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Design of a Secure Has Using Wi-Fi

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ABSTRACT

Home automation is the residential extension of building automation and involves the control and automation of lights, air conditioning, ventilation, and heating (LACVH) appliances using the Internet of Things (IoT) and establishing a wireless connection to various electrical devices within our homes. The main objective of an internet of things is used to help old age people and specially challenged people to control electrical appliances, and the security will be provided to the entry point of the home. In this paper, we are using Wi-Fi to control the home appliances that means we can control the home appliances the devise from outside the Wi-Fi range through internet anywhere, any place, anytime. And it reduces human efforts and power efficiency. The proposed system also deals with the OTP (One Time Password) generation which will be used as home entry password for users. Data from all these sensors is continually received and processed by Arduino Uno board which acts as a microcontroller unit. In case of untoward situations, the Arduino will trigger an alarm and alert messages will be sent to user's mobile via GSM. And the camera module to captures the attacker's picture and sends to the registered mobile numbers. Thus the system ensures home safety as well as security.

Keywords: Arduino Uno, GSM Module, Power Supply, Channel Relay, Camera Module.

I. INTRODUCTION

Home automation is building automation for a home, called a **smart house** or **smart home**. It involves the automation and control of heating, lighting (such as smart thermostats), air conditioning, ventilation (HVAC), and security, as well as home appliances such as dryers/washer, ovens or freezers/refrigerators. Wi-Fi is often used for remote monitoring and control. Home devices, when remotely monitored and controlled home appliances the device from outside the Wi-Fi range through internet anywhere and anytime. In, automation section we can control lights of our home using registered mobile number by sending messages or SMS to the system.

In this system, while developing security section we concentrate on the entry point of the home i.e. entry gate. We gave entry to those who know default password and OTP (One Time Password). The default password is already known to the user which is confidential. OTP is a password which is generated by the system on demand of a user using his registered mobile number which is registered with the system.

This system helps to protect the home especially entry point of the home from burglars and crooks. At the current situation all the industries, banks or organizations use the security system to protect their premises from burglars.

The rest of the paper is organized as follows: The history of Home Automation System (HAS) is discussed in section 2. The review of various Home Automation Systems (HAS) using IoT is discussed in section 3. The proposed secured Home Automation

System (HAS) discussed in section 4. Comparative study of various Home Automation Systems (HAS) with proposed system is discussed in section 5. Finally, the conclusion is discussed in section 6.

II. RELATED WORK

History of Home automation System-The first home automation is introduced by Ray Bradbury, and the smart home term was first coined by the American Association of house builder in 1984. The home automation technology spread to the security system, garage doors, environmental control, fiber optics, entertainment infrared control and more.

A Labour-saving machine was the beginning of Home automation in the1900s with the introduction of electrical power distribution.X10, the first general purpose home automation network technology was developed in 1975.According to ABI research in the United States, about 1.5 million home automation systems were installed by 2012.Three generations of Home automation was introduced in 2016.First generation: Wireless technology with the proxy server. Second generation: Electronic devices controlled by artificial intelligence. Third generation: Robots that interact with humans.

The invention of home appliances (1901 – 1920) – Although home appliances are not what we had considered "smart" they were an incredible achievement in the early twentieth century. These achievements began with the first engine-powered vacuum cleaner in 1901. And the second more practical electricity-powered vacuum was invented in 1907. Throughout two decades refrigerators would be invented, as well as washing machines, irons, clothes dryers, toasters, and so much more. It was very useful for anyone who was employed as a maid by a very affluent family.

Kitchen Computer and the ECHO IV (1966 – 1967) – Although it was never commercially sold, the first smart device is the ECHO IV. This clever device could compute shopping lists, control the home's temperature and turn appliances OFF/ON. The Kitchen Computer, developed a year later, could store recipes0but had the unfortunate tagline, "If she can only cook as well as Honeywell can computer" and therefore sold no models

Telephones and remote controllers (1994-2001) – It is well known that the concept of smart home has focused the attention of researchers, lifestyle practitioners, and the consumers to be directed forward the usage of the recent technology. Considerable efforts have been made to the development of remote control systems for home automation. The earlier work of such systems is mainly based on the use of telephone line, such as a phone-based system for home automation using a hardware-based remote controller [1],[2] based on a personal computer approach [3].

Home automation or Smart homes began to increase in popularity in the early 2000s. As such, different technology began to emerge. Smart homes suddenly became a more affordable option, and therefore a viable technology for consumers. Home networking, domestic technologies, and other gadgets began to appear on store shelves.

These kinds of systems which make use of the telephone as the remote control input device have no way to be connected through any user interface. The proliferation of telecommunications technology has made most of the recent home automation scenarios focus on using wireless communication to communicate the home appliances. Sriskanthan et al.'s [4] have developed an automated system based on Bluetooth wireless technology which allows the user to monitor and control different appliances that are connected over a Bluetooth network based on a mobile host controller.

Shepherd in [5] has introduced the idea of using Bluetooth wireless technology as a cable replacement that exploited the wireless interconnectivity which can be implemented using a radio home automation system method. However, he gave no design and implementation details in his work. Jawarkar et al.'s [6] have proposed a remote monitoring through mobile phone involving the use of spoken commands. These spoken commands are generated and sent in the form of text SMS to the control system via a microcontroller that designed on the basis of SMS where a decision of a particular task can be taken place.

Alkar et al.'s [7] have introduced an Internet-based wireless home automated system for multi-functional devices. Although the system has a low cost and flexible wireless solution to the home automation, there are still some limitations related to the wireless communication range and power failure. Zhang et al.'s [8] showed that a home automation system based on electric power communication (PLC) that uses household electric wire for communication and internet control with logging facilities. Although this system procedure overcomes the shortcomings of communications techniques, but still need some improvement.

El-Medany et al.'s [9] proposed a GSM-based remote sensing for controlling system based on using FPGA. This system has worked as a remote sensing for the electrical appliances at home to check whether it is on or off and at the same time allowed the user to control the electrical appliances at home based on SMS technique. It also works as automatic and immediate reporting to the user in case of emergency for home security. A system that uses a GSM-Bluetooth based controller and remote monitoring system is proposed in [10]. This system is scalable and permitted any number of different appliances to be added with no major changes in its core. But this system is not efficient in some situations that required strong real-time applications.

Carl et al.'s [11] have proposed a cost-effective and flexible automation system that implemented through FPGA controller and mobile phone Bluetooth network. This method provides a parallel implementation of hardware results using fast algorithm execution. A Wi-Fi-based automation system is also implemented in [12] where a microcontroller and Wi-Fi technology for appliances remote control have been used. They showed that from point of view of the scalability and flexibility are better than those methods using the commercially available HAS. The HAS is the use of robotics and computers technologies to household appliances by defining the home automation as domestics. Energy saving is the advantage that a HAS gives to all its clients and especially forgetful ones, in that they can now track energy usage at home or while being away to ensure that unnecessary appliances are turned off as needed to reduce energy consumption[13,14,15].

III. ANALYSIS OF VARIOUS HOME AUTOMATION SYSTEMS (HAS) USING IOT

3.1 Review of Sangal et al.'s HAS using IoT:

In Sangal et al.'s HAS [17], the designed system will help in reducing the energy wastage by continuously monitoring and controlling the electrical appliances. The Infrared sensor (IR) is a low-cost infrared object detection unit that can be applied at home using IR LED's. It gets triggered when a light is detected. When the sensor is sensed it sends a signal to the raspberry pi. From the raspberry pi, by means of IoT concept and Wi-Fi configuration, we can turn OFF/ON the TV &light. Similar to IR, the PIR sensor is used to detect the human being presence and accordingly the fans are turned OFF/ON. This system uses wireless technology to avoid the wired connection between appliances and the gateway. The fans, lights, and television can be controlled by creating a web server on a tablet, personal computer or we can create an app in mobile. It helps to do

complete monitoring and control functionalities of the home environment using wireless sensors and actuators modules than just the switching OFF/ON functionality provided by similar systems.

The author left, the services that provide notification, automation, energy saving and security to all home appliances (Fan, TV, Air Conditioners, etc. ;) for future study.

3.2 Review of Sonar et al.'s HAS using IoT:

In Sonar et al.'s HAS [18] the design to control and monitor the system for smart home or smart house. This whole system is controlled by Lab VIEW software. This system is also connected to control home appliances from anywhere using Lab VIEW. And the Internet of Things is the latest and emerging internet technology that can share information and complete task while you are busy with other activities.

Even though author left SMS or alarm system, home security feature such as open-door and motion detection, energy monitoring for kitchen garden etc.; for future study.

3.3 Review of Thobaiti et al.'s HAS using IoT:

In Thobaiti et al.'s HAS [19], the system is categorized into two different modes: self-automated and Manually-automated modes.

1. Self-automated system

In case of the self-automated mode, the appliances are automatically controlled. Two systems are implemented in this case one is the dark /light sensing system and the other is temperature control and monitoring system. In an automatic light control system, Light Dependent Resistor (LDR) sensor is used to detect the dark /light condition. In dark state the home light will turn on automatically as indicated by the LED, otherwise, it will turn off. In temperature control system, the TMP36 temperature sensor is used to measure the ambient temperature. The temperature is adjusted to be less than 30oC. If the temperature exceeds 30o C, the microcontroller will turn on the fan to reduce the temperature. This application is important for saving the energy.

2Manually-automated system

The appliances in the home are remotely controlled using a cellular telephone with MATLAB-GUI platform. The designed MATLAB-GUI platform can control four appliances individually or all of them at the same time by pressing OFF/ON buttons. That means the system can manually-automated the OFF/ON buttons.

Finally, the authors sad that, by adding wireless sensor network to the existing HAS the system can be for their improved.

3.4 Review of Mali et al.'s HAS using IoT:

In Mali et al.'s HAS [20], the automation system is basically segregated into two sections, the first part deals with the automation, and the other deals with the security-related mechanism. In the automation part of the system, all the techniques and method for ease of operating is handled. Insecurity all the efforts are made for which the system can be secured. The security system made is generally mounted at the entry point of the system. The home or the user/owner has the default password. In case if the password is forgotten or in case of any emergency System also generates the OTP for more security purpose. The OTP is then sending to the Registered Mobile Number (RMN). A note has to be taken that it cannot be sent to any random mobile number but the RMN.

The automation part of the system Using RMN the user/owner sends the message to the appliance /electronic device to state OFF/ON. User/owner then sends the message to the system with the help of the GSM-Shield in which a SIMCARD is been placed. When the System receives the message, the system will perform the respective operation as signed. The

mechanism is set so that the RMN should send the message to the system for the generation of the one-time password (OTP) and then the system will send the OTP to the registered mobile number. The Mobile is connecting to the microcontroller through a GSM Shield. The GSM-Shield we are using is used for the transfer of the messages and for the communication with the microcontroller.

Finally, the authors sad that, by adding a camera module, to existing HAS, the security can be improved where the camera module will capture the image of an attacker (thief).

IV. PROPOSED HOME AUTOMATION SYSTEM

Keeping in view of the above protocols and their future work left, in this paper we are proposed Secure Home Automation System (HAS) using Wi-Fi module. As mentioned the proposed system consists of two processes. The first one is Home Automation process, and the second one is security process. The Block Diagram of a proposed system is shown in Figure 1.

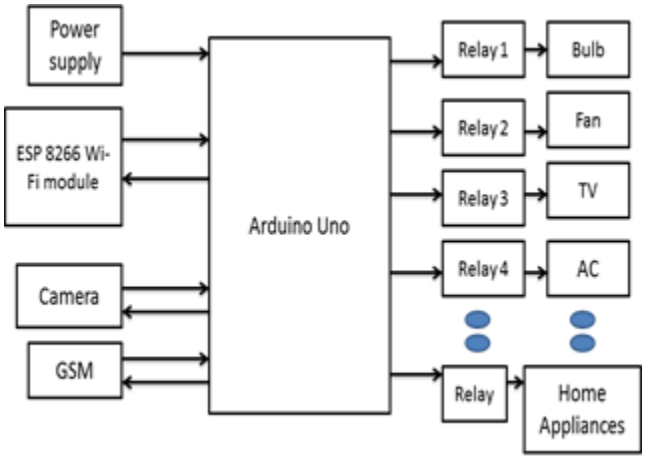

Figure 1. Block Diagram of Home Automation and Security

Figure 1 shows, one channel relay is used for only one function (light or fan or any home appliances). Using ESP 8266 Wi-Fi module, we can control the home appliances anywhere, anytime in the range of internet. Camera module can capture the person picture and sends to the user's mobile numbers.

4.1 Home Automation Process

The proposed system mainly used Wi-Fi module to control the home appliances. In this, we are using ESP 8266 Wi-Fi module. Fig.2, shows the ESP 8266 Wi-Fi module. Let's take a look at the pins of ESP 8266; it has 8 pins, 4 in the row of 2. The first pin on the top left is GND. The pin on the down right side is the RX pin and the pin on the top left is TX. RX and TX are using for sending serial communication from the Arduino to ESP 8266 Wi-Fi module.

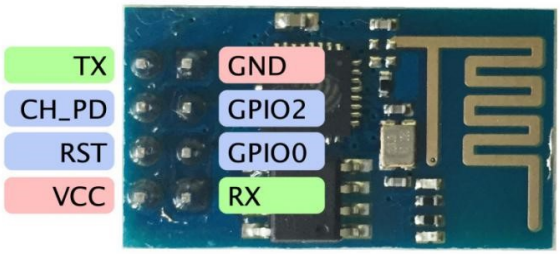

Figure 2. ESP 8266 Wi-Fi Module

The middle pins on the left are CH_PD (chip power-down) and RST (reset). VCC and CH_PD should not be 5v because 5v can destroy the Wi-Fi module. We have to give in only 3.3v. And there are two other pins GPIO0, GPIO2 are output pins.

A Smartphone or PC connected to the system through Wi-Fi router. The main benefit of having this configuration is that, no need to connect and disconnect the device whenever we want to control. It means once the connection is established the router is permanent. We can even control the device from outside the Wi-Fi range through the internet. And it provides secure connections. Wi-Fi enabled to smartphones/mobiles/tablets/computers.

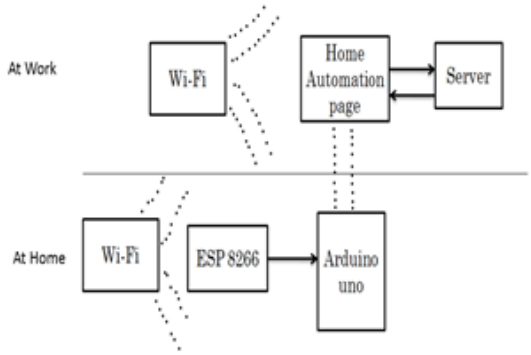

Figure 3. Data Flow Diagram of a System

Figure 3 shows, the Data Flow Diagram of a System. Once this Wi-Fi module is connected to the kit it can be enabled by using a Wi-Fi router. Activation of Wi-Fi module can be done two ways.

(i) By creating an appropriate Wi-Fi app

(ii) By creating an appropriate Web page

The proposed home automation system can control the following appliance,

- ✓ All types of light
- ✓ All types of fans
- ✓ Air conditioner
- ✓ TV
- ✓ Washing Machines
- ✓ Water heaters
- ✓ Microwave ovens

The proposed system can be work in proper way if,

1. Internet connection is available
2. Proper browser is installed
3. Hardware components are connected properly in an Arduino Uno Kit
4. The user is capable of using, smartphones/mobiles/tablets/computers.

4.2 Security Process

In this system, while developing security section we concentrate on the entry point of the home i.e. entry gate. We gave entry to those who know default password and OTP (One Time Password). The default password is already known to the user which is confidential. OTP is a password which is generated by the system on demand of user using his registered mobile number which is registered with the system.

The security system made is generally mounted at the entry point of the system. The home or the user/owner has a default password. In case if the password is forgotten or in case of any emergency system also generates the OTP for more security purpose. The OTP is then sent to the Registered Mobile Number (RMN). The mechanism is set so that the RMN should send the message/popup to the system for the generation of the one-time password (OTP) and then the system will send the OTP to the registered mobile number. The Mobile is connecting to the microcontroller through a GSM Shield. The GSM-Shield we are using is used for the transfer of the messages and for the communication with the microcontroller.

In our proposed system, the security level is implemented in the following 3 cases;

1. Case 1: Password is known
2. Case 2: Password is forgotten
3. Case 3: Unauthorized entry.

Case 1: This case is demonstrated clearly in Figure 4.

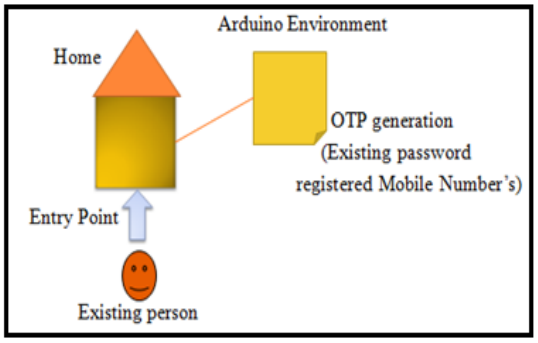

Figure 4. Password is known

In this case, the existing person knows the default password. So the person enters the password then the doors will be open.

Case 2: This case is demonstrated clearly in Figure 5.

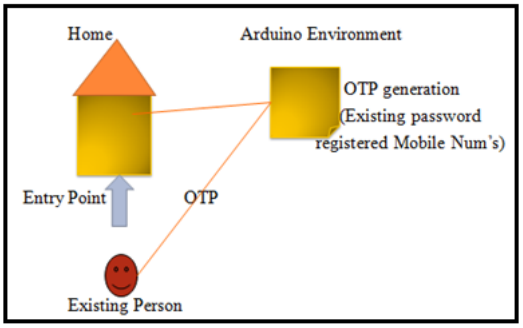

Figure 5. Password is forgotten

In this case,a person is an existing person, but, the person forgets the password. So, in this situation, the person sends the request for OTP to the system. Then the system will check the person's mobile number is registered or not. If the number is registered, then the system will be sending the OTP to the person otherwise not.

The following is the algorithm for providing security using OTP in a proposed system.

Algorithm for Security process:

1) Accept Numbers from Keypad.
2) Convert taken number into a string and further typed numbers get concatenate with that string.
3) Store default Password in one string and compare it with typed string.
4) If it matches then user get entry else can't. Generate one key or number using Random () in Arduino IDE. (This is treated as OTP)
5) Compare this OTP with Typed Key or number.
6) If it matches then user get entry else can't.

Case 3: This case is demonstrated clearly in Figure 6.

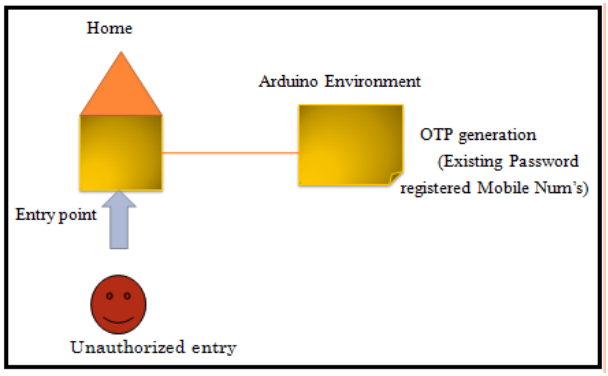

Figure 6. Unauthorized entry

In this case, the person is new (unauthorized), so the person doesn't know the existing password and his/her mobile number is not stored in the system. So in that situation, if a person attempts to enter in a home, more than three times with the wrong password then at that time the Arduino will trigger an alarm and an alert message will be sent to user's mobile via GSM. And camera module will be activated and capture the image of a person who tries to attack thesystem.

V. COMPARATIVE STUDY

The following table shows the comparison among the Factors of Sangal et al.'s HAS [17], Sonar et al.'s HAS [18], Thobaiti et al.'s HAS [19], Mali et al.'s HAS [20] and proposed a system.

Table 1

Various HAS → Factors ↓	Sangal et al.'s HAS	Sonar et al.'s HAS	Thobaiti et al.'s HAS	Mali et al.'s HAS	Proposed system
Lab VIEW s/w	No	Yes	No	No	No
Bluetooth module	No	No	No	No	No
Wi-Fi module	No	No	No	No	Yes
Manually-automated	No	No	Yes	No	No
Self-Automated	No	No	Yes	No	No
All type of Home Appliances	No	No	No	No	Yes
Security	No	No	No	Yes	Yes
Alert message	No	No	No	Yes	Yes
Alarm	No	No	No	Yes	Yes
Camera Module	No	No	No	No	Yes

VI. CONCLUSION

In this paper we are proposed, Wi-Fi to control the home appliances that means we can control the home appliances the devise from outside the Wi-Fi range through internet anywhere, any place, anytime. And it reduces human efforts and power efficiency. The proposed system also deals with the OTP (One Time Password) generation which will be used as home entry password for users. The IoT system integrates electrical devices in a house/home with each other. The techniques which are going to use in home automation include those in building automation as well as the control of domestic activities, such as fans, lights, electrical tubes, TV, refrigerator etc. And security provides to the entry point of the home. In this system is low cost and flexible home security and monitoring using Arduino microcontroller is propose and implemented. Overall Arduino is easy to understand and its coding is easy.

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