IJARETY

International Journal of Advanced Research in Education and TechnologY (IJARETY)

Volume 12, Issue 1, January-February 2025

Impact Factor: 7.394

www.ijarety.in editor.ijarety@gmail.com

International Journal of Advanced Research in Education and TechnologY(IJARETY)

| ISSN: 2394-2975 | www.ijarety.in| | Impact Factor: 7.394| A Bi-Monthly, Double-Blind Peer Reviewed & Refereed Journal |

|| Volume 12, Issue 1, January-February 2025 ||

DOI:10.15680/IJARETY.2025.1201016

Smart Home Automation Using NodeMCU ESP8266

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ABSTRACT: Home automation has achieved remarkable popularity in recent years, with rapid advancements in technology simplifying daily life. Our research paper proposes a comprehensive smart home automation system that integrates multiple modules, including a Smart Door Lock System, Smart Fan and Light Control, Water Tank Monitoring System, and Smart Gardening System. The system uses microcontrollers like NodeMCU ESP8266, enabling control through a smartphone app, with devices connected via Wi-Fi. The system is flexible, user-friendly, and energy-efficient, leveraging the Blynk app to provide seamless remote control and monitoring. Our work demonstrates the potential of IoT technology in transforming homes into intelligent, efficient, and secure environments, with the ability to expand and incorporate additional features.

KEYWORDS: Smart Home Automation, Smart Garden, Smart Door Lock System, Water Tank Level Indicator, NodeMCU ESP8266, Wi-Fi network.

I. INTRODUCTION

A. Overview:

Homes in the 21st century are increasingly evolving into smart, self-controlled, and automated spaces due to the comfort, convenience, and efficiency they provide. Home automation systems offer users the ability to remotely control and monitor a wide variety of electric appliances, creating smarter and more efficient living environments. Many existing and well-established home automation systems are based on wired communication. While these systems work effectively when planned and installed during the construction phase of a building, they pose significant challenges in already existing buildings. Retrofitting wired systems into pre- constructed buildings results in higher installation costs, extensive labor, and significant disruption.

B. Proposed system functions:

Our project aims to develop a simple and efficient smart home automation system using the NodeMCU ESP8266 microcontroller and the Blynk app for seamless control. The system integrates various modules such as Smart Door Lock, Light and Fan Control, Water Tank Level Indicator, and Smart Garden Automation. Each of these modules can be monitored and controlled remotely through the Blynk application on a smartphone, providing users with an enhanced smart home experience.

1. **Smart Door Lock System**: Uses an RFID reader for access control and integrates with the Blynk app for remote lock management.
2. **Smart Light and Fan Control**: Wi-Fi-controlled relays toggle lights and fans, supporting manual and scheduled operations.
3. **Water Tank Level Indicator**: Ultrasonic sensors measure water levels, displaying data on the Blynk app with configurable alerts.
4. **Smart Garden**: Soil moisture sensors trigger an automated irrigation system, monitored and controlled via the Blynk app.

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C. Advantages of Smart Home Automation

In recent years, wireless systems like Wi-Fi have become very common in home networking. Also, in home and building automation systems, the use of wireless technologies gives several advantages that could not be achieved using a wired network only.

1. **Convenience:** Control and monitor your home from anywhere, at any time, using your smartphone or web dashboard.
2. **Energy Efficiency:** Automate lighting, temperature, and security systems to reduce energy consumption and save costs.
3. **Increased Comfort:** Enjoy a comfortable living space with automated temperature, lighting, and entertainment systems.
4. **Remote Monitoring:** Keep an eye on your home, even when you're not there, with live video feeds and sensor data.
5. **Customization:** Tailor your smart home system to your preferences and lifestyle.
6. **Increased Property Value:** Enhance your home's value with modern smart home features.

II. SYSTEM ANALYSIS

A. Problem Definition:

Traditional methods of managing home appliances and systems are often inefficient, inconvenient, and lack modern security and automation capabilities. With the growing demand for smart home technologies, there is a need for a unified IoT-based solution that can remotely control and automate essential home functions to enhance security, convenience, and energy efficiency.

1. **Energy Efficiency:** With rising energy costs and increasing concerns about environmental sustainability, home automation systems can be designed to optimize energy usage and reduce wastage. This could involve automating lighting, heating and cooling systems, and other appliances to minimize energy consumption.
2. **Security:** Home automation systems can be designed to enhance home security by integrating with security cameras, motion detectors, and other sensors to monitor and control access to the home.
3. **Convenience:** Home automation systems can be designed to improve the overall convenience and comfort of living in a home. This could involve automating tasks such as adjusting the temperature, turning on lights, or controlling home entertainment systems, all through a single user interface.
4. **Cost Savings:** Home automation systems can be designed to help save costs in the long run by reducing energy bills, maintenance costs, and other expenses associated with operating a home.

The problem definition will depend on the specific needs and requirements of the home and its occupants, and the home automation system will be designed to address these needs in the most effective way possible.

B. Implementation:

In this NodeMCU ESP8266 project, we have developed a practical IoT-based smart home automation system using the Blynk platform, integrating various sensors and modules to control home appliances and monitor systems remotely. The system includes a Smart Door Lock, Smart Light and Fan Control, Water Tank Level Indicator, and a Smart Garden irrigation system, all controlled via the Blynk app. Additionally, manual control is available for key systems to ensure continuous functionality even without internet access.

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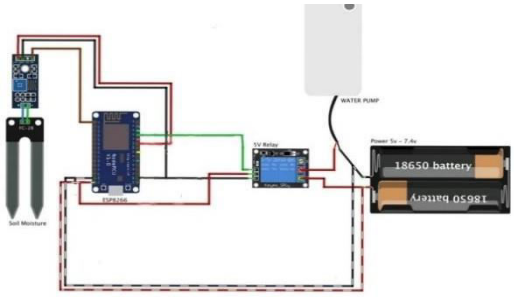
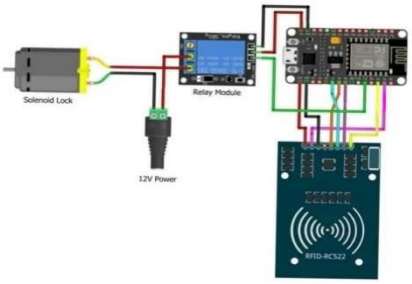
C. Circuit of the IOT Projects using ESP8266:

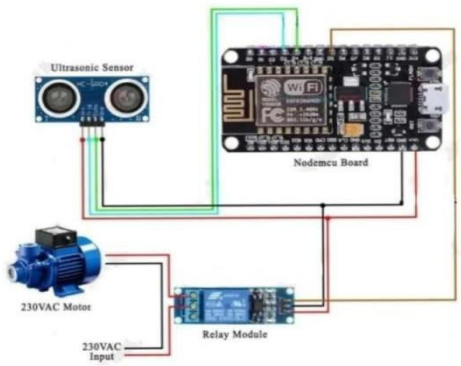
Smart Garden Module



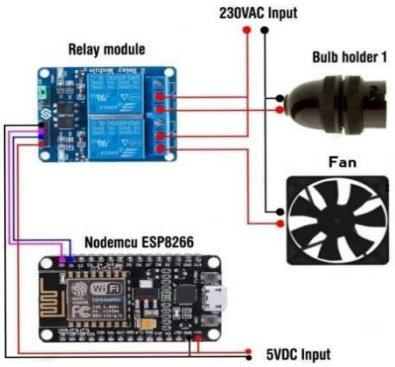
Smart Door Module



Water tank level indicator



Smart Light and Fan Module



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D. Module:

1. Smart Garden System (Top Left)
- Soil moisture sensor detects moisture levels in the soil and sends data to the system.
- NodeMCU triggers the relay module when the moisture level is below the threshold.
- Relay module activates the water pump to irrigate the plants.
- The system is powered by a 3.7V 18650 battery.

2. Smart Door Lock System (Top Right)
- RFID reader detects the RFID card and sends the input signal to NodeMCU.
- NodeMCU processes the signal and triggers the relay module if the card is authorized.
- Relay module activates the solenoid lock to unlock the door.
- Buzzer and LED provide audio and visual feedback for access status.

3. Water Tank Level Monitoring System (Bottom Left)
- Ultrasonic sensor measures the water level in the tank and sends data to NodeMCU.
- NodeMCU processes the data and triggers the relay module when the water level is low.
- Relay module powers the water pump to fill the tank.
- The pump stops when the ultrasonic sensor detects that the tank is full.

4. Smart Fan and Light Control System (Bottom Right)
- NodeMCU ESP8266 connects to the Blynk app for remote control of appliances.
- Relay module is triggered by NodeMCU to switch the fan and light on or off.
- Fan and bulb are powered by a 230V AC supply, controlled via the relays.
- System is powered by a 5V DC input to the NodeMCU.

III. DISCUSSION

A. Interpretation of results:

Based on the implementation and testing of this IoT-based smart home automation system, it can be concluded that the project was successful in achieving its intended functionality. The system, built using NodeMCU ESP8266 and Blynk, integrates multiple modules to provide seamless control and monitoring of home appliances and utility systems. The smart door lock effectively utilizes an RFID reader to enhance security, allowing authorized access while providing real-time status updates and remote control through the Blynk app

B. Comparison with previous research:

This project is distinct in its integration of multiple IoT-based modules into a comprehensive smart home automation system using the NodeMCU ESP8266. Unlike previous research, which may have focused on single-use IoT devices or specific automation aspects, our project combines four unique modules to address various facets of home automation. The integration of these modules provides a holistic approach to automating essential home functions, making it more versatile and practical compared to standalone solutions.In comparison, previous research may have focused on fewer modules or only specific areas of automation, often neglecting a comprehensive and interconnected approach. This project's integration of four diverse modules into a single smart home system demonstrates its innovation and practical applicability. It showcases the potential of NodeMCU ESP8266 and Blynk as robust and efficient tools for IoT applications, presenting a scalable model for future research.

C. Limitations of the study:

The project primarily focused on the implementation of four modules: a smart door lock controlled via the Blynk app and RFID card, smart fan and light control through the Blynk app, a water tank level indicator with manual and automatic pump control, and a smart garden irrigation system based on soil moisture levels. While the system provides a comprehensive solution for home automation, several limitations were observed: Limited Scope of Sensors and Devices:The project utilized a specific set of sensors and devices to demonstrate the functionalities of the system. It did not explore compatibility with a broader range of sensors or IoT devices. Future research could focus on integrating additional sensors, such as motion detectors, gas sensors, or advanced environmental monitoring devices, to further enhance the system's capabilities.

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D. Suggestions for future research:

Future research could delve into several areas to expand and enhance the capabilities of this IoT-based smart home automation system built on the NodeMCU ESP8266 platform. One promising avenue would be investigating the security and privacy implications of using cloud-based IoT platforms, such as the Blynk app. This includes analyzing potential vulnerabilities in the communication between devices and the cloud, as well as developing robust encryption and authentication methods to ensure the system's security against unauthorized access. Privacy concerns regarding user data collected and stored by the IoT platform could also be addressed, exploring solutions such as anonymized data handling and user-controlled data access.

IV. CONCLUSIONS AND FUTURE WORK

A. CONCLUSION:

The IoT-based smart home automation system has been successfully developed and tested, showcasing its ability to remotely control and automate essential home functions via the internet. The system integrates multiple innovative features, including a smart door lock that can be operated using both an RFID card and the Blynk app. This dual control mechanism enhances security and convenience, offering flexible access options for users. Another key component is the smart control of lights and fans, which allows users to switch them on or off through the Blynk app from anywhere, adding convenience and energy efficiency to the home environment. Overall, this project demonstrates the practicality, efficiency, and versatility of IoT technologies in modern home automation. It enhances comfort by providing remote control capabilities, improves efficiency by automating repetitive tasks, and promotes security and sustainability through its thoughtful integration of features. The successful implementation of this system highlights the potential of NodeMCU ESP8266 and the Blynk platform as reliable tools for smart home applications.

B. FUTURE WORK:

As technology advances, the potential for expanding and improving IoT-based smart home automation systems continues to grow. The integration of emerging technologies, such as machine learning and additional sensor networks, can transform these systems into more efficient, reliable, and intelligent solutions. This IoT-based smart home system, utilizing the NodeMCU ESP8266, has laid the foundation for integrating various modules like smart door locks, light and fan control, water tank level monitoring, and smart garden irrigation. However, there is significant room for enhancement and expansion to make the system even more robust, adaptable, and sustainable. Below are some key areas of future scope:

1. Full Smart Home Integration: Smart fans and lights could be seamlessly integrated into broader smart home ecosystems, coordinating with thermostats, security systems, smart blinds, and other devices. For example, when a user leaves the house, the system could automatically turn off fans and lights.
2. Low Power Modes: Lights could automatically switch to low-power or "eco" modes when users are not present, further reducing energy consumption.
3. In the future, we will be integrating a few more sensors like the dissolved oxygen sensor(This sensor will measure the amount of oxygen dissolved in the water, which is an important parameter for water quality.), conductivity sensor(It will help monitor the purity of water), to deliver a more reliable system for the domestic water tank.
4. Predictive Watering: Machine learning algorithms can predict plant watering needs based on weather forecasts, soil types, and plant species, optimizing water usage and preventing overwatering or underwatering.

ACKNOWLEDGEMENT

We would like to express our sincere gratitude and appreciation to the experts whose invaluable contributions have played a key role in the development of the Smart Home Automation project. We extend our heartfelt thanks to our project guide, assistant professor Ms. S.S. Kolapate, project co-ordinator Mr. R. C. Dhandekar and HOD Mr. P. D. Kate for their constant support, guidance, and invaluable suggestions throughout the course of this project. Their expertise and thoughtful recommendations have been instrumental in improving the quality and effectiveness of our work. We are also deeply grateful for her encouragement, which motivated us to successfully complete this project. Additionally, we would like to thank the faculty members of our department for their constructive feedback and consistent support during every stage of our project.

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International Journal of Advanced Research in Education and Technology

ISSN: 2394-2975 Impact Factor: 7.394

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