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IOT BASED SMART SECURITY AND SMART HOME AUTOMATION

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Abstract - Smart home automation is an Internet of Things (IoT) application that utilizes the Internet to monitor and control appliances using a automation system. Our home uses this method to automate and conveniently place the appliances. This system utilizes a node microcontroller unit (Node MCU) as a Wi-Fi-based gateway to connect different sensors and updates their data to server. The collected data from several sensors (temperature, humidity, gas, and motion sensors) can be accessed. A set of relays is used to connect the Node MCU to control home appliances. The designed system is in a structured and portable manner, also developed an application which is used to monitor and control the home appliances. The proposed IOT-based system for home automation can control appliances over the Internet support and home safety with autonomous operation. It is a low cost and reliable smart home system that reduces energy consumption notably provide convenience, safety, and security. This study presents a cost-effective and hybrid (local and remote) IOT-based home automation system with a user-friendly interface website.

Key Words: IOT, Node MCU, Wi-Fi, Thing Speak, Automation

I. INTRODUCTION

The advent of the Internet of Things (IoT) has revolutionized the way we interact with our homes. With the increasing popularity of smart home automation, homeowners can now remotely control various appliances and devices, such as lights, thermostats, and security systems, with the help of their smartphones or other smart devices. This not only provides convenience but also enhances energy efficiency and home security. However, as with any connected device, there are potential security risks associated with IoT-based smart home systems. Hackers can gain access to these systems and manipulate them for nefarious purposes, such as stealing personal information or even causing physical harm. Thus, it is essential to develop smart home systems that prioritize security, as well as functionality. Nowadays there are many smart devices that can be used in home to make daily life easier and more convenient, some of the devices are smart thermostats, smart speaker, smart lighting, smart locks, smart security camera, smart plugs. Such smart devices can communicate and interacting with one another to form a smart environment [1]. An automation system should be developed to manage the communication between smart devices within smart home automation.

While smart home automation products offer many benefits, there are also some potential disadvantages to consider as Cost: Smart home automation products can be expensive, which may make them inaccessible for some households. The cost can be even higher if you need to purchase multiple devices to fully automate your home. Some smart home automation products may not be compatible with other devices or systems in your home, which can create connectivity issues or require you to purchase additional devices. With any connected device, there is always a risk of cyberattacks or data breaches, which can compromise your personal information or even your physical safety if the device controls critical systems in your home [2]. Smart home automation products rely on technology, and if the device malfunctions or the power goes out, you may lose access to certain features or functionality. Smart home automation products often require a learning curve to fully understand their features and how to use them effectively. This can be challenging for some users, especially those who are not tech-savvy[3] [4]. Various automation technologies, such as remote control for TVs, fans, air conditioners, and music players, have been used to control home appliances with the required systems for easy monitoring and control [5, 6]. With the widespread introduction of electricity into homes and the rapid advancement of information technology, a new era of controlling home appliances has started by using mobile devices with short-range communication interfaces, such as Bluetooth and ZigBee [7], and by Wi-Fi networks and GSM modules . All these systems and technologies are useful for indoor control of home appliances and does not allow residents to monitor and control their homes from the outside. Although such systems allow interaction with inhibitors to provide convenience, comfort, safety, and energy efficiency at all times, they have many limitations in functionality and communication range [8]. The microcontroller is the primary component of the IoT-based home automation system.

The main microcontroller in this project is a node microcontroller unit (NodeMCU) Wi-Fi-based controller board [9], an opensource platform for IoT applications. NodeMCU is primarily used to collect data from sensors and transfer it to an Internet of Things server. Also, this microcontroller is given instructions to carry out particular tasks by users via cellphones or laptops [10].

The project's major goal is to improve the security and automation of smart homes by utilizing the Internet of Things [IOT]. The goal of this project is to deliver low-cost, dependable security and automation with an easy-to-use system. To enable monitoring of home conditions and automated control of home appliances via the internet at any time and from any location. The entire design system is built to be portable. The suggested system is a low-cost, dependable automation system that decreases energy usage while also providing significant convenience, safety, and security to smart homes. safety and comfort, particularly for the elderly and crippled. The project's main goal is to address the shortcomings of home security systems by providing information about the current situation while the owner is away from home. It will also improve the network security of IOTs. This research is formulated to increase the knowledge of development and implementation of the smart home automation system using cloud service. It is an automatic system which can work 24/7.

II.LITERATURE SURVEY

2.1 , Wireless interface: Bluetooth/GSM, Controller: PIC

Anandhavalli et al. In an S automation control using Bluetooth and GSM module was proposed. The objective of this study is to help handicapped and elderly people to control home appliances from remote places. People used Bluetooth and GSM wireless communications to control the home. Bluetooth was also used to control the appliances indoor and GSM to control the appliances outdoor. Bluetooth can reduce system costs because most cellphones and laptops have this built-in application. Users can monitor and control the appliances from remote places by sending SMS through GSM. However, such a system has limitations in the two cases. Bluetooth has a limited range and data rate, and GSM is expensive because of SMS costs [11].

2.2 Wireless interface: Bluetooth/Wi-fi, Controller: Raspberry Pi

Davidovic and Labus et al. They proposed smart home automation based on sensor technology that can automatically control home appliances using Android-based smartphones as a remote controller. The authors utilized Raspberry Pi as the microcontroller and Bluetooth as the communication protocol. Wi-Fi was used to connect the smartphone to the Raspberry Pi controller, which was connected with smart appliances to the same network AP. All sensors updated their data to a local server via Raspberry Pi. However, the user cannot access the server and cannot directly use the smartphone to send the commands to the Raspberry Pi controller when he is outside the range of Wi-Fi. It has limitations in the Bluetooth because it has a limited range and it is cost effective [12].

2.3 Wireless interface: Bluetooth/Wi-fi, Controller: Arduino Mega

David, et al. In, a home automation and environmental monitoring system was developed using Arduino Mega 2560 microcontroller with Bluetooth module. Several sensors and switches were used to control home appliances through websites or Android applications. The website controls Arduino by passing information to it as codes. Arduino Mega is more expensive than Node-MCU, and the use of Bluetooth is unsuitable for smart home applications due to its limited features [13].

2.4 Wireless interface: RFID, Controller: PC server

Konidala, et al. They used RFID tags to successfully identify various elements within a smart refrigerator. This technique was used to improve home security but required many elements within the home. These elements included home population with RFID tags, which were difficult to implement considering the memory lapses of humans [14]

2.5 Wireless interface: Ethernet, Controller: Arduino Mega

Imran, et al. They developed prototype allowed users to control and monitor the home through Wi-Fi by using Arduino Mega integrated with Android-based application. However, the prototype had limited connectivity, can only perform local control, and the remote control of the developed system should be enabled based on IoT to allow users to control it using a webserver even when they are not around their house. The prototype also lacked automation of windows and doors and did not consider the safety and security of SH. A similar system using Arduino Mega with IoT[15] .

III. SYSTEM ARCHITECTURE

In this section we have provides the compact architecture of our project IoT Based Smart security and smart Home Automation system. The compact architecture consists of a web application to monitor and monitor the security system and to control the home appliances using ThingSpeak Cloud services, NodeMcu , Relays and sensors. Fig. 1 below which presents the system architecture.

The above picture provides the translucent information about the implementation of the system. The detailed description of the equipped devices are stated below:

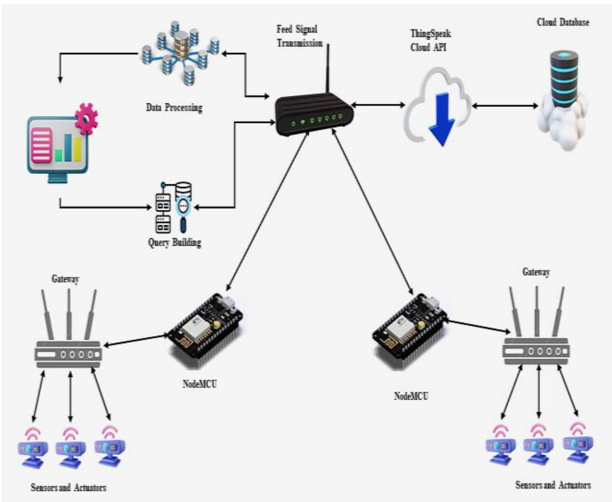


Fig 1. System Architecture

3.1 Web Application

Web Application which is created to provide the interface to control the home appliances. Users ON and OFF the electric and electronic appliances. The website is designed responsive so the users can use this website to control the appliances and also sensor data retrieved from the ThingSpeak and the graphical representation of the data are displayed on the data collection dashboard.

3.2 Thing Speak

ThingSpeak is a cloud-based IoT analytics tool that allows you to collect, visualise, and analyse live data streams. ThingSpeak delivers real-time visualisations of data sent to it by your devices. You can undertake live analysis and analyse data as it comes in, with the option to execute MATLAB code in ThingSpeak. ThingSpeak is frequently used for IoT system prototyping and proof-of-concept testing. We are using this cloud service for signal communication and signal data storage. The stored data can be used from the ThingSpeak database.

3.3 Node MCU

In this system, NodeMCU is used as the microcontroller which acts as a control for both the sensors and relays these NodeMCU gets the signals from the ThingSpeak cloud and based on that signal the nodeMCU sends the signals to the relays and also the data collected using the sensors are processed and if any of the readings exceeds the limit the nodeMCU turn on the buzzer to intimate the user to avoid risks

3.4 Circuitry

Following circuits in Fig. represents the circuit diagrams for the modules. This circuits involves conceptual prototypes and real components which can have a slight visual difference in design and appearance. The circuit contains two nodeMCU and circuit of the gas, pir, water level sensor, fire, relays, buzzer and a esp32 camera and the data collected via sensors are used for the security and automation purposes. The gas sensor works by monitoring the amount of gas in the atmosphere according to the threshold values where LPG is given. The fire sensor is employed for monitoring the outbreak of fire. The PIR motion sensor uses infrared radiation by receiving the amount of heat emitted or reflected by the objects. The water level sensor which is connected to this circuit works by calculating the pressure on the front surface of the sensor is converted into the water level height which is used to calculate the amount of water. The fire sensor which is used here is an IR flame sensor which detects the presence of flame or fire in the range. The relay which is employed as the switch it is actually used here to turn ON/OFF the electronic component or the home appliances. It works by closing and opening the circuits based on the input given. The buzzer is used here as an alarm to alert the users which works by the input given by the microcontroller when the threshold values exceed it is used as a security feature. Finally an esp32 camera is used as the door camera in which the feeds are locally transmitted within the same network. Fig 2 shows the circuit diagram.

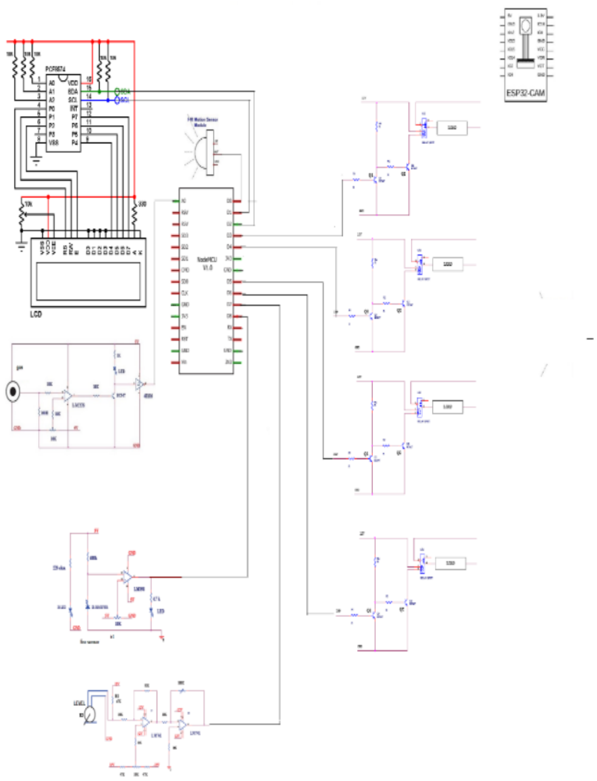


Fig 2 Circuitry Diagram

IV. METHODOLOGY

An applied methodology has been proposed for this system. A system is developed to simulate the features provided as follows:

A) Features of the proposed system

- Users can control the appliances remotely from any device which supports a browser
- Maintains the data log over the cloud
- Show the data of the each and every sensor on the data collection dashboard
- Signals are used to control the appliances
- Buzzer is used to alert the user

B) Components used

Several ways are available and lots of components are available in the market which can be used in alternate for developing the system. Table I which is present below consist of the components we are used in our project based on their usage and availability of the components. We can also use the components which are similar to the specification an functionality. Exact components which has been used in the project is listed below in Table 1 with the quantity,

Sl.NO	Name of the component	Quantity used	Usage of the component
1	Device which can support latest browser	1	User interface for the control
2	NodeMCU Esp2866	2	Controller
3	Step Down transformer	1	Convert the variable current to the regulated amount
4	16 X 2 LCD display	1	Displays the Status of the system
5	PIR sensor	1	Used for motion detection
6	MQ2 Gas sensor	1	Used for the gas leakage detection
7	Fire sensor	As required	Used for the fire detection
8	Relay module	As required	Used as the gateway for controlling the appliances
9	Water level sensor	1	Used to detect the water level
10	Buzzer	1	Used as the alarm for emergency
11	Esp 32 camera	1	Used as the door camera

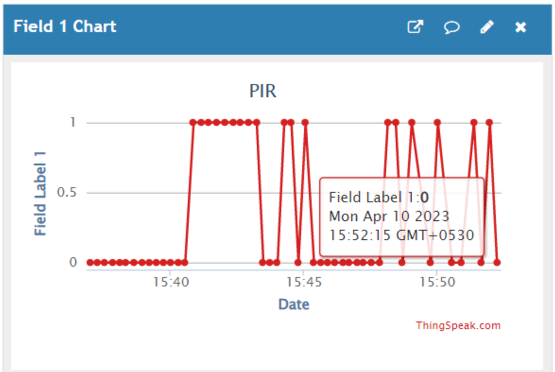
Table 1. Components List

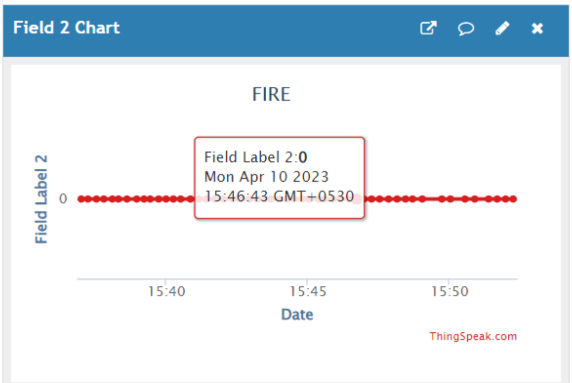
C)System Implementation

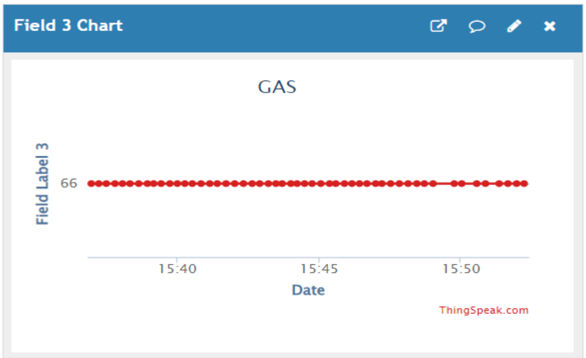
The implementation of this project is discussed here. First of all we have to configure the cloud for that we have been using the Thingspeak cloud

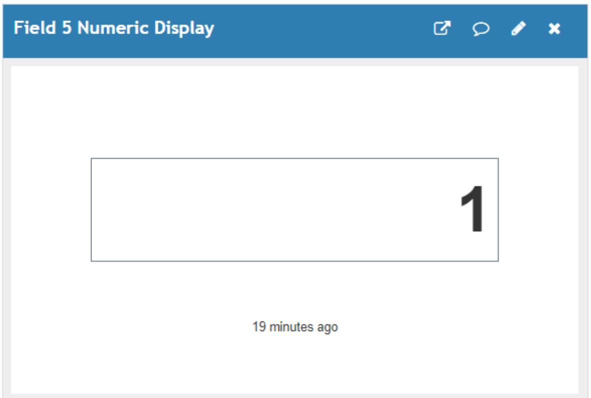
i) Cloud configurations:

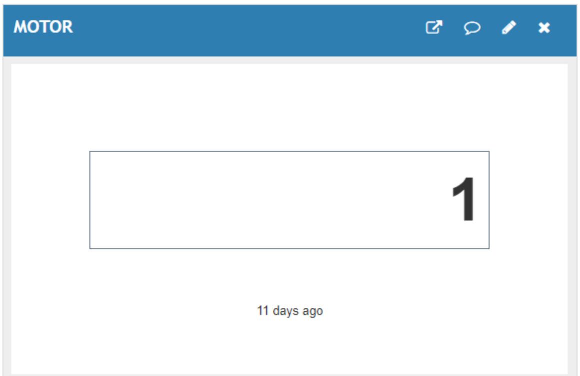
We are using the Thingspeak cloud services for our cloud. For that first and foremost we have to signup in the Thingspeak website in order to use the services. After a successful registration now, we can create channel for our project. In our channel we can now create the required number of fields with name. the fields are now used to control the appliances and monitor the sensors by linking to it.It used to represent the data which has been collected in the cloud for the fields we have added. The sensor data are represented in the 2d graph and the appliances status are represented as 1 and 0 where, 1= ON and 0 = OFF. We can access these data whenever we want and we can download the data in XML,JSON,CSV formats.

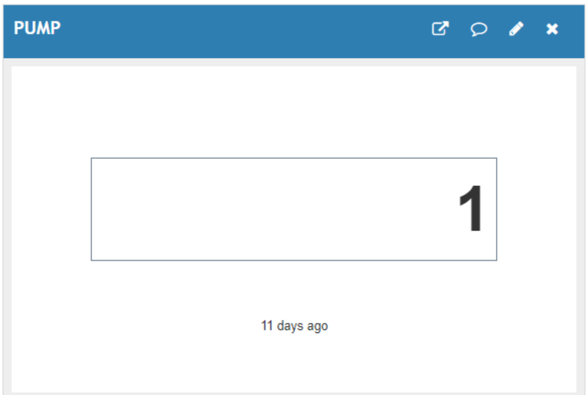


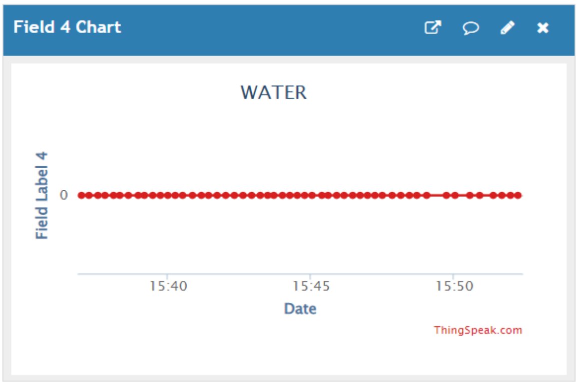












We can access the services using the Thingspeak API. The Thingspeak API uses GET requests for the query execution. The queries are generated using our website and the NodeMCU is used to send signals and the log is maintained in the Thingspeak cloud database.

The query building happens in the following way these are the main way to upload and download the query. They are

URL= https://thingspeak.com/

Field = # ('#' represent the field number')

Chanel = # ('#' represent the chanel number')

API_KEY= "###AB##ABAB##ABA''

Time_zone = "Asia/India"

ii) NodeMCU configuration

The nodeMCU is the heart of the system. The whole system is controlled by the NodeMCU microcontroller it plays a vital role in the project so it is very important to configure the NodeMCU. There are many ways available to connect the components with the system. We have used serial communication in this system.

NodeMCU continuously access the signals which is stored in the cloud database and based on the signals it passes the instructions to the buzzer and specific the relays according to the signal received. And the standalone mode of the sensors works by capturing the signals, it triggers the response accordingly and the sends back to the NodeMCU as an acknowledgement and to upload the log on cloud. A LCD display is used to display the status of the system the senor's threshold values are displayed once the limit is reached and a buzzer is connected to the system for the hazard indication and safety purpose.

iii) User Interaction

A website is developed as the main interaction tool with the easy user interface which can be much easier for newbies and elders while accessing the site. The website provides the remote access to the users to control the home appliances. The data collected through the sensors are also displayed in the data collection dashboard so, it is easy for the user to monitor their home using the sensor from any part of the world just using a web browser and they can control the appliances with the help of the internet.

The website works with the help of the ThingSpeak cloud server API keys. The query execution needs a secure internet or wifi connection. The appliances and sensor data updation both needs a internet connection which is used to connect with the cloud. We can also download the data from our website in the .CSV format in which we can have a clear view with the timestamp and status of the all fields during each timestamp which will be helpful to calculate the energy consumption we can use power formula ,Power = $Energy \div time$ Power consumption is denoted as kWh = Kilowatt hour.

iv) System data flow

In this section we have showcased the data flow diagram in the fig 4

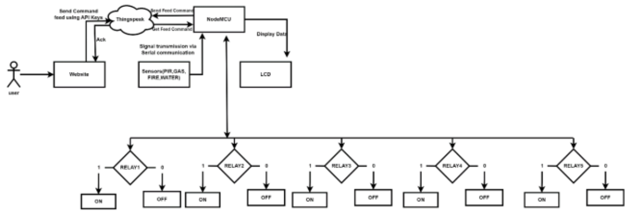


Fig 4 Data Flow Diagram

The system contains sensors and relays which are connected to the central control system which is linked with the Thingspeak cloud. The nodeMCU acts as the central control system or the hub between the sensors and devices From where the signals are triggered and the data are collected from the sensors and stored in the cloud. A website is used to control the devices and the data collected from the sensors are processed and displayed on the data collection dashboard and users can also download the data from the website. For the security we have used a standby mode where the sensor data were monitored and analyzed and alert the user by turning the buzzer on whenever the threshold value were exceeded.

VI. RESULTS

This section presents the findings from testing the functionality of the implemented IoT system in the Smart Home prototype. As a result, Smart Home successfully controls home appliances like lights ,water level and monitors different factors, such as temperature, humidity, gas, water level, and motion, via websites powered by ThingSpeak. By connecting to the Internet, users can monitor and control the Smart Home prototype at any time and from any location.

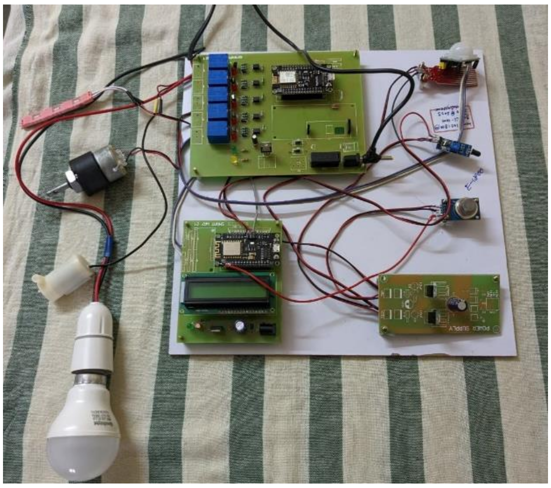


Fig-5: Hardware Module of Smart Home

This Fig 5 is the Hardware module of the system ,to keep the system connected to the Internet, NodeMCU is linked to a predefined Wi-Fi network. Users may use any mobile device, laptop, or personal computer. Log in to ThingSpeak applications on a computer to access the developed control system, which uplinks sensor data from NodeMCU and downlinks used commands to NodeMCU. Users can thus control all electrical appliances and monitor the house's motion, temperature, gas, water level, and humidity.

Fig 6: Data Collection Dashboard

We can access the services using the Thingspeak API. The Thingspeak API uses GET requests for the query execution. The queries are generated using our website and the NodeMCU is used to send signals and the log is maintained in the Thingspeak cloud database.

VII LIMITATION

The estimated system has several limitation on operation. To start with the this system works with the help of electricity without electricity without the electricity the system will not synchronize so the constant power supply is required for uninterrupted operation of the system. the suggested system is purely based on IOTso the system definitely requires a stable internet connection to connect with the cloud for execution and data transfer. These limitations can be resolved with the simple solutions a backup power source is added to the system to solve the power failure and a stable internet connection is required for solving the connectivity issues.

VIII CONCLUSION

The suggested system was designed and developed with the aim of reducing the cost and size in employing the usual home automations using the internet of things (iot). Our main goal is providing this system to the end users in a very affordable and portable in manner. Now this system has produced a expected results in real time by compact and portable in architecture and in cost effective manner. This will be more useful for tenants and it will be a great development if this system was implemented in large scale and implemented while designing for house plan and employed during the construction of the home. A GSM module can be added in future to send SMS and Call the users and emergency services during the emergency and a door lock system with fingerprint access can be added to the architecture. An algorithm may be developed for learning the usage patterns of the users for future usage and to act based on the environmental conditions and scenarios. An artificial intelligence (AI) based voice assistant may be implemented in the system to control the system with the voice assistant. A smart energy monitoring system can be employed to monitor the energy usage and suggest tips the user to the users about energy savings. We think this research paper will be useful for future references and future development based on this system

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