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Home Automation System based on IoT

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Abstract— The internet of things (IoT) has been very important when it comes to the automation of smart homes and buildings. In the smart homes and buildings automation, IoT is combined with cloud computing and rule-based event processing to ensure that individuals occupying any premise can enjoy their safety, convenience, and comfort. This study indicates that the use of IoT on smart home automation was fully embraced in the 21st century after commands and controls that were channeled through the electrical wiring had their signals affected by the radio band interference. Iteratively, IoT has been found to have enhanced the smart home automation by ensuring that home appliances and devices can be commanded remotely and at a convenient, safe, and comfortable mode. This study focused on the use of cases of various appliances and devices that are commanded and controlled through the integration of IoT, cloud computing, and rule-based event processing. The appliances that have been considered for this review are fire prevention systems, surveillance cameras, Smart TVs, lighting systems, smart thermostats, Air conditions, doors, fans, Humidity and Gas System. Without the use of IoT, the mentioned appliances and devices have performed haphazardly when it comes to smart home automation. Therefore, this study confirms that the use of IoT has streamlined the performance and the automation of home and building devices and appliances to ensure that they provide effective and efficient safety, comfort, and convenience required for a smart premise.

Keywords: IoT, Smart Home, Home Automation System.

1. INTRODUCTION

The advancement of Automation technology, make human life easier, more comfortable and less demanding in all sector [1]–[8]. Smart home automation system allows you access to control and monitor home appliances in your home from a smart mobile or laptop any corner in the world. Nowadays automation system is being preferred over manual system [9]–[14] . Internet of Things (IoT) is a promising technology which used for connecting and managing your home appliances over the Internet [15]–[20]. The development of communications technology has attracted considerable attention to smart home automation systems. Home automation system is an Internet of Things (IoT) which utilizes the Internet technology to connect and manage home devices using a smart home automation system [21]–[25]. A system consists of internet of things technology interconnected sensors and home appliances can communicate independently with a bit or no human interaction. A smart home automation system, tasks like (humidity, monitor lights, air flow, heat, doors, fan, and etc.) in and around our living units can be easier. It also adds a list of desirable states, like, security, safety, logistics, economy, comfortability, convenience, peace of mind, and reliability [26]–[29]. The Internet of Things is a vision for an internetwork of communicating and smart objects like home devices, vehicles, factory machines, wearable devices and different kinds of sensors. Technologies are convergence

such as communications, ubiquitous wire¬less machine-learning, embedded systems and real time analytics has made novel Internet of Thing applications possible in a various of aspects. A government combination initiatives and commercial interests have made smart homes, cities, healthcare, and transport primary areas of concentrate for Internet of Thing applications enhancement [30]–[34]. The Internet of Things is a very common way of connecting and monitoring the electronic devices over the internet and it can be used to adjust various parameters of those electronic devices via the internet. The IoT is basically a network of interconnected electronic devices and various embedded devices, sensors and controllers that all communicate with each other in order to perform the desired tasks demanded by the user over the internet. IoT is used to communicate various non-internet electronic devices to the internet and have absolute control and monitor over them [35]–[39]. Internet of Things involves developing network to collect, store and analyze the data proficiently from different actuators and sensors. Then, sends the collected data to the smart device such as personal computer or mobile phone over a wireless connection. Nowadays, security is a very important, where there is an increasing intrusion. Intrusion safety, leakage of gas, fire and theft are the most important requirements of home automation system for the human life [40]–[44]. Homes devices system is one of the most systems that make significant impact on electricity consumption, because of need high energy to turn on. the smart home systems aims to reduce the wastage of energy from homes and various building where contributing to conserve energy which has a great need nowadays [45]–[49]. Smart Home automation system has to provide a user- friendly interface allowing the user to setup home devices and controlling and monitoring them efficiently. additionally, the smart home automation system have to be high speed enough, provide reliable communication with acceptable data rate and connection range to realize the true power of wireless technology [50]–[55]. This paper looks into how the IoT has affected and controlling homes and buildings in terms of processes such as fire prevention systems, surveillance cameras, Smart TVs, lighting systems, smart thermostats, Air conditions, doors, fans, Humidity and Gas System providing specific use cases for the processes that can be controlled and monitored using the smart home automation.

2. Literature Review

In 2015, Mandula et al. [56] Provided a system that used to control the sensors data, like light, gas, motion, temperature and actuates a process depending on requirement, such as turning on the lights when it getting dark. In addition, use Gmail to store data in a timely manner. In 2016, Pothanaicker [57], presented basic idea of how can control home devices by computer technology as shown in figure 1. It saves energy and provides security, and accessing home devices by website, which can access it even if we are far away from home where the Wi-Fi is available.
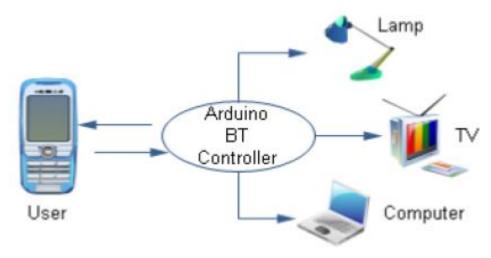

Figure1: Home automation system block diagram [57]

In 2017, Singh et al. [58], design a system that can perform different functions to be performed at home. This allows accessibility via internet from any position in the world. The project used to minimize the usage of energy and reduce human efforts. The smart home system incorporates different aspects of technologies such as wireless networking, communication via cloud. The data stored onto the cloud then analyzed. The user can access multiple home devices over the internet as per their convenience. This is a low-cost system. This system can control multiple home devices. In 2016, Kodali et al. [59], introduced a project that focused on creating a wireless security system where sends alarm notification to the home owner over the Internet if any action occurred and the alarm raises optionally. Adding to that, the sensors can also be utilized for smart home system. The system preferring over the other existing systems of the same type is that, sending the status and alert by the Wi-Fi connected microcontroller monitored system which can be received by the owner on his smart device such as (mobile) from any corner of world irrespective of whether his smart device is connected to the internet or not. In 2017, Sharma et al. [60] Smart home automation system has been designed to communicated with mobile android system. Mobile and system communicate with each other by Wi-Fi. We can download mobile application and communicate with proposed system from any compatible equipment. The commands to switch ON/OFF electrical peripherals such as air conditioners, fans, lights and etc. Timer setting at home to send quickly and easily from the mobile by comfortable and simple Graphic User Interface application, which can be used by any normal user. The home automation system responds to users' commands by taking actions per commands and gives the result. Also, the user can see commands result on mobile application with android system within covered distance of Wi-Fi.

In 2017, Soliman, et al. [61] Designed and implemented a real time home automation system concepts based on microcontroller 'Arduino' board and LabVIEW platform. Two hardware components are involved in the proposed smart home system: use laptop as a local server including the LabVIEW platform management and the second is Arduino microcontroller board. Sensors and home devices are connected to the Arduino microcontroller board. The home devices controlled, managed, and connected automatically and to any command came from home owner. Architecture and flow chart of the proposed smart home system have been progressed. Effectiveness and reliability of the proposed system evaluated, a hardware realization for three operational home devices: security camera, light, energy saving, temperature management, and based on an ultrasonic distance detection sensor has been developed. System is proposed to be simple and easy to use, flexible and reduce cost that making it a suitable for the smart home future. In 2018, Satapathy et al. [62], Arduino microcontroller board is used to present a cost effective, reliable and flexible smart home automation system, with additional security. Local Wi-Fi with IP connectivity for controlling, monitoring and accessing home appliances by system user with authorization using applications of smart phone. Independent server and Internet of things (IoT) depended in the proposed system to monitor home devices like industrial machine to consumer goods. User can use smart phone application, web browser or IR remote module for accessing and monitoring different home appliances. In 2018, Hossain, et al. [63], presented smart home automation system that services the segregation of objects that connected through the motion sensor, fog computing, server and switch connection among things. This system uses a personal computer to control the home appliances. operate household components via sensing the motion sensor. When the sensor detects a motion, then the components are automatically switched ON/OFF. The designed smart home automation system has the abilities to observe the objects in users' home and control the following activities: Fan ON/OFF, Light ON/OFF, Door ON/OFF, Webcam/CC-Camera ON/OFF Window ON/OFF, and Fire-Alarm/Sprinkler ON/OFF. In 2018, Kousalya et al. [64], presented a project that focusing on monitoring fans and lights referred as smart home automation system, additional security provided by capturing an image if any object is detected and send to the owner via an E-mail. "Node MCU" Module is used t to implement this system. The proposed system will be more useful and helpful for aged people and Handicapped.

In 2018, Singh et al. [65], improved smart home automation by considering a Wireless sensor node. various electrical devices integrated in Home automation system and automated them with minimum or no intervention of system user. The smart home system keeps track of various environment variables present and guides the home devices to work according to the needs of the system user. The system used to automate home appliances and send notification about the price of his electric bill to the home owner in regular interval and booking the gas cylinder automatically, when the gas reaches lower level than the threshold.

In 2019, Hoque and Davidson [30], proposed an architecture for smart door system, the system is a flexible and cost effective, mobile Android application is used to inform a home owner of door open events in office or home environment. Architecture of the designed system consist of Raspberry Pi 2 board for connection with a web-server that implements a RESTful API along with the Arduino microcontroller board compatible Elegoo Mega 2560. In 2019, Vishwakarma et al. [66], designed an efficient smart home automation system that used to access, control and monitor home appliances from any distance in the world. Smart home automation system connects to main internet supply connectivity unit. IP static address is depended for wireless connectivity. multimodal application based in Home automation system that can be operated using voice recognition command of the owner using web-based application or via Google Assistant. In 2017, Kulkarni et al. [67], intended to use any smart mobile system to construct a smart home automation system that monitor the home devices. Internet of Thing (IoT) is depended is This smart home automation system. This system is very exciting field when it uses new technologies like (IoT). Raspberry pi minicomputer used which supports large number of devices, allowing to control and monitor home devices simultaneously. Local server is created on Raspberry pi. Smart devices required such as laptop or smart phone used by the system user with User Interface UI created on web pages to operate home appliances from any corner in the world.

3. Discussion

The various researchers have therefore come up with studies on how the internet of things technology can be utilized. The internet has evolved and a larger population in both developed and developing countries have significant access to technology. However, the idea of the Internet of Things represents the next phase in the human engagements. The need to have a system that can control all the electronic devices in the house to work in collaboration with each other cannot be overlooked. Risks such as fire result from careless human mistakes and they require a proper mechanism to handle them The IoT concept means that incidents such as fire will be noticed early and neutralized on time. Another critical aspect from the literature review is that the IoT is a modern trend. The various studies focused on how the IoT can be utilized to make life easy and improve safety such as in the cases of CCTV and alarm systems. The world is embracing the ideas of sustainability especially when it comes to environmental pollution. The IoT technology guarantees proper uses of limited resources, such as food and nonrenewable energy. For example, when the system reminds the homeowner of the available food and thus no need to buy food that is not needed. It is a hope for the growing world's population, especially with the concerns for food sustainability. Thus, the IoT trend because it is solving some of the human problems. Besides, it is evident that the IoT will lower the cost of leaving because it improves the management of the entire system. The ability is essential because it can monitor the number of people who have access to the system. Therefore, contrary to the claims that the IoT system will expose the security of the homeowners is misplaced. Proper use of technology has higher benefits. However, the significant features of previous work explained in literature review section are summarized and tabulated as shown in Table 1.

Table 1. An overview of Home Automation Systems.

Author(s)	Home Devices Controlled	Tool	Aims

Mandula et al. [56]	• Humidity and Temperature • Detect motion • Fire detection • Lights on/off/dim • Fan on/off	• The Intel Galileo development board • web server. • Wi-Fi technology used connects sensors and server.	low cost flexible and expandable allow a different device to be monitored.
Pothanaicker [57]	• Light • Fan • Humidity • temperature control.	• ASP.NET • C++ platform • Arduino Tmega2560 • Relay • diode resister are integrated on PCB	provides security, saves energy and help handicapped people.
Singh et al. [58]	• Temperature • Gas • PIR motion • LDR	• ESP8266 • Wifi Module • Rasberry pi • Voltage Regulator • Connecting the home Automation Circuit	reduce the usage of energy and reduce human efforts.
Kodali et al. [59]	• Home Appliances	• TI CC3200 Launch Pad • Accessible Wi-Fi • Motion detector Sensor • Alarm • Relays • controlled doors or windows, • Mobile phone to receive Voice Call • Energia (Software)	Home automation and Wireless Home security
Sharma et al. [60]	• Lights • Fans • air conditioners etc.	• Wi-Fi on Android Mobile Device • Arduino UNO • ESP8226 Wi-Fi module	control of home appliances and provide security against the mishaps.
Soliman et al. [61]	• Temperature management • Light • Security camera	• Arduino microcontroller board • Sensors • Pc as server • LabVIEW platform	introduce a simple system to be implemented as compared to the others.
Satapathy et al. [62]	• Light • Fan • TV	• Arduino UNO • 4-Channel Relay • ESP8266-01 is a highly compact board • ESP8266-01 Wi-Fi module • Gas Sensor • Temperature Sensor	Design low cost, reliable and flexible smart home automation system with additional security.

Hossain et al. [63]	• Light ON/OFF • Fan ON/OFF • Door ON/OFF • Window ON/OFF • Webcam/CC-Camera ON/OFF • Fire-larm/Sprinkler ON/OFF.	• Cisco Packet Tracer. • Server-PT • Switch-2960 • Laptop-PT • SBC-PT • Motion Sensor	system is much secure than the others because they use identical eye retina scan pattern for professed sensor's response which will detect the owner of that home
Kousalya et al. [64]	• Light • Fans • Capture images for Security issues	• Arduino board, Node MCU • Relays for connecting home devices. • Air purity Sensor (MQ135). • Temperature and Humidity (DHT11). • IR Sensor • Camera module (OV7670) • Mobile phone • Blink application • *H.* Arduino IDE (Software)	using Wi-Fi as communication protocol to monitoring home appliances and building a smart security system.
Singh et al. [65]	• Energy consumption • level of the Gas cylinder • door cartons • Light • Fan	• Arduino UNO. • LDR module • Node MCU ESP8266 • Sensors like LM35, IR sensors	cost saving and energy conservation.
Hoque and Davidson [30]	• doors	• Raspberry Pi 2. • Arduino or Elegoo Mega 2560 board. • Magnetic reed switch. • RF receiver–transmitter pair (433 Hz). • Emulator or Android phone. • Female-to-Female–Female-to-Male Jumper Cables.	using RF based communication in a household to provide a low-cost architecture to create an IoT enabled home security system
Vishwakarma et al. [66]	• home equipment's	• Arduino Software (IDE). • Node-Mcu (ESP8266) • IFTTT • Adafruit	Provide more security and intelligent to home automation system.
Kulkarni et al. [67]	• Home Appliances	• Raspberry Pi • Relay and Relay Driver Circuit • Mobile Devices • PHP language	using Raspberry pi to design an Internet of Things based home automation system.

4. Conclusion

The ideas and benefits that are brought by the adaption of the internet of things (IoT) are likely to revolutionize how humans respond to their environment. The developments have made it possible for humans to operate the various functions within a home from one system. Even though there are security concerns on having all the house functions being managed by a single system, the fears are baseless. The technology customizes the features, and in case of intrusion in one area of the system, the chances of the homeowner noticing the change are high. More so, the IoT concept is beneficial to the environment where it embraces the responsible use of resources in the community. For example, when the light bulb goes off because there is no darkness anymore, it shows that the wastage is minimized. More so, when the fridge reminds the house owner that the expiry date of a product is close, it means that there is hope for responsible use of our food resources. Therefore, it is high time for a larger population to adopt the brilliant ideas of the internet of things.

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