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Comparative study on home automation using IoT

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Abstract

The term "home automation system" refers to a procedure that automates or adjusts routine home tasks, such as the user-commanded regulation of lighting and HVAC systems. A portable and versatile hand held device is perfect for use as a UI into home automation system. More and more people need home automation systems with Internet of Things capabilities as internet consumption and associated costs continue to rise. Smart home applications, in which gadgets are smartly connected altogether to give comfort in daily life and enhance people's wellbeing & lifequality, have benefited greatly from IoT mobile systems.

Keywords: Home Automation; IOT; MQTT; Smart security; Machine Learning; AI

1. Introduction

More than eighty years have passed since the first "automated house" or "smart home" was built, and since then, the concept has been hampered by a number of technical hurdles. Recently, a new initiative has been launched by service providers and manufacturers of household appliances to make the concept of smart homes a reality. The proliferation of cutting-edge methods of transmitting data and voice has contributed to the rise in acceptance of home automation systems (HASs). One use case for the IoT is the "smart home," which enables remote access to and management of one's house's electronics and appliances via an integrated network of sensors and control devices. Sensors are used to monitor environmental characteristics in a smart home system, and the data gathered is then sent to the users through various channels (e.g., GSM, Bluetooth, Internet).

The term "Internet of Things" (or "IoT") is used to describe network of interconnected electronic gadgets and other "smart" items that exchange data with one another through built-in computer systems. The advancement and birth of a new age of technologies for information and communication may be attributed to the development of IoT architecture using embedded devices & unification of mobile systems into IoT applications. Connecting any and all devices, wherever in the world is now easier than ever thanks to the IoT's cutting-edge, dynamic network.

Through the use of several sensors and actuators, IoT makes previously dumb household appliances smart. These sensors keep tabs on the health of the gadget and its surrounding environment, relaying that data to an IoT gateway. Hardware and software come together to form doorway devices. These gadgets serve as a central point of contact for a wide range of sensors and actuators. A gateway connects Internet of Things (IoT) sensors to the wider network. These access points provide user oversight and command of a wide range of sensors and actuators. Data might be kept in a database or the cloud, and it is sent to the user through an Internet gateway. The finest examples of IoT gateways are Raspberry Pi and Arduino. Smart home applications, in which gadgets are smartly connected altogether to give comfort in daily life and enhance individuals well-being & higher lifequality, have a lot of room to grow thanks to the Internet of Things technology and mobile systems.

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Long Term Evolution (LTE) is a cordless board spectrum transmission that is mostly used for mobile communication and is among standard protocols in use by IoT. LTE-A, the next iteration of LTE, is a high-speed, advanced variant with a maximal downstream speed of 1Gbs or an uplink speed of 500mbs; its access mechanism is OFDMA/SC-FDMA. RFID, or radio-frequency identification, employs a magnetic field's ability to read and write data to tags placed on an object's surface. For RIFD, there are two types of tags: those that do something and those that don't. Using the OPV improves the RFID tag's performance. The smart card's communication mechanism, near field communication (NFC), provides superior performance and data security. To link distant devices with a tiny code footprint & low network traffic, MQTT Protocol, an OASIS standard message protocol for the IoT, is used.

2. Related Work

Shruti Dashet al[1] has offered a prototype home automation system built with user's budget and comfort in mind. The author employs the Object Oriented Design and Analysis (OOAD) approach to design. The primary purpose of this article is to create a plan for a three-part IoT-based home automation system..

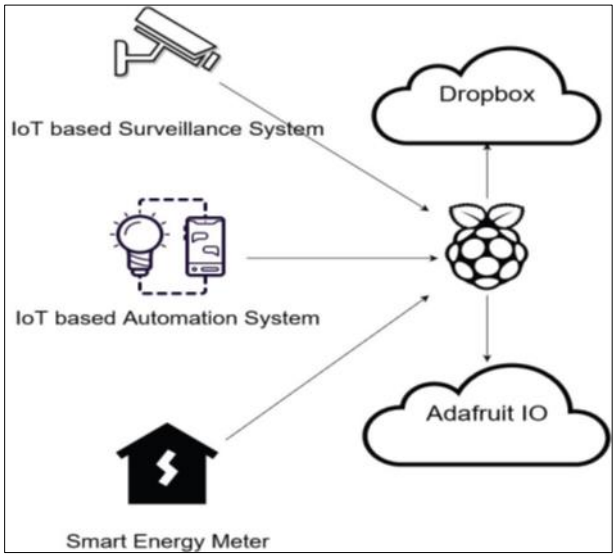

Figure 1 Schematic diagram of proposed system

The intelligent monitoring apparatus relies mostly on the Raspberry Pi & Pi Camera. The PiCamera broadcasts real-time video of its environment, and computer vision is utilized to identify moving objects and recognize faces. Every bit of information obtained by PiCamera is saved to Drop Box as timestamped snapshots. The linked devices (light bulbs) are managed by an IoT-based appliance, which in turn controls the relays that feed power from the normal AC supply source via an energy meter. The current sensor monitors the power used by appliances, sending that information to Arduino Nano, which in turn sends it to the RPi. Adafruit IO platform maintains the data on the RPi's current consumption and allows for control of the associated relay modules. In the instance of a smart energy meter, voltage by single-phase energy meter is transferred via a network that includes a step-down transformer and bridge rectifier, reducing the value to a level that can be detected by an Arduino nano & sent to Raspberry Pi. RPi then sends the collected data about energy use to Adafruit IO in the cloud. This technique may be used successfully in households and smaller businesses to monitor and regulate electric energy usage, enhance security, and provide users simple access to their appliances. With cloud's convenient accessibility from anywhere, this paradigm may be utilized for wide range of tasks.

Sanzid Hossain Tayef et al[2] The primary result of our research is an affordable, adaptable IoT Home system that can monitor and operate home security and appliances in real-time from anywhere in the world. Utilizing a cheap microcontroller (Wi-Fi module) as well as a free mobile application which could be utilized with our already-existing smart phones, this IoT-based managed smart home system shows to be straightforward and cost-effective. It saves money on utilities because of the convenience of remote appliance management. People with disabilities, those who live alone, or the elderly may benefit greatly from this system, since they will likely be unable to switch on or off equipment without assistance.

Table 1 Following is a list of some of improvements:

Feature	**Possible Enhancement**
Pi Camera used for surveillance	Night visions can be overcome with Infrared Cameras
Facial Recognition requires preloaded data	To overcome preloaded data we can use machine learning
Appliance control through Adafruit platform	Development of a personalized app is possible for control
All data is accessed on the user's cloud account using internet	It is possible to store the data offline with the help of a designated server, thus improving data security

A smart home couldn't function without the ongoing two-way flow of information between the Internet of Things platform and the user end. Because of its suitability for low-bandwidth applications and resource-limited devices, the MQTT communication technology is chosen for this purpose. Specifically, the NodeMCU ESP8266 microcontroller is utilised, having integrated Wi-Fi connection system. Widely utilised in IoT projects, NodeMCU acts as a controller by collecting data from sensors, sending it to MQTT IoT platform, but then acting on instructions from IoT dashboard. The notification was sent out using IFTTT app. Webhooks allow IFTTT program to communicate with IoT control panel (web link).

Ravi Kishore Kodali et al [3], The goal of this Internet of Things project is to create a wireless security system for a house that can transmit notifications to owner through Internet as in event of a break-in and, if desired, sound an alarm. On top of that, the same suite of sensors may be used for home automation. This system has an advantage over comparable ones already in market since user's mobile device, which is not necessarily online, may receive warnings and status updates delivered by wifi-connected microcontroller-managed system from any location.

An intelligent security system based on PIR motion sensors is presented, with these sensors placed at the building's entryways. Human activity is tracked by these sensors. The microcontroller receives this detection signal as an input trigger. A voice call to the owner's cellphone will be made, alerting him to the fact that "There is an Intruder in House," whether or not the owner is now present in structure. The homeowner may activate the lighting & alarm system at his home by pressing the number "1" on his mobile keypad, giving the burglar a timely warning. In addition, if the proprietor determines that his property is unsafe, he may describe the issue by short message service (SMS) to the appropriate authority in the police department. After a certain amount of time, alarm & lighting will automatically switch OFF thanks to the module.

The concept of a home automation system in a smart house may be better understood via illustration. Let's say a visitor to the owner's home finds him unavailable. The host may now get a video call as his visitors approach his home. However, the owner may now stop the security system entirely by pressing any number other than 1 (for example, pressing 3 for lighting, 4 for fans, 5 for A/C, and so on). If the user or someone else leaves the home, he will still get a video call, but this time he will be able to turn off the appliances or re-enable the security system by hitting the appropriate numbers. Because the relay connects to the mains supply, the appliances may be readily managed by a micro-controller. The present prototype employs a TI-CC3200 Launch pad board, which, thanks to its integrated microcontroller and onboard Wi-Fi shield, allows for the remote management and control of all of the electrical equipment in the house.

The system's potential in the future hinges on the user's discretion and ability to assess the situation, with camera attached to microcontroller providing additional information that could aid the user in deciding if for activating security system or to welcome the guest. Following face detection, the user may get an email with the taken image of the visitor or invader. If the user suspects that the person in the picture is an inducer, he may then send the same image to the police. A further step toward synchronization would be to include the voice call capability into identical smart phone app via which user may even operate his household appliances with no voice call being prompted to his phone.

Table 2 Analytical table highlighting several pieces of hardware and software

S.No	Authors	Paper Title	H/W & S/W Components
1	Shruti Dash and Pallavi Choudekar	"Home Automation using Smart Devices and IOT"	RPI & RPI Camera, ADA Fruit IO platform
2	Sanzid Hossain Tayefet al	"Design and Implementation of IoT basedSmart Home Automation System"	NodeMCU, MQTT IoT platform, IFTTT software
3	RaviKishore Kodali et al	"IoT Based Smart Security and Home Automation System"	PIR motion sensors, TI-CC3200 Launch pad
4	AmnaEleyan and Joshua Fallon	"IoT-based Home Automation Using Android Application"	Arduino and PIC Microcontroller, Phidget Module, MQTT protocol
5	Brundha SM et al	"Home Automation in Client-Server Approach with User Notification along with Efficient OR DNS Security Alerting system"	NodeMcu server via NOIP or DNS, PIR Sensor
6	Vivek G.Vetal	"Enabling iot services using wifi zigbee gateway for a home automation system"	Cubieboard control unit, ZigBee and Wi-Fi, Xbee module
7	Dr.Nupur Giri et al	"Home Automation Using Panoramic Image Using IoT"	Raspberry Pi, Pano2VR software, MQTT Protocol
8	Waheb A. Jabbar et al	"Design and Implementation of IoT-Based Automation System for Smart Home"	Arduino Mega microcontroller along with Wi-Fi module ESP8266, Virtuino android application
9	Mr.E.Venugopal et al	"IOT based AWS home automation using Node MCU"	NodeMCU ESP8266, Amazon Echo, Relay Board, Arduino IDE
10	Mr. Harsh Kumar Singh et al	"A step towards home automation using IOT"	Node.js, Express.Js, Node MCU, Relay
11	Mrs.Vagdevi P et al	"IOT Based home Automation using NFC"	Mifare Classic NFC card, CR0381 NFC reader, ARM LPC2142 microcontroller, Light Dependable Resistor (LDR), LM35 Precision centigrade temperature sensor, LCD, Hand-off, GPRS modem
12	Mr. Vishwajeet Hari Bhide, Dr.Sanjeev Wagh	"An intelligent self-learning system for home automation using IOT"	Sensor array, microcontroller board, relay, motors, alarm
13	T Satyendra K. Vishwakarma et al	"Smart Energy Efficient Home Automation System using IoT"	NodeMCU (ESP8266), IFTTT, ADAfruit, Arduino Software (IDE)
14	Majid Al-Kuwari et al	"Smart-Home Automation using IoT-based Sensing and Monitoring Platform"	Arduino, Raspberry Pi, and NodeMCU
15	Vignesh Govindraj et al	"Customary Homes to Smart Homes using Internet of Things (IoT) and Mobile Application"	WiFi module ESP8266, Arduino, RF module

AmnaEleyan and Joshua Fallon[4] This article presents a cheap smart home automation, using more affordable controller Phidget Module than the Raspberry Pi, Arduino, or PIC Microcontroller utilized in the aforementioned works. The MQTT protocol facilitates interaction between mobile apps and IoT gadgets in the home. With its reduced overhead compared to HTTP, MQTT is an ideal choice for the limited bandwidth of the Internet of Things. how different parts of an automated house work together. The MQTT protocol is built on the publish/subscribe architecture, which divides

the client which sends a signal from client which receives message . Both android app & Phidget controller/servo motor act as MQTT clients with in proposed automation system. The MQTT broker manages the communication between these clients. The broker's responsibility is to sort all incoming messages & deliver them to the relevant recipients. Subscribed to the topic "House/door1" on a MQTT broker, both the client android app and the Phidget controller would receive all messages sent to that topic. This article introduces a cheap Internet of Things-based smart home automation system that utilizes an android app &Phidget controller to manage in-house amenities like the door lock. In upcoming updates, voice recognition control for android app's use of home devices will be enabled.

Brundha S.M. et al[5] The study is focused on how to detect an intruder and set off an alarm: An picture of the person who entered is captured by a webcam when an Arduino communicates with Matlab and activates the camera in response to a high PIR reading. The picture is processed to extract a face, and then that face's characteristics are compared with trained photos in a database; if a subject isn't one of trained images, an alert is sounded, and a warning is delivered to the user via server. By connecting to the NodeMcu server using NOIP or DNS, the user may get the intruder's picture after they have been detected. The setup utilizes a camera module and

WiFi server based on the NodeMcu module. Port forwarding allows users to connect to a server from outside a local network. Modifying the router to capture an intruder's picture is a straightforward process that entails assigning the NodeMcu a static IP address and enabling a local port.NodeMcu local port has been added to Windows firewall to allow for the relaying of requests for the specific port from the external network to NodeMcu, which works well with a static IP address. Low-cost Wi-Fi security and automation modules that provide a safe and secure home environment. The security system sends notifications to the user's phone if there is an issue in the house. The intruder's picture is recorded by a camera module linked to the microcontroller. To detect potential intruders, our prototype system checks for familiar faces and sounds an alert.In a potential future iteration of this project, the collected picture will be sent to local police station. For the house's actuation section, additional sensors and actuators are needed to construct a smart home.

Vivek G.V et al[6] In this scenario, a Wi-Fi ZigBee gateway is installed to automate the house. From the cubieboard control unit, which has a graphical user interface and acts as a gateway, the sensors and actuators are wirelessly sent to their final deployment location, where the gateway facilitates both local user interaction and distant access through ZigBee and Wi-Fi. With the help of a gateway, which mediates communication across several networks, it is possible to build "Smart Houses" that make use of a wide variety of sensors and actuators. Our home's temperature, lighting, and door locks can all be monitored using this system. With the help of a dedicated interface for measuring current consumption, we can keep tabs on our home appliances' power use in real time from anywhere with an internet connection, opening up Wi-Fi-based access to all of our electronic gadgets. In order to create a relaxing atmosphere, actuators and sensors are linked to various electronics such as a tube light, a bulb, a television, & dimmer for speed of a fan. Through the use of WSNs, we may greatly improve our living conditions and degree of autonomy.

Figure 2 Panoramic Image

Home automation systems that can connect to the internet of things (IoT) are in high demand due to rising internet use and decreasing costs of related components. This experiment shows that the suggested gateway works effectively by receiving and transmitting commands from multiple protocols like Zigbee, and is part of a prototype home automation system with user interaction capabilities.In the end, the Xbee module was able to communicate with door sensor,

temperature controller, & light sensor in proposed system. All readings were collected at outlying site, relayed wirelessly to home station, & stored there.

Dr.(Mrs.)Nupur Giri et al[7]This was mostly concerned with MQTT-enabled Smart IoT devices. It is the primary protocol used by the System to relay information between many connected smart IoT devices & server. In addition, MQTT is used for the connection between the Android smartphone and the server. Pano2VR software is used to set up the panoramic picture that will be used to operate home appliances. This technique relies only on predetermined states. When viewed on a mobile device, this picture provides a panoramic panorama of the whole house. The panoramic picture after being cropped using Pano2VR software to highlight the appliance and activate OnClick functions.

At this Home Automation system in place, the user will have complete command over all of his or her household appliances with the touch of a finger. MQTT, the communication protocol we're employing, is a lightweight publish-subscribe protocol, therefore it'll improve QOS. Since fewer electrical lines will need to be rounded off thanks to this system, overall costs will go down. Because we will be utilizing digital switches rather than electrical ones, the number of accidents involving electrical equipment will drop significantly. Using this System, a user who is unfamiliar with the workspace or its appliances will have immediate access to those appliances. Since we will be utilizing a local server (a Raspberry Pi), we will have an Intranet, and the likelihood of an outside hacker accessing our system is quite low.

A potential in the module's future is to employ dynamic implementations of static methods.

Waheb A. Jabbar[8], et al. The study is focused on how to use the Arduino Mega microcontroller and the ESP8266 Wi-Fi module in a home automation system. We set up a local Wi-Fi-based control system in addition to a distant one by Iot. To control and monitor through smartphone, we use Virtuino, an appropriate Wi-Fi-based android application chosen for its user-friendly interface and its ability to function quickly with Arduino Mega. The Arduino controller can communicate with the Virtuino software thanks to certain pre-programmed code.

Direct connections will be made between Wi-Fi module, buzzer, humidity and temperature sensor, and the Arduino Mega microcontroller. The microcontroller's inputs stand for the sensors. The relay board is fed signals by the Arduino Mega, and its outputs are linked to the lighting and fan that stand in for actual household appliances. The sensor's capabilities include tracking the house's temperature, humidity, and motion. When the motion detector detects activity within the home, the buzzer will sound. Using Virtuino, you can manage every single one of your home's electrical devices. An Android-based phone can also track the relative humidity, temperature, and motion levels in a home.

In the future, the project's goal is to allow users to access and manage the system they've built from anywhere in the world through a webserver and an internet connection, thanks to the Internet of Things (IoT) idea. To avoid wiring complications, we can use a gateway to link all sensors towards an IoT platform, and we're also considering swapping out certain sensors with wireless ones. The ultimate result should be a little box that can be easily wired into the relay board of a real house's appliances and used for more secure control.

Mr.EVenugopalet al[9]. We frequently use Amazon Echo, Amazon's cloud services, and Amazon's speech services to power our system. Because of the hardware component, Arduino ESP8266 is used to provide practical solutions for non-smart houses. We frequently go into detail about the many components of our products and may demonstrate how well our system turns on and off our appliances. Any equipment or appliances in the house will be able to be controlled using voice commands. When compared to conventional homes, this can lead to greater communication in automated homes..

In further This author's goal was to study and assess the present home automation solutions. The standards, hardware architecture, software models, and protocols of the corporations are kept secret, therefore the majority of widely used home automation approaches and how they function have been conjectured. Successful studies and studies of many models of home automation approaches have been completed. This findings may have an impact on how we construct and design our own home automation system.

Mr.Harsh Kumar Singhet al[10]The goal of this project is to develop an IOT-based home automation system using a microcontroller with Wi-Fi support. The goal of this project is to develop an IOT-based home automation system using a microcontroller with Wi-Fi support. Why should our home be an exception when we are making technical gains in robotics, machine learning, and mobile when the scope of technology is expanding daily? In today's homes, standard/human input-based appliances are quickly making way for smart/IOT-enabled appliances that can be controlled remotely. Home automation systems today use technology that is exclusive to that one thing. In other words, we are enabling IOT on our smartphones, not our houses. In the context of this work, a NodeMCU (ESP8266)

microcontroller and relays are utilised to remotely operate electrical switches from a Node.js server. A web browser may be used to operate switches.

In Further work This project successfully creates a real-time home automation system that is very efficient in terms of technology and performance. Home automation systems are still very uncommon. Even so, there is a very strong probability that it will continue to be popular in the future.

The log file was created as a consequence of the appliances' changing status. It may be used to monitor user activity, such as when they control appliances. We can train the system using this log file to use machine learning, which will teach it how the user uses his home's appliances. Based on the ML's outputs and the behavior of the information, the system may automatically modify the status of the appliances..

Mrs.Vagdevi P et al[11] proposes an architecture for home automations that incorporates mobile devices, general packet radio service, and near field communication. As near field communication aids in supplying the necessary security and energy efficiency. This article uses it as the main system to automate the user's home environment, including the lights, air conditioning, fans, television, personal computer, and mobile devices.

In further Intelligent house built on INFC is a robust and intense structure. In this essay, we have shown how NFC can be used to computerise the domestic setting. This idea isn't just limited to the house; it can be developed further by applying NFC technology to additional areas and building more safe systems. Numerous simple-to-use portable apps and sophisticated mobile phones with NFC capabilities are readily available in the business sector and can ease a worker's, a child's, a disabled person's, a patient's, or a senior's daily activities.

Vishwajeet Hari Bhide et al[12]The Internet of Things is an extension of the current Internet for the purpose of communication, interconnection and internetworking Also known between various types of devices or physical objects as "Things." We've published an efficient use report for loT in this paper. for the monitoring and control of environmental conditions Homes. We are also responsible for the detection and correction of faults Automatic connection of these devices to this system.

3. Proposed System

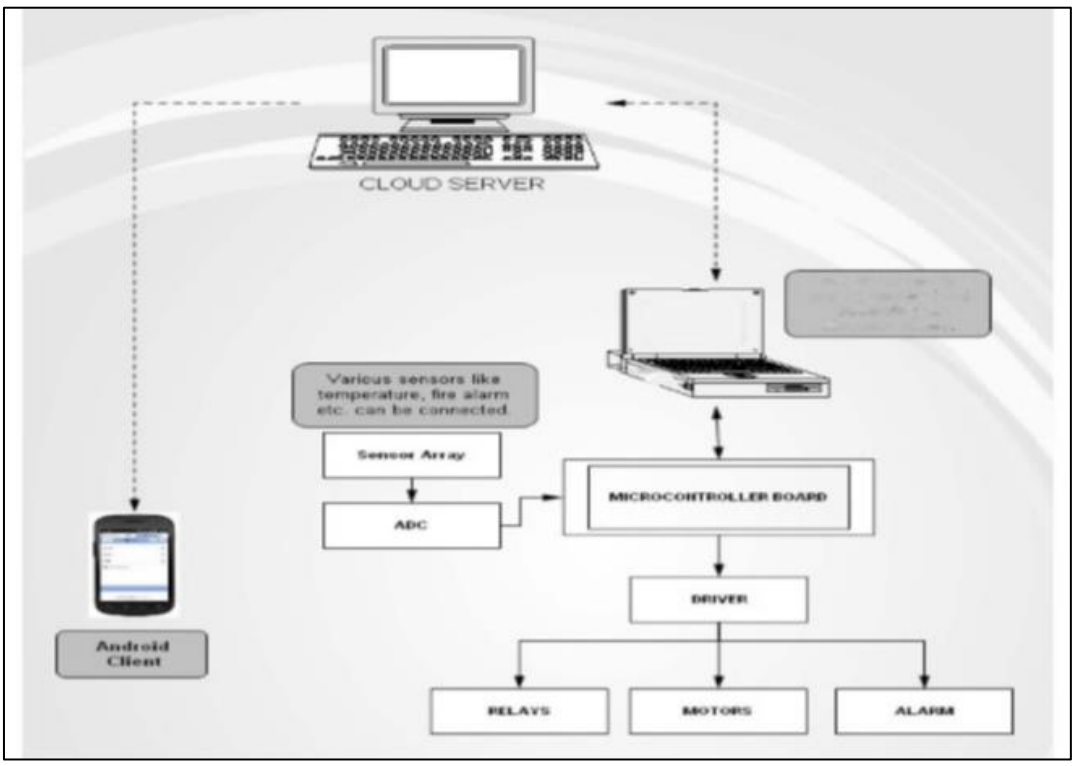

Figure 3 Block Diagram of Existing System

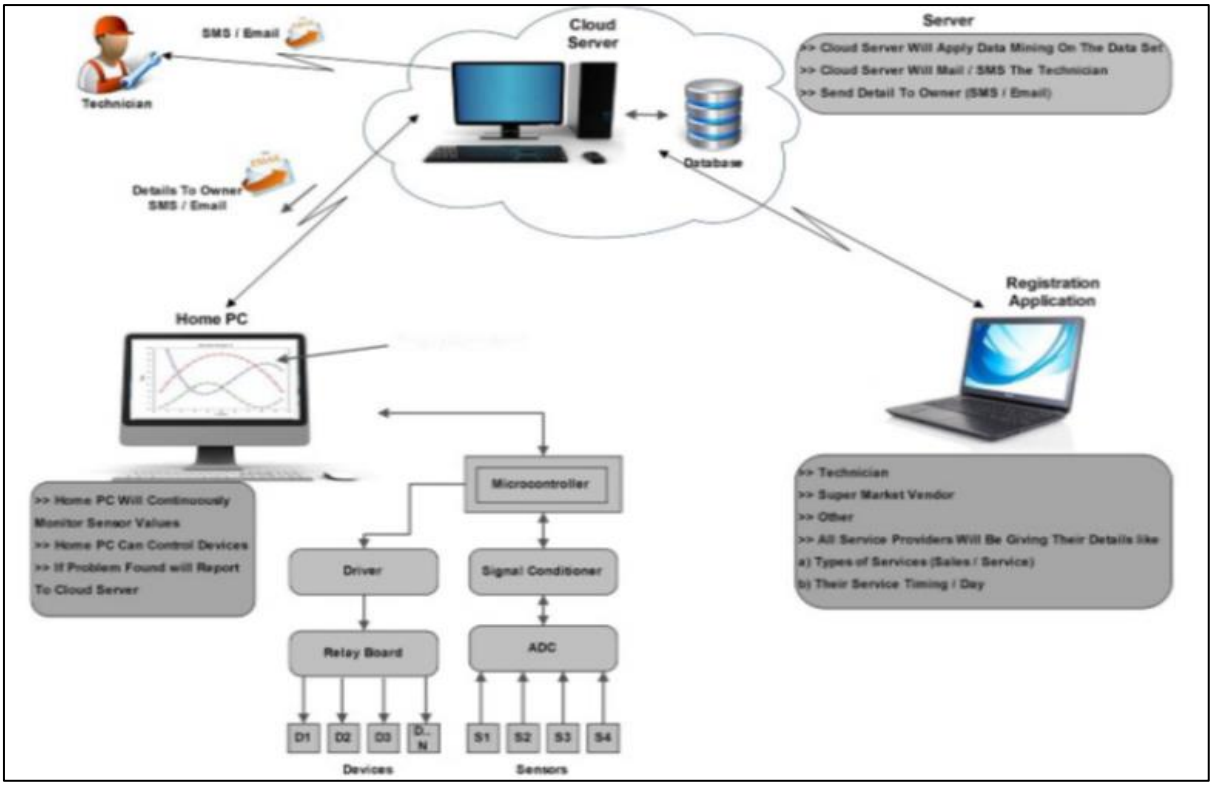

Figure 4 Architecture of Proposed System

T Satyendra K. Vishwakarma et al[13]There is now ubiquitous Internet connectivity, and developments in IoT-based applications are increasingly regarded by researchers as state-of-the-art technology. The importance of web-based and Android-based technologies has increased in this cutting-edge technology to improve the program's usability. An ingenious, energy-efficient home automation system that enables access to and control of domestic appliances from any location in the world is proposed in this article. An Internet connectivity module that may be accessed online is attached to the main power unit of the home system for this system. A permanent IP address is used to facilitate wireless communication.

We provided the detailed procedures in this document. method for a controller unit for smart home automation. Home appliances may be created with the aid of the design control unit. employing IoT, made into a smart and intelligent object. With the aid of connecting the three bulbs, the proposed model's functionality was experimentally verified. Two benefits come with the proposed system. First, IoT connectivity enables us to easily monitor and access our smart home from anywhere, which will unquestionably prove to be energy-efficient.

Majid Al-Kuwari et al[14] presents the overall design of an Internet of Things-based sensing and monitoring system for automated smart homes. The suggested architecture for data gathering, data visualisation, and remote control of home appliances and devices makes use of the EmonCMS platform. The selected platform is very user-friendly and versatile. The microcontroller board NodeMCU-ESP8266 is used to sense a variety of things in the house. Real-time data sensing, processing, and uploading and downloading to and from the EmonCMS cloud server are all made possible by this device.

This research proposed a straightforward and adaptable system for solar home automation and monitoring. The platform chosen is the EmonCMS, which employs the IoT principle to gather data from sensor nodes utilising a cloud server. The collected data can be displayed, saved, analysed, and utilised to operate home appliances. The NodeMCU and ESP2866 work together as the main processing unit to collect data from the sensors, process it, and then upload it to the EmonCMS cloud server. The same server from which the NodeMCU receives commands and data may also be used to read data from switching devices. This completes a smart home automation and monitoring system based on the Internet of Things (IoT).

By adding more sensors, measuring devices, and control devices, the suggested design of the smart solar home may be simply scaled and adapted to bigger structures. Additionally, more functionality and intelligence might be added to the

current system to allow the house automation system to develop, change, and improve on its own utilising cutting-edge artificial intelligence.

VigneshGovindraj et al [15] The primary goal of is to create a smart house automation system based on the Internet of Things (IoT) that will convert a standard home into a smart home that can be accessed and managed remotely using an Android-based smart phone app. To be more specific, we intend to employ the Internet of Things (IoT) to build a low-cost, scalable, flexible wireless smart home automation system that enables users to operate a variety of devices from remote locations thanks to an intuitive user interface and simple setup. In order to enable customers to remotely control a variety of electrical appliances (such as lights and fans) within their houses, this article describes the development of a smart home automation framework that integrates wireless and cloud networking. By testing, we proved that our IoT-based home automation functions well. Linking basic electrical devices that are easily managed from a distance or wirelessly over the internet.

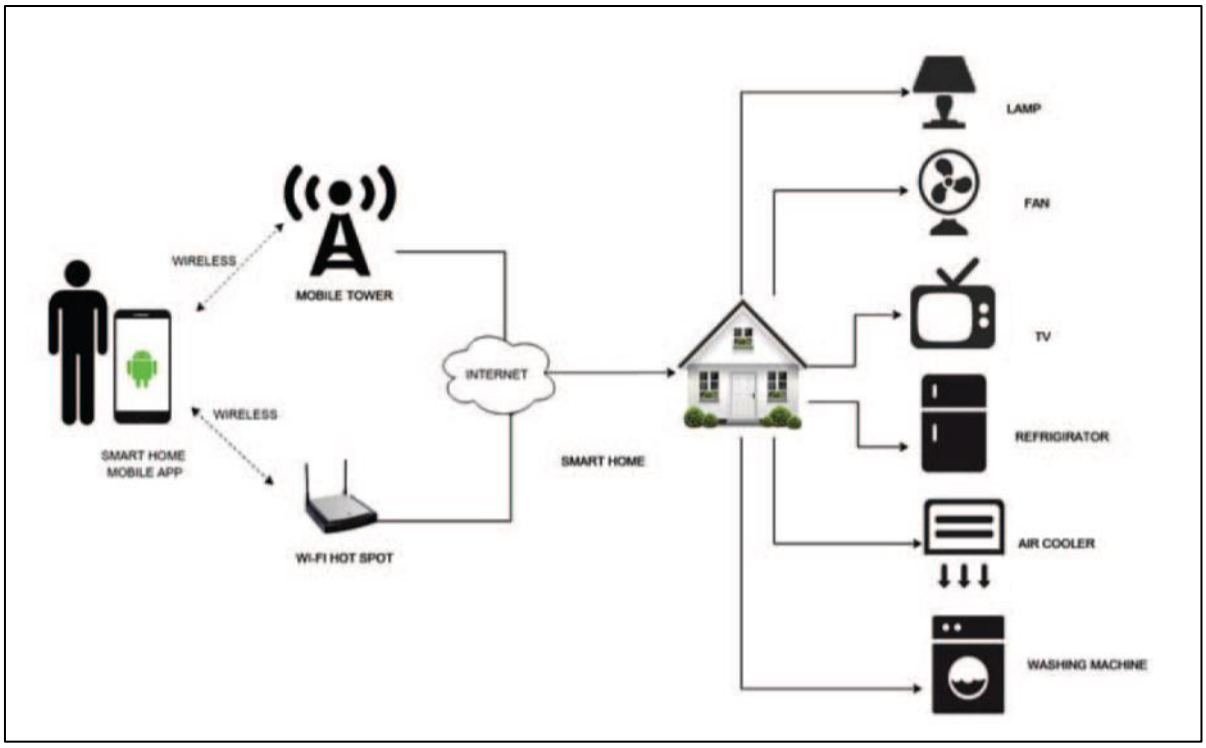

Figure 5 The concept of the Wireless Home Automation System (WHAS) using IoT

4. Conclusion

With this study, we have completed a preliminary overview of the many approaches to designing and deploying IoT-based home automation systems. Smart houses are the logical next step in today's technological environment, and this research compares their varied implementations. One-way technology like remote temperature monitoring is useful for creating a relaxing environment at home. The sensor's capabilities include tracking the house's temperature, humidity, and motion. When the motion detector detects activity within the home, the buzzer will sound. security and home automation in one, with the use of inexpensive Wi-Fi components. The security system sends notifications to the user's phone if there is an issue in the house. While this prototype has seen tremendous development in a number of key areas, there is still room for improvement. This system may be expanded to include real-time monitoring of power use, which has the dual benefit of lowering the likelihood of accidents while simultaneously cutting down on energy costs. This system gives an affordable option for implementing a Home Automation System that is both dependable and adaptable. We anticipate that scholars will find this survey useful in gaining a better grasp on the history, present state, potential pitfalls, and potential futures of Internet of Things-based home automation.

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