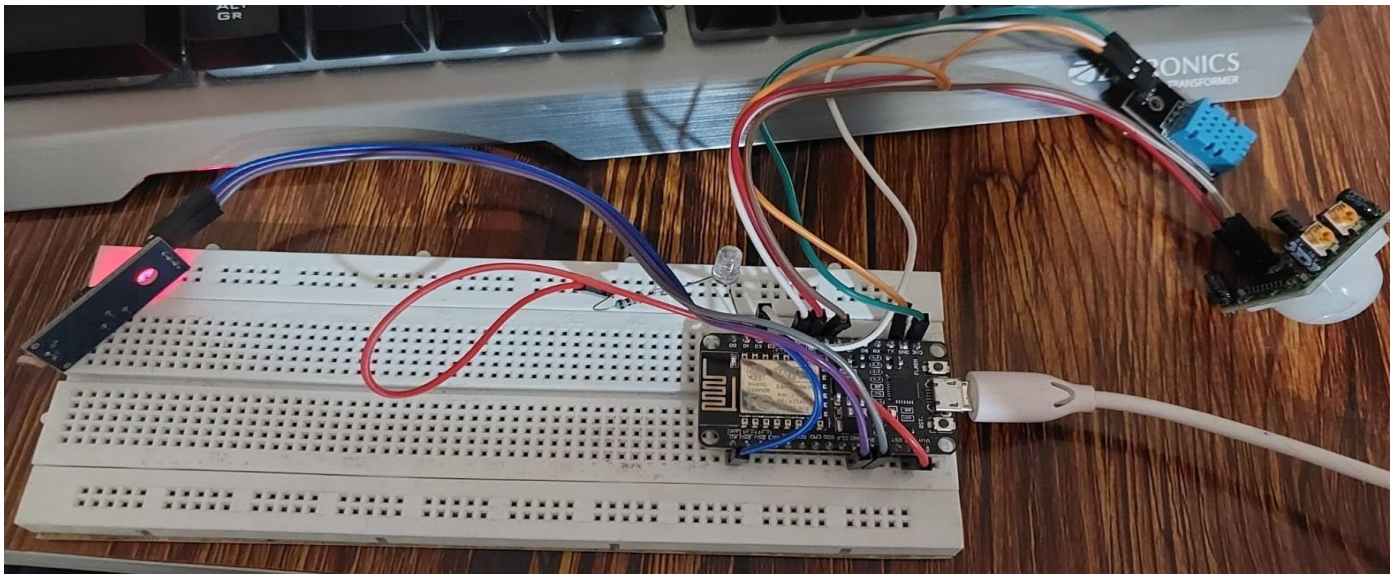
This paper explores the development and implementation of an Intelligent Home Automation System that leverages Generative AI and the Internet of Things (IoT) to enhance personalized energy management and reduce carbon footprints. As energy consumption patterns evolve, integrating smart technologies allows homeowners to optimize energy usage dynamically. The system utilizes IoT devices to collect real-time data on energy consumption, environmental conditions, and user behavior, while Generative AI analyzes this data to provide actionable insights and personalized recommendations. By automating energy management processes—such as adjusting heating, cooling, and lighting based on occupancy and preferences—this intelligent system not only enhances energy efficiency but also lowers operational costs. Furthermore, it fosters sustainable living by encouraging eco-friendly habits. The findings indicate that such a system can lead to significant reductions in energy waste and greenhouse gas emissions, offering a viable pathway for households to contribute to environmental sustainability in an increasingly energy-conscious world.

INTRODUCTION

The Intelligent Home Automation System that integrates Generative AI and the Internet of Things (IoT) represents a cutting-edge approach to personalized energy management. This system enables homeowners to optimize energy consumption through real-time monitoring and intelligent automation. By connecting smart devices—such as thermostats, lighting, and appliances—these systems can analyze usage patterns and environmental data to provide tailored recommendations. The use of Generative AI enhances this functionality by predicting energy needs and adapting settings to maximize efficiency. This not only helps reduce energy bills but also significantly lowers the carbon footprint of households, contributing to a more sustainable environment. As energy conservation becomes increasingly important, such smart home technologies offer a practical solution for individuals to actively engage in eco-friendly practices while enjoying the conveniences of modern living. Home automation systems have evolved from simple remote-controlled devices to sophisticated networks that monitor, control, and optimize energy use in real time. By harnessing IoT, these systems can connect various devices—such as smart thermostats, lighting, appliances, and energy meters—to create a cohesive ecosystem that responds to user behavior and environmental conditions. Generative AI enhances this system by analyzing vast amounts of data to identify patterns, predict energy usage, and recommend optimal settings tailored to individual households. This personalized approach not only maximizes energy efficiency but also promotes sustainable living practices by encouraging users to adopt energy saving habits.

IMPLEMENTATION OF HOME AUTOMATION STEP BY STEP WITH IMAGES:-





asdfghjkl | Arduino IDE 2.3.2

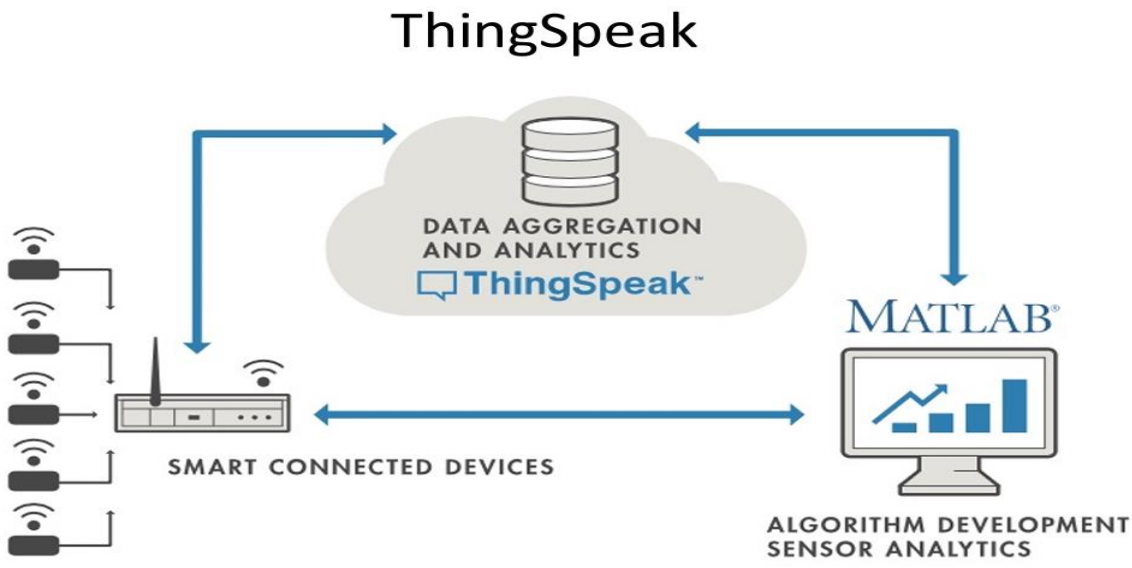
File Edit Sketch Tools Help

NodeMCU 1.0 (ESP-12E ...

asdfghjkl.ino

```
#include "DHT.h"
#include <ESP8266WiFi.h>
#include <ThingSpeak.h>

#define DPIN 4        // Pin to connect DHT sensor (GPIO number) D2
#define DTYPE DHT11   // Define DHT 11 or DHT22 sensor type
#define PIRPIN D5

// WiFi credentials
const char* ssid = "vivo T3 5G";          // Your WiFi SSID
const char* password = "1234567890";  // Your WiFi password

// ThingSpeak credentials
unsigned long myChannelNumber = 2689958;
const char* myWriteAPIKey = "ON0H58INN69KWRQM";

WiFiClient client; // WiFi client for ThingSpeak
DHT dht(DPIN, DTYPE);
int ldrPin = A0;         // LDR module connected to A0
int ledPin = D1;         // LED connected to pin D1 (GPIO5)
int threshold = 500;     // Light intensity threshold for LED
```

Output



ThingSpeak™ Channels Apps Devices Support Commercial Use How to Buy VR

Home Automation System

Channel ID: **2689958**
Author: mwa0000035387668
Access: Public

Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

Write API Key

Key: ON0H58INN69KWRQM

Generate New Write API Key

Read API Keys

Key: 17Y7XVTVBCO39GZX

Note:

Save Note | Delete API Key

Add New Read API Key

Help

API keys enable you to write data to a channel or read data from a private channel. API keys are auto-generated when you create a new channel.

API Keys Settings

- **Write API Key**: Use this key to write data to a channel. If you feel your key has been compromised, click **Generate New Write API Key.**
- **Read API Keys**: Use this key to allow other people to view your private channel feeds and charts. Click **Generate New Read API Key** to generate an additional read key for the channel.
- **Note**: Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel.

API Requests

Write a Channel Feed

```
GET https://api.thingspeak.com/update?api_key=ON0H58INN69KWRQM&field1=0
```

Read a Channel Feed

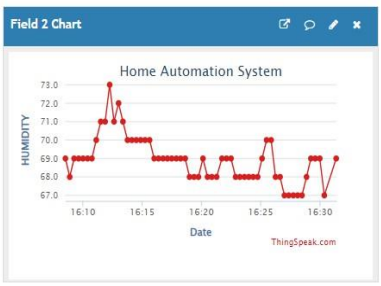
```
GET https://api.thingspeak.com/channels/2689958/feeds.json?results=2
```

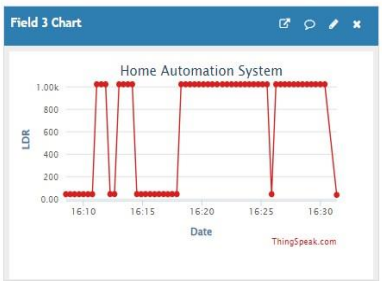
Read a Channel Field

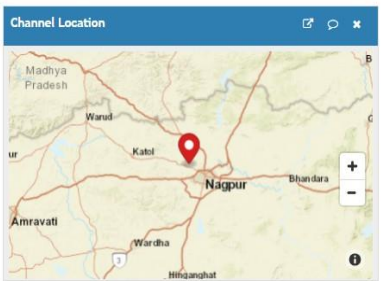
```
GET https://api.thingspeak.com/channels/2689958/fields/1.json?results=2
```

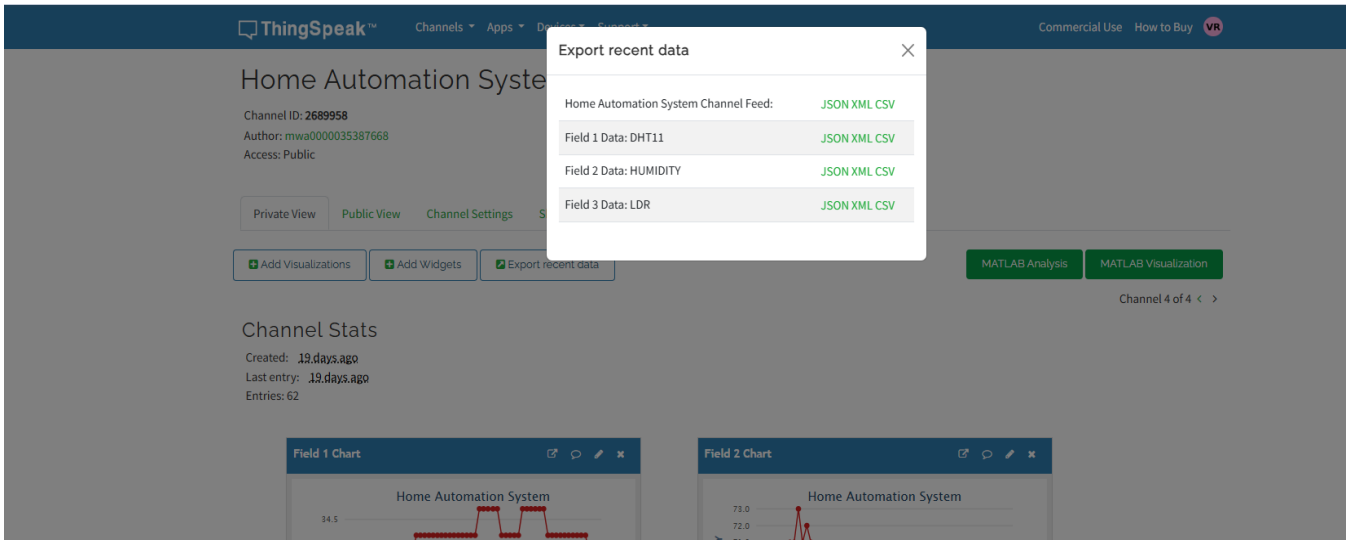
ThingSpeak™ Channels Apps Devices Support Commercial Use How to Buy VR

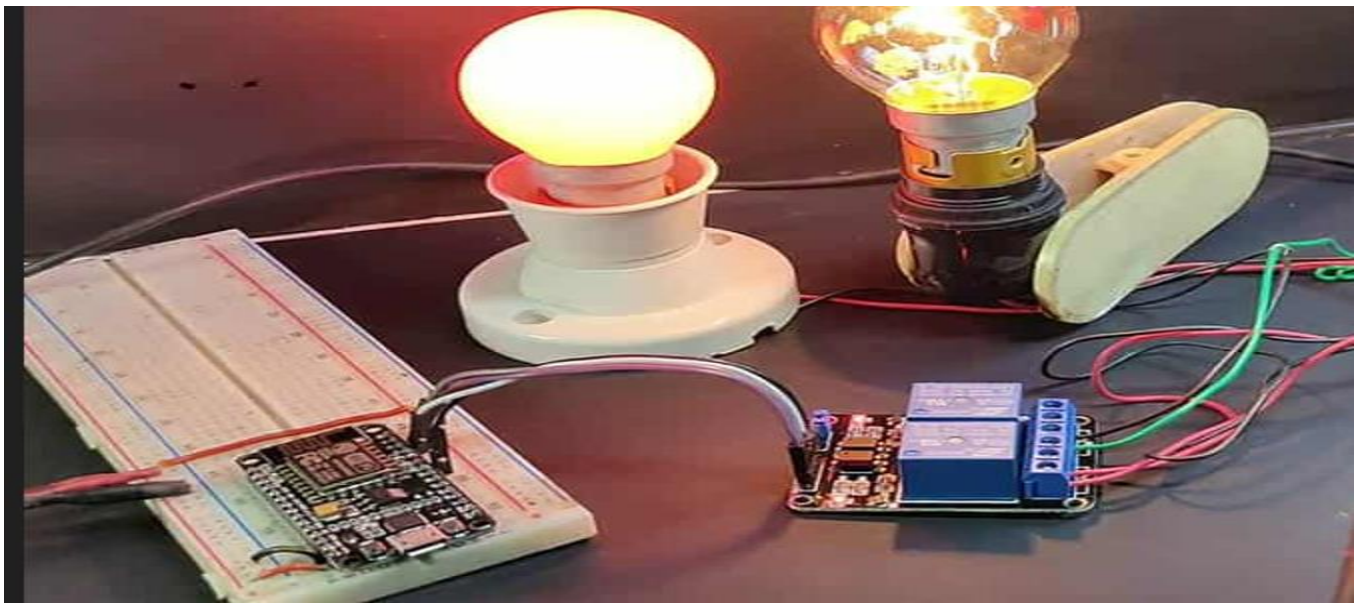
Entries: 62








ThingSpeak™
Channels
Apps
Commercial Use
How to Buy
Home Automation Syste
Channel ID: 2689958
Author: mwa0000035387668
Access: Public
Private View
Public View
Channel Settings
Add Visualizations
Add Widgets
Export recent data
MATLAB Analysis
MATLAB Visualization
Channel 4 of 4
Channel Stats
Created: 19 days ago
Last entry: 19 days ago
Entries: 62
Field 1 Chart
Home Automation System
34.5
Field 2 Chart
Home Automation System
73.0
72.0
Export recent data
Home Automation System Channel Feed: JSON XML CSV
Field 1 Data: DHT11 JSON XML CSV
Field 2 Data: HUMIDITY JSON XML CSV
Field 3 Data: LDR JSON XML CSV



AIMS & OBJECTIVES OF PROJECT

Aim:

The aim of the project is to develop an Intelligent Home Automation System that uses Generative AI and IoT to optimize personalized energy management and reduce household carbon footprints.

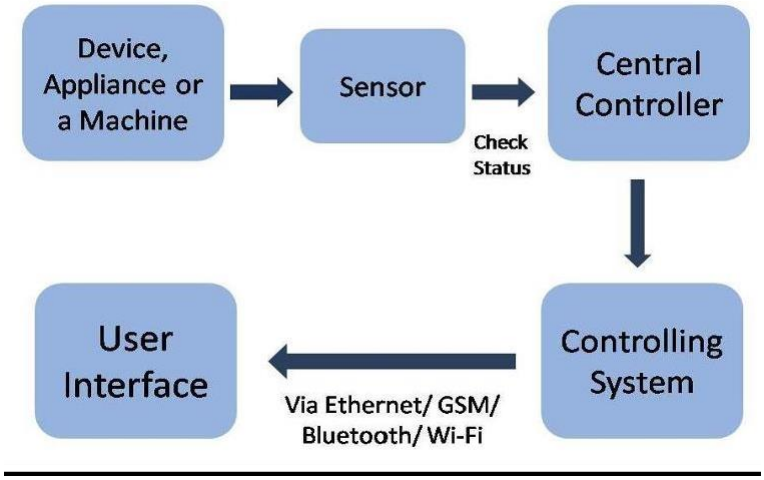
Objectives:

- ✓ Implement IoT-enabled sensors and devices to continuously monitor energy consumption patterns and environmental conditions within the home.
- ✓ Design and integrate automated controls that adjust energy settings in real time, ensuring maximum efficiency without compromising comfort.
- ✓ Design the system to be scalable and adaptable to different household sizes and types, ensuring broad applicability and ease of implementation.
- ✓ Develop a user-friendly interface that provides tailored suggestions for optimizing energy use, such as adjusting heating, cooling, and lighting settings based on occupancy and individual habits.
- ✓ Ensure seamless connectivity and interoperability among various smart home devices to create a cohesive energy management ecosystem.

LITERATURE REVIEW

The incorporation of Artificial Intelligence (AI) and Internet of Things (IoT) technologies has extensively advanced the concept of smart home automation. This integration enables the advent of intelligent structures that could enable the security, convenience, and protection of modern-day living spaces. AI algorithms, along with gadget studying and getting to know deep, can analyze information accumulated through IoT gadgets to make knowledgeable choices and automate numerous tasks in the home environments. Home automation system is one of the intelligent systems meant to create new opportunities for industry and business, as well as new experiences for users and consumers. This project is about designing, developing and testing a web-based intelligent home automation system called i Home. Problems arises from the manually flick switches to control lighting and difficulty in monitoring houses, these activities can be automated. The main users will be residents in any residential area i.e. gated community, terrace housing area, condominium and others. One of the topics which is gaining popularity is Home Automation System because of its innumerous advantages. Home automation refers to the monitoring and controlling of home appliances remotely. with the never ending growth of the Internet and its applications, there is much potential and scope for remote access and control and monitoring of such network enabled appliances. Home automation is becoming popular due to its numerous benefits. Home automation refers to the control of home appliances and domestic features by local networking or by remote control. Artificial Intelligence provides us the framework to go real-time decision and automation for Internet of Things (IoT).Home automation with AI and IoT is an emerging technology that is transforming the way we live in our homes. This paper provides an overview of the key concepts and technologies involved in home automation with AI and IoT, including machine learning, natural language processing, predictive maintenance, cloud computing, and privacy. The advancement of renewable energy infrastructure in smart buildings has highlighted the importance of energy self consumption by energy-demanding IoT-enabled devices (e.g., heating/cooling and appliances), which refers to the process of intelligently consuming energy at the time it is available. This stabilizes the energy grid, minimizes energy dissipation on power lines but more importantly is good for the environment as energy from fossil sources with a high CO2 footprint is minimized.

PROPOSED WORK



The proposed intelligent home automation system is designed to reduce carbon footprints by using AI and IoT in the following ways:

1. Personalized Energy Management: The system will dynamically adjust energy consumption based on user-specific preferences and real-time data, ensuring that no energy is wasted. For example, it could reduce the use of air conditioning when the user is not at home.

2. Predictive Analytics: By using predictive models, the system can anticipate energy needs and prepare accordingly. It will suggest actions like pre-cooling the house before peak energy rates or using renewable energy sources when available (e.g., solar panels).

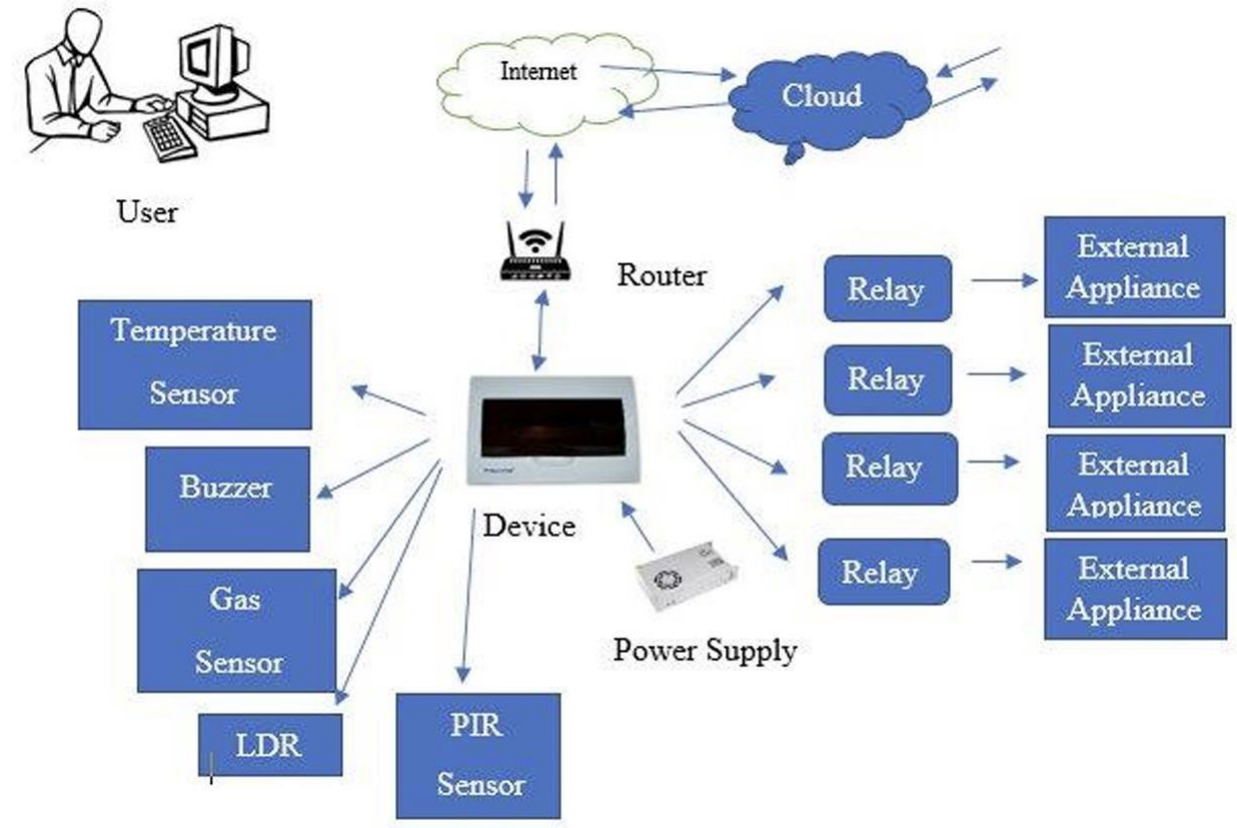
3. Energy Usage Insights: The system will generate detailed reports on energy usage patterns and offer insights into how users can further reduce their consumption.

4. Integration with Renewable Energy: If the household uses renewable energy sources such as solar panels, the system will prioritize the use of clean energy and manage battery storage efficiently to minimize reliance on grid power.

5. Carbon Footprint Monitoring: The system will track carbon emissions saved through optimized energy management and provide regular updates to users on their environmental impact.

This combination of AI and IoT provides a powerful tool for both automating home management tasks and contributing to global sustainability efforts through energy optimization.

Research Methodology



- User Interface: The user, represented by a computer or mobile interface, interacts with the system via the internet. This interface allows the user to monitor and control appliances in the home environment.

- Internet and Cloud Connectivity: Router: The system is connected to the internet through a router, which enables communication data to between the home automation system and the cloud.

- Cloud Platform: A cloud server (e.g., ThingSpeak or AWS IoT) stores the sensor data, processes it, and helps automate appliance control. The cloud also enables remote access and data analytics.

- Sensors: Temperature Sensor: Monitors the room's temperature, sending data to the device (ESP8266 or microcontroller).

- Gas Sensor: Detects the presence of harmful gases in the environment, triggering alerts or automation (e.g., turning on ventilation).

- LDR (Light Dependent Resistor): Measures the ambient light levels, helping to control lighting automatically based on external light conditions.

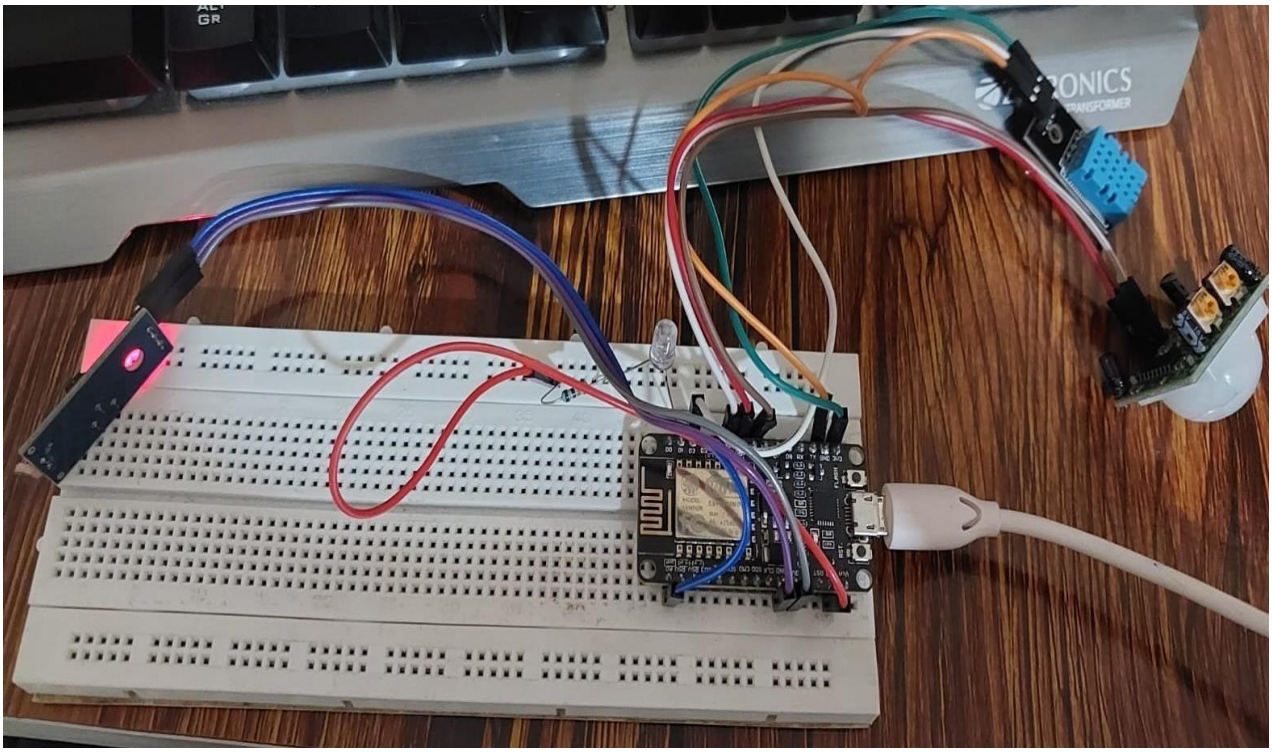
- PIR (Passive Infrared) Sensor: Detects motion in a room to automate lights and appliances based on occupancy.

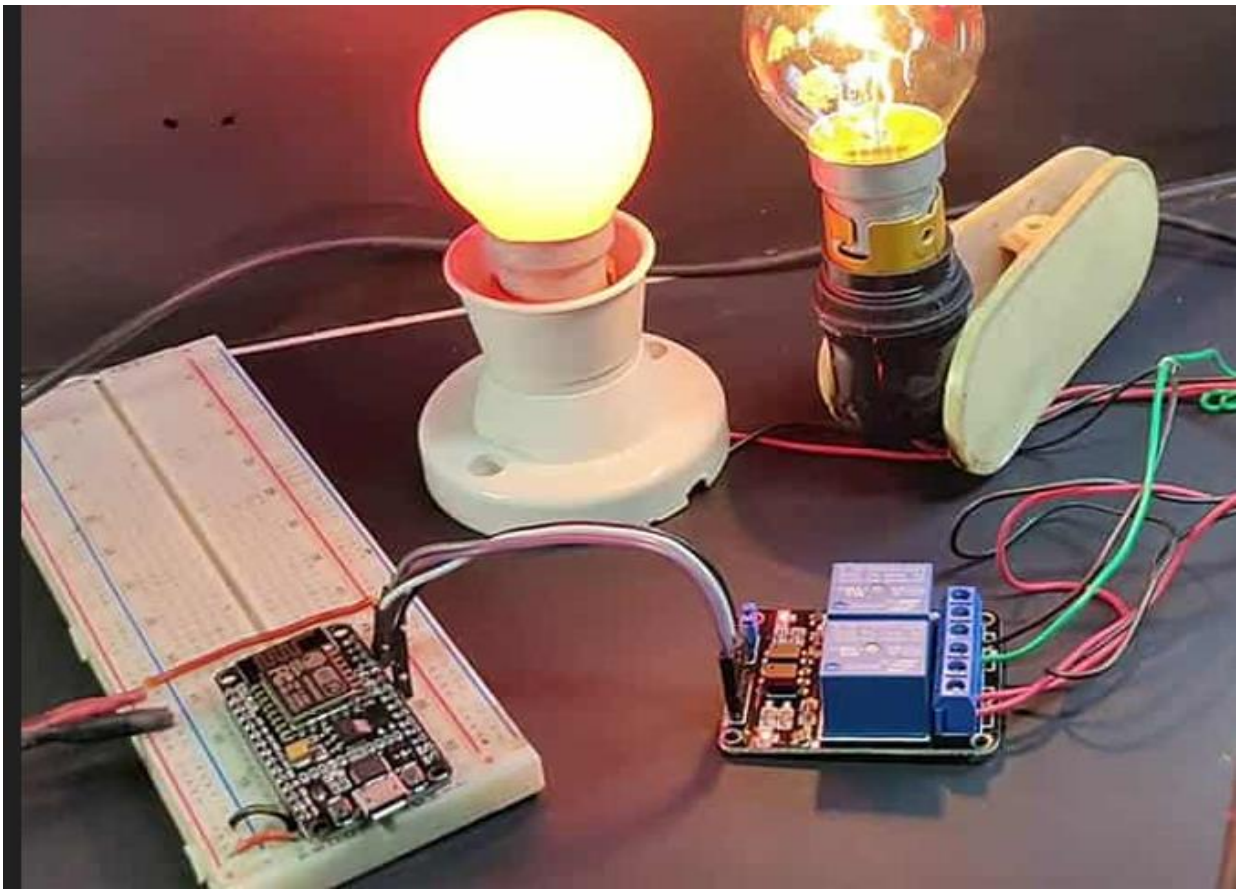
- Buzzer: Provides audio alerts for various scenarios, like detecting gas leaks or intrusions.

- Device (Controller): This central unit, typically an ESP8266 or similar microcontroller, gathers data from sensors and communicates with the cloud platform. It makes decisions about appliance control based on sensor input and cloud-based AI algorithms.

- Power Supply: The system includes a power supply unit that ensures continuous operation of the device and connected sensors.

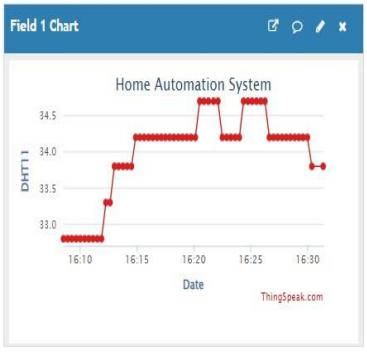
RESULT

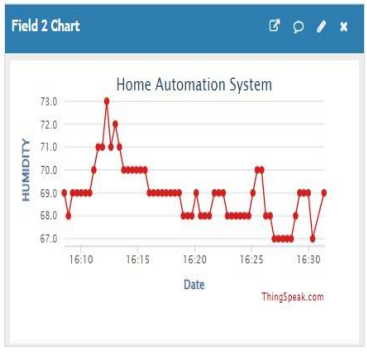


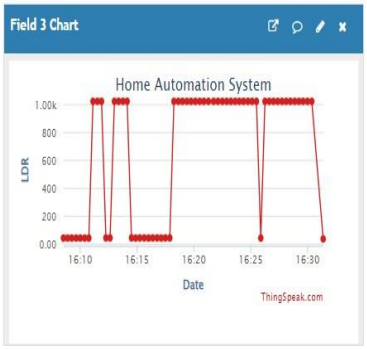


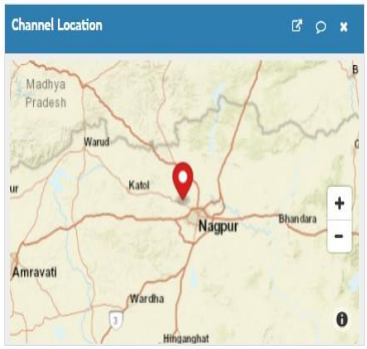
ThingSpeak™ Channels Apps Devices Support Commercial Use How to Buy VR

Entries: 62









CONCLUSION

The project on the "Intelligent Home Automation System Using Generative AI and IoT for Personalized Energy Management to Reduce Carbon Footprint" presents a transformative approach to modern energy consumption in households. By integrating advanced technologies, such as Generative AI and IoT, the system empowers users to optimize their energy usage in real time, leading to significant reductions in energy waste and carbon emissions.

Through comprehensive research and development, the project aims to create a user-friendly platform that not only monitors and manages energy consumption but also educates and engages homeowners in sustainable practices. The personalized recommendations generated by the AI algorithms encourage proactive energy management, making it easier for individuals to adopt eco-friendly habits.

Ultimately, this intelligent system contributes to a broader goal of environmental sustainability, aligning with global efforts to combat climate change. By demonstrating the effectiveness of smart home technologies in enhancing energy efficiency, the project paves the way for a more sustainable future, where households play an active role in reducing their carbon footprints while enjoying the conveniences of modern living.

FUTURE SCOPE

1. Enhanced Machine Learning Algorithms:

- As machine learning techniques evolve, integrating more sophisticated algorithms can improve the accuracy of energy predictions and recommendations. Continuous learning models that adapt based on user feedback and changing behaviors will enhance system responsiveness.

2. Integration with Renewable Energy Sources:

- Future systems could seamlessly integrate with solar panels, wind turbines, and other renewable energy sources. This would enable homeowners to optimize the use of clean energy, manage energy storage solutions, and reduce reliance on grid power, further decreasing carbon footprints.

3. Smart Grid Connectivity:

- Connecting home automation systems to smart grids can facilitate real-time energy trading and load balancing. Homes could participate in demand-response programs, receiving incentives for reducing energy consumption during peak periods.

4. Advanced User Interfaces:

- Developing more intuitive and interactive user interfaces, including voice and gesture controls, augmented reality (AR), and virtual reality (VR) applications, could enhance user engagement and make energy management more accessible.

5. Expansion to Smart Communities:

- The concept can be scaled beyond individual homes to smart neighborhoods or communities. Collaborative energy management systems could share resources, optimize energy distribution, and collectively reduce carbon emissions on a larger scale.

6. Integration with Home Health Monitoring:

- Future systems could incorporate health monitoring features, adjusting energy settings based on the health and comfort needs of occupants, especially the elderly or those with medical conditions, thereby promoting both wellness and sustainability.

7. Data Privacy and Security Enhancements:

- As systems become more data-driven, ensuring robust cybersecurity measures and transparent data privacy policies will be critical. Future developments should focus on protecting user data while maintaining system functionality.

8. Regulatory Compliance and Incentives:

- As governments increasingly emphasize sustainability, future systems could include features that help users comply with environmental regulations and qualify for incentives or rebates for energy-efficient practices.

9. Global Adaptability:

- Adapting the system for different geographical and cultural contexts will broaden its applicability. Customization for varying climate conditions, energy markets, and user preferences can enhance global adoption.

10. Integration of Artificial Intelligence in Other Domains:

- Future research could explore the integration of AI in other areas of home automation, such as security, appliance management, and entertainment systems, creating a holistic smart home ecosystem.

11. Longitudinal Studies and Impact Assessment:

- Conducting long-term studies to assess the impact of such systems on energy consumption, user behavior, and carbon footprint reduction will provide valuable insights that can guide future improvements.

REFERENCES

1. A. Z. Alkar and U. Buhur, "An Internet based wireless home automation system for multifunctional devices," Consumer Electronics, IEEE Transactions on, vol. 51, pp. 1169-1174, 2005.

2. Ejaz Ahmed, Ibrar Yaqoob, Abdullah Gani, Muhammad Imran, and Mohsen Guizani,IEEE Wireless Communications "Internet-of-Things-Based Smart Environments: State of the Art, Taxonomy, and Open Research Challenges", 1536 1284,October 2016

3. C. Chiu-Chiao, H. Ching Yuan, W. Shiau-Chin, and L. Cheng-Min, "Bluetooth-Based Android Interactive Applications for Smart Living," in Innovations in Bio-inspired Computing and Applications (IBICA), 2011 Second International Conference on, 2011, pp. 309-312.

4. G.Kortuem, F.Kawsar, D.Fitton, and V.Sundramoorthy,"Smart objects as building blocks for the internet of things," Internet Computing, IEEE, vol. 14, pp. 44-51, 2010.

5. Luca Mainetti, Vincenzo Mighali, Luigi Patrono "An IoT-based Usercentric Ecosystem for Heterogeneous Smart Home Environments", IEEE ICC 2015 SAC - Internet of Things, pp. 704-709.

6. M. A. Al-Qutayri and J. S. Jeedella, "Integrated Wireless Technologies for Smart Homes Applications," in Smart Home Systems, M. A. Al-Qutayri, Ed., ed: InTech, 2010.

7. Majed AlOtaibi and Lo'ai A. Tawalbeh, Yaser Jararweh," Integrated Sensors System Based on IoT and Mobile Cloud Computing", 978-1-5090-432,IEEE, 2016.

8. Lei Jing, Kaoru Yamagishi, Junbo Wang, Yinghui Zhou, Tongjun Huang, and Zixue Cheng "A Unified Method for Multiple HomeAppliances Control through Static Finger Gestures", IEEE/IPS International Symposium on Applications and the Internet,2011 , pp.82-90.

9. KUMAR, P. M., and SANDHYA, N. (2015). BLUETOOTH BASED WIRELESS HOME AUTOMATION SYSTEM USING FPGA. Journal of Theoretical and Applied Information Technology, Vol.77, No. 3

10. R. Piyare and M. Tazil, "Bluetooth Based Home Automation System Using Cell Phone," in Consumer Electronics (ISCE), 2011 IEEE 15th International Symposium on, 2011, pp. 192-195.

11. Piyare, R. (2013). Internet of things: Ubiquitous home control and monitoring system using Android based smart phone. International Journal of Internet of Things, Vol.2, No. 1, pp 5-11.

12. Satria, A., Priadi, M. L., Wulandhari, L. A., and Budiharto, W. (2015). The framework of Home Remote Automation System based on Smartphone.International journal of smart home, Vol.9, No. 1, pp 53-60

13. 1.Vidyasagar, K., Balaji, G., and Reddy, K. N. (2015). Android Phone Enabled Home Automation. Journal of Academia and Industrial Research (JAIR) Vol.4, No. 2, pp 65.

BIBLIOGRAPHY

1. BOOKS:

1. Smart Homes and Their Users" by Jennifer S. Preece and David P. G. B. Reddy
2. Artificial Intelligence for Smart Cities" by Pradeep Kumar and Shailesh Kumar
3. The Smart Home Manual: How to Create the Ultimate Connected Home" by E. Brian E. Smith
4. Energy Management Systems: Operation and Control" by D. H. Wang and W. H. K. Lam

2. WEBSITE:

1. https://ieeexplore.ieee.org/Xplore/home.jsp
2. https://link.springer.com/
3. https://www.researchgate.net/
4. https://www.iotforall.com/
5. https://www.greenbuildingadvisor.com/