International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: SJIF: 5.995
Available Online at www.journalijcar.org
Volume 6; Issue 11; November 2017; Page No. 7484-7488
DOI: http://dx.doi.org/10.24327/ijcar.2017.7488.1161

Research Article

A STUDY ON VARIOUS IOT BASED HAS

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A R T I C L E I N F O

Article History:
Received 18th August, 2017
Received in revised form 10th September, 2017
Accepted 06th October, 2017
Published online 28th November, 2017

Key words:
Home Automation System, Wi-Fi Module, Bluetooth Module, Different Sensors. GSM, OTP, RMN(Register Mobile Number), Arduino Uno, Web portal.

A B S T R A C T

Home automation is the residential extension of building automation and involves the control and automation of lights, heating, ventilation, air conditioning (HVAC) appliances using the Internet of Things. Establishing a wireless connection to various electrical devices within our homes is the main objective of this prototype. It reduces human efforts and power efficiency. The main objective of an internet of things is used to help especially challenged people and old age people to control electrical appliances.
In this paper we present a Review of Sonar *et al*.'s Home Automation using IOT, Sangle *et al*.'s Smart Home System based on IOT, Mali *et al*.'s Home Automation and Security using Arduino Micro-Controller and Thobaiti *et al*.'s Home Automation System based on Arduino Uno Single-Board Microcontroller. Finally, we have done a comparative analysis of all the above-mentioned methods.

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 via the Internet, are an important constituent of the Internet of Things (IoT). Modern systems generally consist of switches and sensors connected to a central hub sometimes called a "gateway" from which the system is controlled with a user interface that is interacted either with a wall-mounted terminal, tablet computer, mobile phone software or a web interface, often but not always via Internet cloud services. While there are many competing vendors, there are very few worldwide accepted industry standards and the smart home space is heavily fragmented. The popular communications protocol for products includes Ethernet, X10, 6LoWPAN, RS-485, Bluetooth LE(BLE), Z-Ware and ZigBee, or other proprietary protocols all of which are incompatible with each other. Manufacturers often prevent independent implementations by withholding documentation and by litigation. Worked on, the home automation systems in the market was worth US$5.77 billion, in 2013, predicted to reach a market value of US$12.81 billion by the year 2020.

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Bluetooth Based Home Automation System (HAS)

Nowadays, people have smart phones with them all the time. So it makes sense to use these to control home appliances by using smart phones. Presented here is a HAS using a simple Android app, which you can use to control electrical appliances with voice commands or clicks. Commands are sent via Bluetooth to Arduino Uno. So you need not get up to switch off or switch on the device doing some work or while watching a movie.

Circuit

The circuit is built on Arduino Uno board, a 3-channel relay board, and Bluetooth module HC-05 board. The number of channels depends on the number of appliances you wish to control. Arduino Uno is powered by a 12V DC adaptor/power source. The relay module and Bluetooth module can be, in turn, powered using a board power supply of Arduino Uno. Connection details for each appliance are shown in below.

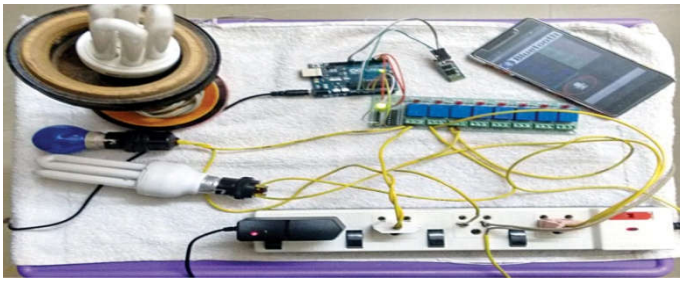

Fig 1 Circuit Connections

Relay module

A relay allows you to turn off or turn on a circuit using voltage and or current much higher than what Arduino could handle. Relay provides complete isolation between the low-voltage circuit on Arduino side and the high-voltage side controlling the load. It gets activated using 5V from Arduino, which, in turn, controls electrical appliances like lights, fans, and air-conditioners. The 8-channel relay module can be seen in Fig 2

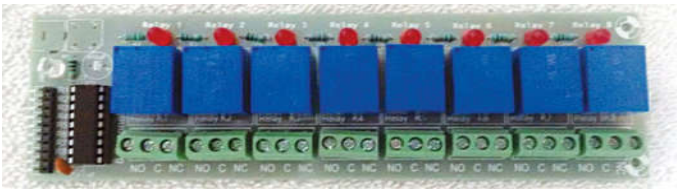

Fig 2 An 8-channel relay module

Bluetooth module

Bluetooth module used in this HC-05, which supports master and slave mode serial communication (9600-115200 bps) SPP and UART interface. Using these features it can communicate with other Bluetooth-enabled devices like tablets, laptops, and mobile phones. The module runs on 3.3V to a 5V power supply. The 8-channel relay module can be seen in Fig 3

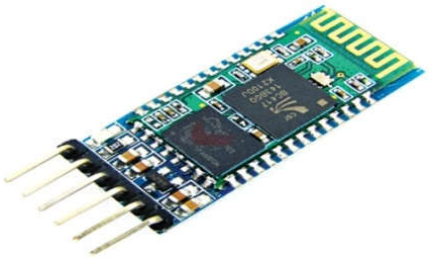

Fig 3 Bluetooth module

For the, the rest of the paper is organized as follows; the history of HAS is discussed in section 2 the Review of various HAS using IoT is discussed in section 3 comparative study of various HAS is discussed in section 4 and section 5 concludes the paper.

Background

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.

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 recipes, but 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 HASgives 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].

Review of various Home Automation Systems (HAS) using IoT

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

This home automation model consists of a number of relays to connect various devices. Firstly, all the devices are connected to the internet through Wi-Fi. When the connection is established in on a web page we provide virtual switches to operate the connected devices. Also, it will start reading the parameters of devices. If particular device exceeds the threshold set point then the server will give notification to the user on a web page and that device will automatically turn off. If problem found it reports to cloud server.

The system allows the user to control various home appliances (which can operate on 230v also) from PC and smart phones from anywhere in the world through an internet connection. It also allows the user to control their units within their home from a wireless remote. In this proposed a Novel technique that will give us best results and provides Notifications to the user if a problem occurs on any device.

In this home automation system provides notifications to the user only but in future work can also add some voice alerts, SMS or alarm system and also expanded to include various other options which could include home security feature such as open-door and motion detection, energy monitoring for kitchen garden etc.

Review of Sangal et al.'s HAS using IoT

The block diagram of Sangal *et al*.'s system is shown in Fig.4. The Infrared sensor (IR) is a low-cost infrared object detection unit that we can be applied at home using IR LED's. It gets trigged 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 and lights and television can be controlled by creating 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.

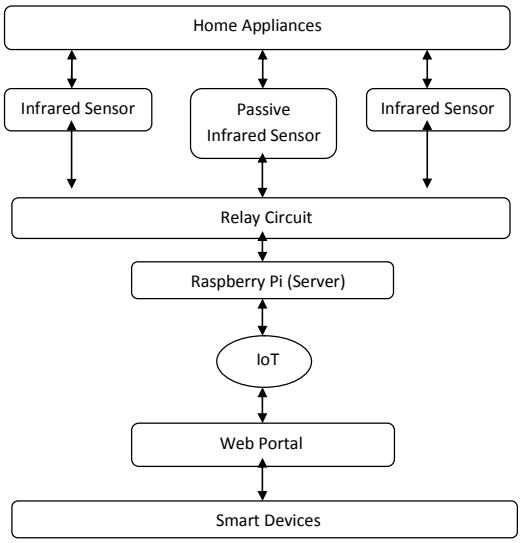

Fig 4 System Architecture

Multiple appliances can be controlled and monitor using IoT in propose system web portal will play an interface between appliances and android app to be developed. If the web affiliation is down or the server isn't up, the embedded system board still will manage and operate the appliances domestically. Raspberry pi which will control devices and sensors in propose system; relay controller will be used to automate the home appliances.By this, we provide a climbable and price effective HAS.

Raspberry pi-The Raspberry Pi is a low-cost and like a credit card sized single board computer, developed by a raspberry pi foundation. Raspberry pi is controlled by a modified version of Debian Linux optimized for the ARM architecture. The heart of the HAS is this mini- computer. In this system, are using model B plus and proposed system raspberry pi act as a web server.

Home appliances-In proposed system operate there are three types of home appliances like as a fan, LED light and also Television (TV). These appliances can operate using smart devices.

Sensor-Sensors are used to continue sensing the home appliances. The IR sensor module is easy for operation.IR sensors detect infrared light, which is used to turn OFF/ON of lights. The passive infrared sensors (PIR) sensor is used to detect the human being presence and accordingly, the fans are turned OFF/ON. The sensors sense same data and send to the raspberry pi board which acts as a server.

Relay circuit-A relay is an electromagnetic switch which is continually operated by a relatively small electric current that can turn OFF /ON a much larger electric current. relay circuit act as actuators, in a proposed system smart device, is sent OFF/ON command to the server, after that server sends OFF/ON signal to the rely on a circuit which used to control the home appliances.

Smart devices-Smart devices like as smartphone, tabs, pc (personal computer) etc. so using smart devices monitor home appliances and Android app control.

WI-FI Router-The WI-FI unit provides the medium for communication between sensors and home appliances. The WI-FI should be configured with user commands and certain address will be directing through Wi-Fi unit. It can be also configured to make security services.

In this, the future works can be done on increase this protocol model by including all home equipment and services that provide notifications, automation, energy saving, security, telecommunication, entertainment, and computers etc and thus make a more intelligent HAS.

Review of Mali et al.'s HAS using IoT

This automation system is basically segregated into two sections, the first part deals with theautomation, and the other deals with thesecurity-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

When the System receives the message, the system will perform the respective operation assigned.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.

In the HAS, more security purpose camera module can also be implemented on the system. If any person attempts to enter a home with more than three times wrong password then at that time camera module will be activated. And camera module will capture the image of a person who tries to attack system.

Review of Thobaiti et al.'s HAS using IoT

This system is categorized into two different modes: self-automated and Manually-automated modes.

Self-automated system

In case of the self-automated mode, the appliances are automatically controlled. Two systems are implemented in this case one isthe dark /light sensing systemand 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.

Manually-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.

Table 1: Comparative Study of Various HAS

S.no	Home Automation System	Requirements	Results	Extensions
1	Sonar et al.'s HAS	Arduino software,Arduino kit, different sensors, power supply, GSM module.	The system allows the user to control various home appliances (which can operate on 230v also) from smart phones and PC from anywhere in the world through an internet connection.	HAS can also extend by adding some voice alerts, SMS or alarm system etc., to improve security.
2	Sangal et al.'s HAS	Arduino, Raspberry pi, sensors, Wi-Fi, web portal.	The system switching on the light when it gets dark. Any Android based smartphone can be used to access the home equipment remotely through the internet.	HAS can also extend by including all home equipment and services that provide notifications, energy saving, automation, telecommunication, security.
3	Mali et al.'s HAS	Arduino 1.6.1, Arduino Uno, different sensors, GSM module, Keypad, Mobile Phone(GSM)	In this automation system, all electrical devices can operate the mobile and security provided to the entry point of the home.	In this HAS system more security purpose camera module can also be implemented on the system.
4	Thobaiti et al.'s HAS	Home automation, Arduino Uno, Wi-Fi, Mat lab-GUI platform, Manually-automated, self-automated.	The manually-automated system, in which users can monitor and control their home appliances from anywhere in the world. And the self- automated system, which made the Arduino Uno controller capable of monitoring and controlling different appliances in the home automatically in response to any signals, came from related sensors.	HAS improvement can be added to the proposed system using wireless sensor technologies. The proposed system can be developed and fabricated as a commercial hardware package.

In this HAS, the future improvement can be added to the proposed system using wireless sensor technologies. The proposed system can be developed and fabricated as a commercial hardware package.

Comparative Study

The following table shows the comparison among the Sonar *et al.*'s HAS, Sangal *et al.*'s HAS, Mali *et al.*'s HAS and Thobaiti *et al.*'s HAS in terms of requirements needed for implementation of a HAS and their extensions for the future perspective.

CONCLUSION

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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How to cite this article:

Hema Uggirala and Archana Raghuvamshi (2017) 'A Study on Various IOT Based HAS', *International Journal of Current Advanced Research,* 06(11), pp. 7484-7488. DOI: http://dx.doi.org/10.24327/ijcar.2017.7488.1161

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