IoT-Driven Smart Home Security with Voice Commands

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Abstract— Home security systems are really important to provide personal comfort and protection for goods, especially in the digital world that is evolving at an increasingly high speed. When humans come together with the Internet of Things (IoT) and smart homes, very efficient systems can be created. The integration sows convenience, efficiency,security, and responsiveness for installation which includes intelligence of automation in it. We are studying an IoT-based home safety system using passive infrared (PIR) sensors, working on a better version by focusing on user interfaces—interfaces with PIRs, secure voice controls for automation based on various communication protocols. This includes provisions for lighting, and an alarm system for movement [sic]. It tests the voice commands and PIR sensor-based intruder detection. The method of the research comprises bright interfe rence control and PIR intruder detection, coupled with a variable time-delay for response identification. The study's results are presented in terms of the mean actual response time, distinguishing between performance over Wi-Fi and fourth- and fifth- generation mobile networks. DISCUSS AT GOOGLEThe results show consistent light toggling via Google Assistant. In the end, this research contributes to an existing body of work by creating an IoT system that can be readily adopted as part of normal life.

Keywords: Node-MCU, home automation; home security system; Internet of Things; intruder Detection; PIR sensor; smart home; voice commands

1.   *INTRODUCTION*

The rapid advancement of technology has led to significant improvements in home security Systems, transforming them into sophisticated networks of interconnected devices. Among These innovations, the Internet of Things (IoT) stands out as a transformative force, enabling Seamless communication between various smart devices to create a more secure, efficient,

And user-friendly home environment. One of the most intriguing and practical applications Of IoT in home security is the integration of voice commands, which offers an additional Layer of convenience and control.

The Evolution of Home Security Systems traditional home security systems relied heavily On manual monitoring and wired connections, limiting their flexibility and responsiveness.However, the advent of IoT has revolutionized this landscape by introducing wireless, Interconnected devices that can be monitored and controlled remotely. These modern systems Not only provide real-time alerts and notifications but also offer advanced features such as Remote access, automation, and voice control.In recent years, the integer IoT-driven smart home security systems utilize a network of Sensors, cameras, and controllers to monitor and manage home security in real- time. These Systems can detect motion, capture images or video, and send alerts to the homeowner, Ensuring that any unusual activity is promptly addressed. Central to this functionality are Devices such as Passive Infrared (PIR) sensors, NodeMCU microcontrollers, ESP32 cameras, And the MQTT messaging protocol.

Internet of Things (IoT) technology into home security systems has revolutionized the way We protect and manage our homes. The concept of a smart home, equipped with Interconnected devices that communicate seamlessly with each other and with the Homeowner, offers unparalleled convenience, efficiency, and safety. One of the most Compelling applications of IoT in this context is smart home security with voice command Capabilities.

The internet of Things (IoT) is pivotal in modern applications, transforming industries through enhanced Connectivity, efficiency, and data-driven decision-making. By enabling devices to communicate with Each other and with centralized systems, IoT facilitates seamless data exchange. This connectivity is the Backbone of smart homes, cities, and industries, leading to improved quality of life and operational Efficiency.

2.   *LITERATURE SURVEY*

IoT technology has provided opportunities for the developments of smart homes The benefits that dring these to the consumer will include home automation, increased convenience, energy efficiency and of course, security. Smart homes Use interconnected sensors, cameras, and actuators while talking to each other Via the internet to manage various tasks of monitoring, controlling and automation Household activities. Well, a network of devices that can talk to another as seen in IoT[1].Services data to provide self-service and smart results To automate a home using IoT.ActionEvent to Improve conformity and basic standards in end-user applications,remoteensing   would   make

fort,convenience,security and energy utilization easier. Even monitoring and controlling your home appliances and systems. The study highlights the Innovation which will be provided by IoT in every day living by enabling the next pushes towards automations, control and Real-world settings in homes. The review includes the basic parts of the game. Advantages, limitation and future of IoT-based home automation. IoT technology can be used for the realization of smart homes[2].where devices and systems Integrated, enabling improved access for automation, management and monitoring. This study is based on incorporating fire and smoke detection systems as part of a smart home that will distribute the awareness to all over the IoT world. Enhance security and emergency services. Up to the development stage of better and robust sensors For fire and smoke detection. The purpose of this study is improving home security while IoT. We developed technologies to detect and react to events such as fire or smoke in a timely fashion. The system In this article is developed aiming at Real-time fire alerts and fire management, the gate implemented for the future work. Related emergencies[3].In contribute to the understanding of Intrusion Detection Systems (IDS) tailored for the Internet of Things (IoT). The chapter provides an overview of various IDS methodologies And technologies specifically designed to detect and mitigate threats in IoT environments. It Explores the challenges, advancements, and future directions in IoT-specific intrusion Detection. A smart IoT security system designed for smart homes, integrating motion Detection and facial recognition technologies. This system aims to enhance home security By leveraging IoT capabilities to detect and identify intruders using advanced sensor Technologies and facial recognition algorithms. IoT technology enables the development of Smart home security systems that can monitor and control various aspects of home security Remotely[4].Emerging research focuses on applying IoT biometric systems for the purposes of improving 'security' and 'identity verification' in educational institutions. The purpose of this study is to evaluate the quality and Numerous IoT technologies are used to incorporate these systems (biometric recognition systems) into education. Such systems adjoin improve destination

security, automating attendance, and even simplifying identity management of students, staff, and visitors amongst others are these systems for students and these systems in enhancing security and management of several identification means in schools. An explorational paper addressing the design and operation of an intelligent home automation and control system based on IoT. The same paper however concentrates on the use of various IoT devices and technologies to improve the safety, comfort, and efficiency of homes.Rest of the home environment based on AT&T since IoT enables.connecting/set of devices in a single head wireless system where control, monitoring and security enhanced. Automation systems at home employing things Arduino microcontroller system with integrated internet applications[5].A study on the development and Applyation of a secure smart home Mechanization And Watching system using Internet of elements (IoT) technologies. The report focuses on Enhancing the certificate gadget and Productivity of house environments away integrating Various iot devices and technologiesiot enablesthe interconnectedness of devices andsystems Within amp house provision automatic check Watching and increased security[6].In the execution of house high-tech systems exploitation arduino microcontrollers Combined with cyberspace of elements (iot) technologies. The study aims to Make an efficient Cost-effective andscalable home Mechanization Answer that can control and Watch various Home devices and systems remotely.Home Mechanization systems leverage IoT technologies To provide remote control and Watching of home devices such as lights appliances and Security systems.The study focuses on using Arduino microcontrollers as the core Part for Constructing a home Mechanization system highlighting their affordability and Versatility[7].In a study was conducted to develop a safe and intelligent home automation system consisting of Speech recognition and force measurement capabilities The purpose of this system is home improvement. Security Facilitates users through voice commands. And increase energy efficiency Monitoring energy use Smart home automation makes use of IoT technology. To provide users with remote control, monitoring and automation of home devices that The study focuses on integrating speech recognition for user interaction and power measurement…To check and increase energy efficiency. Increase efficiency and overall safety…Home automation system[8].In a study on the development of an IoT-based smart surveillance system designed for In a highly secure area This system integrates various IoT technologies to enhance surveillance. Providing real-time monitoring and ensuring a high level of security, IoT technology enables this. Developing an advanced surveillance system that can truly monitor high-security areas.The time is. The study focuses on leveraging IoT devices and communication protocols to improve Performance and reliability of the tracking system[9].
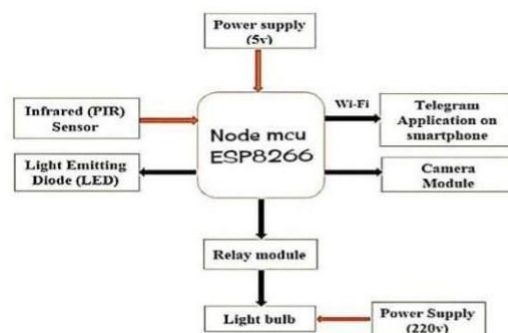
3.   ***SYSTEM BLOCK DIAGRAM***

Fig3.1: Block diagram of the system

A smart home security system can be built using a PIR sensor,NodeMCU (ESP8266), relay, buzzer, And camera module to enhance safety. When the PIR sensor detects motion near the door, it triggers The NodeMCU to activate the relay, turning on the lights and buzzer. Users can control these devices Via voice commands using Google Assistant or Amazon Alexa. Simultaneously, the camera module Captures a photo of the person at the door and sends it to the homeowner through a Telegram bot, Providing immediate visual confirmation and alerting the homeowner to potential intruders Efficiently and cost-effectively.The results examine the average effective response time in depth. By revealing Wireless fidelity (Wi-Fi) and four and Fifth generation mobile connectivity Demonstrates reliability in results Voice-activated lighting control via Google Assistant with precise responses. Command rate for Thai vowels is 83% and English is 91.50%. Voice commands There is also

a telegram mobile app available.

Unusual precision when it comes to manipulating commands with the P.I.R fire button.

4.   *HARDWARE DESCRIPTION*

The hardware required for this project are 1.NodeMcu

2. ESP8266 WI-FI

3. LED

4. PIR

5. RELAY

6. BUZZER

7. ESP32CAM

5.   *HARDWARE SPECIFICATIONS*

5.1 NodeMCU

NodeMCU is a widely used open source development board and firmware.ESP8266 -12E WiFi module. It is also an open source IOT platform. This is a module Program with the simple and powerful LUA programming language or the Arduino IDE. Company Just a few lines of code allow setting up a Wi-Fi connection and assigning input/output pins.Turn your ESP8266 into a web server to do just that and more. It is equivalent to Wi-Fi. Of the Ethernet module. The NodeMCU development board directly supports USB-TTL.Flashing from a USB port, it combines the features of a WIFI access point and a station. Microcontroller These features make NodeMCU an extremely powerful tool for Wi-Fi. Network. Can be used as an access point and/or station. Host web server or connect to the internet To fetch or upload data, there is an accessible NodeMCU that has built-in WiFi. Support provides you with an easy way to design IoT applications according to your technical needs.
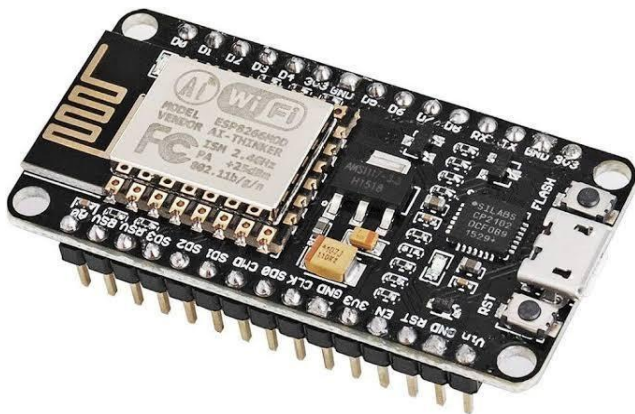

Fig5.1: NodeMCU

NODEMCU FEATURES

- Open-source
- Arduino-like hardware
- Status LED
- Micro-USB port

- Reset/Flash buttons
- Interactive and Programmable
- Low cost
- ESP8266 with inbuilt wifi

5.2 USB to UART converterESP8266WI-FIModule

The ESP8266 provides a comprehensive and independent Wi-Fi solution.The connectivity allows it to run programs or provide Wi-Fi functions independently.Other application processors act as the sole application processor and While hosting the program, the ESP8266 can boot directly from the external flash.Because of the embedded cache So when does the system perform better and use less memory When using this type of application.

Fig5.2:ESP8266

Alternatively, any microcontroller-based device with basic connection can have wireless Internet access enabled by means of the CPU AHB bridge interface or UART interface, acting As a Wi-Fi adaptor. The ESP8266 can easily connect to sensors and other specialized devices Using its GPIO pins, thanks to its onboard processing and storage capabilities, requiring Minimal effort during both development and runtime. It requires less circuitry because it has a High degree of on-chip integration, including antenna switch baluns and power control Converters. This solution includes front-end modules that use very little PCB space.

5.3 *LIGHT EMITTING DIODE(LED)*

LED is an abbreviation for Light Emitting Diode. It is nothing but just a combination of A semiconductor that emits light when an electric current flows through it. Semiconductors throughout the years Technology is advancing further. And light-emitting devices are part of This revolution And because of this, we have LEDs that produce better light in less time Power consumption.
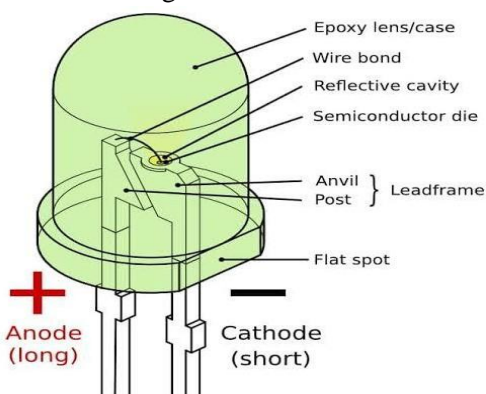
Fig5.3 :LED

5.4 PASSIVE INFRA-RED SENSOR

5.5 Passive infrared sensors (PIR sensors) are key components in motion detection systems that rely on Concerning the ability to detect infrared radiation emitted by objects within the search area, Etani The sensor works by using a pyrotechnic material that creates a voltage when exposed to infrared Radiation This material is divided into sections. Each section is responsible for detecting changes in IR Layer when an object moves across the sensor's field of view. It will cause rapid fluctuations I detected an infrared layer in these parts. PIR sensors are widely used in security systems. Automatic lighting settings and smart home appliances for energy saving Fast response time And affordability Despite being effective But it is also sensitive to environmental factors such as Temperatures change and they require direct line of sight to effectively sense internal movement General.
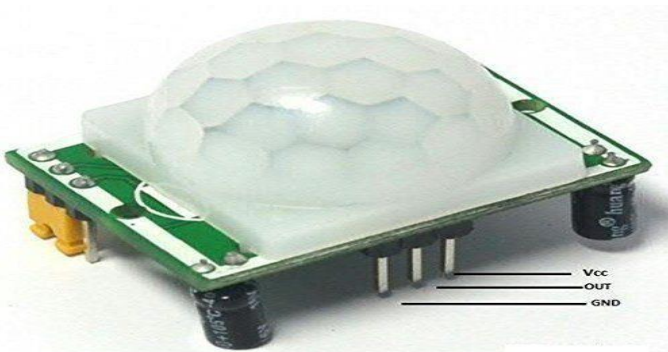

5.6 BUZZER

Fig. Relay module

Fig5.5: Buzzer

Sensors are usually built as part of an integrated circuit and one (1), Two (2) or four (4) 'pixels' of the same area of pyrotechnic material. There may be dual pixel sensors.Wire it to the opposite input of the differential amplifier. In such configuration, PIR The measurements cancel each other out. Therefore, the average temperature of the field of view is subtracted From the electrical signal. The increased IR energy across the sensor cancels itself and The device will not trigger. This helps the device resist false alerts about changes in events. Of exposure to fluorescent light or area-wide illumination (Constant glare can move Saturation of the sensor with material prevents the sensor from recording any additional information) at At the same time This differential arrangement minimizes common mode interference. The device resists stimulation due to nearby electric fields. However, the dual sensors are different. This configuration is special because temperature cannot be measured in that configuration.Motion detector.

5.6 RELAY

A relay is an electromechanical switch, which perform ON and OFF operations without Any human interaction. General representation of double contact relay is shown in fig. Relays are Used where it is necessary to control a circuit by a low-power signal (with complete electrical Isolation between control and controlled circuits), or where several circuits must be controlled by One signal.

A buzzer or beeper is a signaling device. Often electronic Often used in vehicles Household appliances such as microwave ovens or game displays It generally consists of a number of switches and sensors connected to a control unit. This determines which f-key is pressed or after a preset amount of time. And always brighter Lights up on the appropriate button or control panel. And continuously emits a warning sound Intermittent humming or beeping sound Initially, the device was based on electromechanical systems. The system is like an electric bell without the metal gong. (which has a sound Noise). Often these units are bolted to a wall or ceiling and used to soundproof a roof or wall Circle. Another use for some AC connected devices is to implement a circuit. A speaker can be driven by converting AC current into a loud sound, and this circuit a Cheap 8 Ohm Speaker Nowadays, the use of ceramic-based piezoelectric acoustics is more popular Like a loud warning sound Often these are connected to the circuit. "Driver" Which changes the pitch or makes the sound vibrate

5.7 ESP32-CAM

Fig5.7 : ESP32-CAM

ESP32-CAM is a very small camera module based on the ESP32S chip. About $10, in addition to the OV2640 camera and

RESULTS:

7. RESULTS AND DISCUSSION

several GPIOs for connecting peripherals. There's also a microSD card slot, which is useful for storing images taken with the camera. Or store files to serve customers Modules can operate independently as the smallest systems with only their size 27*40.5*4.5mm and deep sleep current as low as 6mA. ESP32-CAM can be widely used in various IoT applications, suitable for smart home Industrial wireless control equipment wireless monitoring and QR wireless identification .
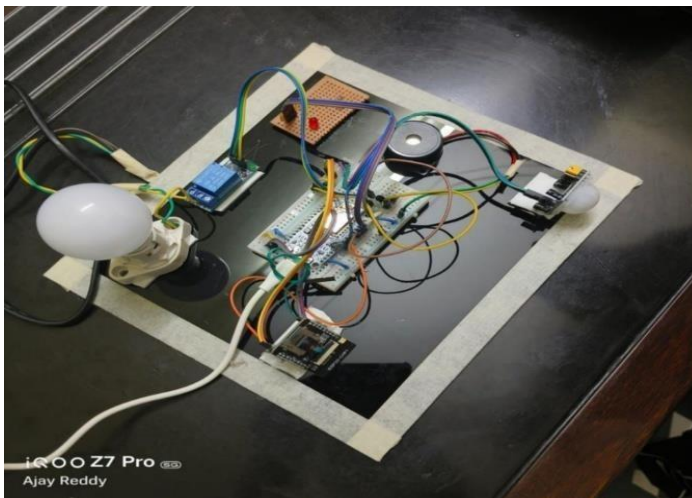
6.   IMPLEMENTATION

6.1 **Methodology**

Fig6.1: System Setup

A smart home security system can be built using a PIR sensor, NodeMCU (ESP8266), relay, buzzer,And camera module to enhance safety. When the PIR sensor detects motion near the door, it triggers The NodeMCU to activate the relay, turning on the lights and buzzer. Users can control these devices Via voice commands using Google Assistant or Amazon Alexa. Simultaneously, the camera module Captures a photo of the person at the door and sends it to the homeowner through a Telegram bot,Providing immediate visual confirmation and alerting the homeowner to potential intrudersEfficiently and costeffectively

6.2 CIRCUITDIAGRAM
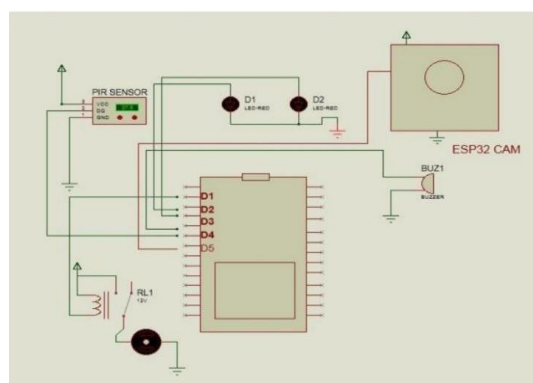
1.   *Motion Detection and Activation:*

- The PIR sensor reliably detects motion near the door, triggering the NodeMCU to Activate the relay.
- Lights and buzzer respond promptly, providing immediate alerts when someone Approaches the door.

2.   *Voice Command Control:*

- Integration with Google Assistant or Amazon Alexa allows users to control lights And buzzer with voice commands.
- This feature enhances user convenience and accessibility, allowing for hands-free Operation of the security system.

3. Photo Capture and Telegram Integration:

- he camera module captures clear photos of individuals at the door upon motion Detection.
- Photos are successfully sent to a Telegram bot, ensuring homeowners receive visual Confirmation of visitors or potential intruders.

Discussions:

1. System Reliability and Responsiveness:

- Evaluate the reliability of the PIR sensor in detecting various types of motion and Environmental conditions.
- Discuss the responsiveness of the system in activating lights and buzzer, considering Any delays or latency issues.

2. User Interface and Accessibility:

- Assess the usability of voice commands via Google Assistant or Amazon Alexa for Controlling the security system.
- Discuss any challenges or improvements needed for enhancing user interaction and Accessibility.

3. Security and Privacy Considerations:

- Address security measures implemented in the system to protect against Unauthorized access or manipulation.
- Discuss privacy implications of capturing and transmitting photos via Telegram, Ensuring user data protection.

4. Cost-effectiveness and Scalability:

- Evaluate the cost-effectiveness of using components like NodeMCU, PIR sensor, And camera module compared to commercial security systems.
- Discuss scalability of the system for expanding functionalities or integrating Additional sensors in larger home environments.

8. CONCLUSION AND FUTURE SCOPE

Conclusion:

This project demonstrates the feasibility of creating a cost- effective and efficient smart home Security system using readily available components. By integrating motion detection, voiceCommand control, photo capture, and Telegram integration, the system provides robust security Features while offering user- friendly operation and real-time alerts. Discussions around reliability, User interface, security measures, and scalability highlight areas for further development and Optimization in future iterations of the system.

Future Scope:

The future scope of the smart home security project includesintegrating facial recognition for Automatic visitor identification, enhancing sensor sensitivity and power efficiency to improve Detection accuracy and reduce energy consumption, leveraging cloud integration for data storage And advanced analytics, enhancing user experience through intuitive interfaces and automation Capabilities, and prioritizing robust security measures to protect user data and device interactions. These enhancements aim to elevate the system's functionality, reliability, and user satisfaction, Paving the way for a more intelligent and secure smart home environment.

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