Comparative Analysis of GSM and Internet Based Home Automation Systems

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Abstract:

Home Automation System (HAS) is gaining popularity because of its countless advantages. Home automation refers to the monitoring , controlling and automation of home appliances remotely. This paper deals with comparative analysis of GSM and Internet based HAS. The performance has been analyzed on the basis of cost, security, real time monitoring, status, user friendly environment, Graphic User Interface(GUI) etc. The Home Automated System (HAS) based on Internet not only controls but also provide real time monitoring and status of home environment through sensors whereas GSM based home automation only control home appliances but not provide real time status of appliances. The GSM based HAS is more secure as compared to Internet based Home Automation System (HAS). GSM based HAS sets a Pin code on SIM (Subscriber Identity Module) which is inserted in GSM module and also accurate AT (ATtention) commands which is given in program while Internet based system requires webpage to login through personal Gmail account. Internet based Home Automation System (HAS) has user friendly GUI which shows easy ON/OFF buttons for home appliances and real time graphs of sensors data. Whereas in GSM based HAS only define SMS format for user. GSM based system is cost efficient as compared to Internet based system. Besides all these advantages including cost efficiency, GSM based HAS lacks in providing the today's most advanced and more innovative HAS features of real time monitoring and status of home environment through PIR Motion and LM35 temperature sensors.

Keywords:

Home Automation, Arduino, Internet, GSM

I. Introduction:

Automation is the today's reality, with more things happening automatically every day, usually the basic task of turning certain appliances ON/OFF, even remotely or close proximity. When the machine completely takes over the equipment, the process of controlling, monitoring and reporting the equipment becomes more important. We are increasingly giving up the ability to do simple but routine tasks, while we need to maintain as much control over automated processes as possible. Automation reduces the possibility of human judgment but does not completely eliminate it.[1].

Home automation refers to the home that improves the quality of life of residents by promoting a flexible, relaxed, healthy and secure environment [2]. Home automation not only means reduced manpower but also increases system efficiency and save time [3]. Smart Home is an advanced technology that makes homes intelligent and automated, allowing sensors to change by adopting environmental changes [4].

Home Automation Systems (HAS) are designed to monitor and control various Home appliances can be accomplished through various communication methods, such as; wireless LAN technology, dial-up modems, private radio networks, satellite communications, Bluetooth, Zigbee, RF and more. All these system are efficient but not cost-effective. In the proposed research, the main focus is to analyze the performance of two remotely controlled Home Automation Systems (HAS) that provide efficient cost effective solution. The HAS we are focusing on are:

- Internet
- GSM

Both methods are designed for users who want to remotely access Home appliances. Therefore, the main goal of our use of the GSM network for home-to-user communications is its broad coverage, making the entire system almost always online. Another advantage of using GSM network in Home Automation is its highly secure communication that provides maximum reliability so that the information sent or received is not monitored by eavesdroppers.

Although using the GSM network has all these important advantages over other communication methods, it will be limited in real-time monitoring and in the home environment status. Real-time monitoring has always been an important function that can be used in Home Automation Systems (HAS) Therefore, we use an Internet-based home automation system that alerts the user when any changes in the Home environment state occur [5].

The proposed idea introduces the concept of comparison of two Home Automation System (HAS), which are Internet based HAS and GSM based HAS. The use of sensors in home automated system for monitoring and collecting their data on web server and alerting the owners when necessary changes should be made is the key concept for a smart Home Automation System. In this comparative analysis system, the two system's different performance parameters are compared such as: cost, security, real time monitoring, status, user friendly environment, Graphic User Interface (GUI) etc. Two systems are controlled and monitored remotely using Internet network and GSM cellular network as shown in figure 1.

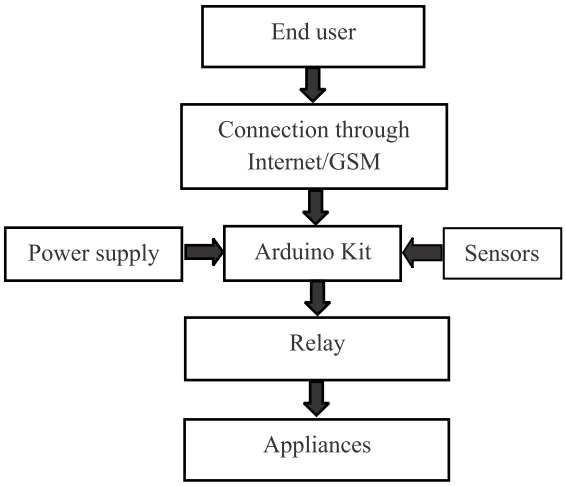

Figure 1: System block diagram [6].

The Arduino sends the collected data to the Web server. This proposed system would be able to monitor Home environment in real time and uploads data to the website. This paper is divided into the following main parts: the first part introduces the concepts, the second part describes the related work, the third part describes the prototype design and methods, and the fourth part discusses the results and comparisons. The fifth part concludes the paper and gives directions for the future.

II. Related Work:

Kotiyal et.al in [7], has developed Arduino based web server is used instead of PC based web server. Without using a computer, Idea is used to monitor and control the maximum number of home appliances or industrial equipment. Different sensors installed in the workplace helps to sense real-time environmental conditions such as temperature, light, and humidity. Web server provides a website for hosting where client can request for services.

Pawan Singh et.al in [8], has used GSM technology to solve the problem of range limitation for many technologies like Bluetooth and Zigbee. In this system, home appliances are controlled and accessed via SMS. So this technology provides a cost-effective solution for remotely controlling household appliances. The system is wireless, so it is cost-effective and easy to install.

David et.al in [9], has used Internet for communication with end user and Home appliances. In this research, it is implemented using the Arduino as a miniature web server, through which it connects hardware design, receives status updates from them, and sends control information to the microcontroller.

Shah et.al in [10], has made an approach to make the most efficient low-cost system that can control home appliances in the largest range. In the process, he made a system that can switch 15 appliances from a single remote location. The system also includes a GSM modem that will notify the owner of the relationship between the current switch ON or switch OFF state of the appliance and its predefined specific mobile phone number.

III. Prototype Design and Methodology:

This research aims to perform the performances analysis of two Home Automation Systems one is Internet based and second is GSM based and make comparison of two systems. It mainly focuses on monitoring and controlling household appliances through the Internet and GSM cellular networks. The system consists of two main parts: a hardware interface module and a software communication module. The first part consists of: Arduino UNO microprocessor, Wi-Fi module, GSM module and relay module. The microprocessor is the central device that connect the Wi-Fi module and GSM module, and receives instructions to monitor and control the home electrical appliances. The server and GSM cellular network handles the communication between the end-user and microprocessor, thus monitoring and controlling the appliances remotely. The software communication module uses a webpage as the frontend, which serves as an interface to the user to communicate with the microprocessor. It presents a list of home appliances with which the user can interact.

Arduino and server program for Internet based HAS:

The software communication part also contains Arduino IDE programming with Internet network to communicate with cayenne server. The program is make

with Token number given by server when we create account on server. The server is connected with the system through commands in command prompt.

Arduino and GSM module program for GSM based HAS:

Arduino IDE programming with GSM module to communicate on GSM cellular network. The GSM module works on AT commands for example to make call, AT command for call is ATD+92XXXXXX. This +92XXXXX shows the number which you want to call from GSM module. According to these different AT command we set a program in Arduino IDE to make communication possible of Arduino and GSM module.

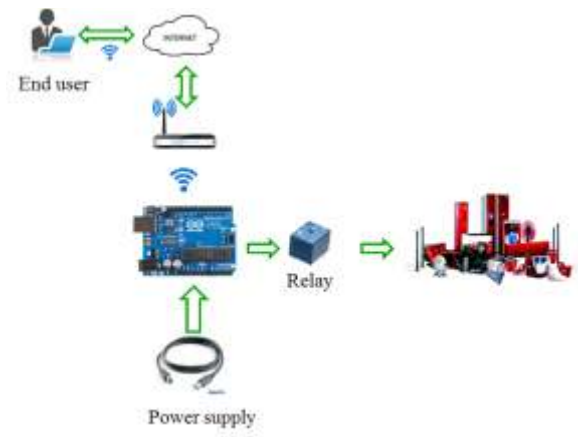

Figure 2a. Internet based HAS Architecture

Figure 2a shows the architecture of Internet based Home Automation System. In which it show that end user is connected with Cayenne (server) through Internet by server URL. After the connection with end user and Cayenne server is established successfully. Now program the Arduino with Token given by Cayenne server and then connect the Arduino serially with ESP8266 Wi-Fi module so as to Arduino communicate with Internet.

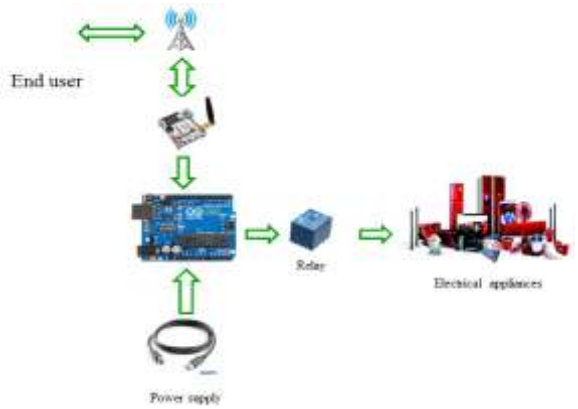

Figure 2b. GSM based HAS Architecture

Figure 2b shows the architecture of GSM based Home Automation System. In which it show that end user is connected with GSM Cellular network with phone. Now to communicate Arduino to GSM Cellular network, we used A6 GSM module and connect serially through RX and TX pins. A6 GSM module works on AT commands so in order to program Arduino we use different AT commands to set program for controlling appliances with Arduino microcontroller on GSM cellular network.

Arduino and Relay connection and programming:

In this case, the electrical equipments that are going to be controlled are LED lights and Fan. Arduino UNO is firstly programmed to communicate with the relay. It is designed as a controller to control the relay that act as a switch. The relay is used in this circuit because it is an electric switch that can be directly connected to the output. Relay switch connections are usually marked as Command (COM), Normally Closed (NC) and Normally Open (NO). In switched ON state, the circuit will be connected to COM and NC. On the other hand, the circuit will be connected to COM and NO in switched OFF condition.

IV. Results and Comparison:

Two systems (GSM and Internet Based HAS) were proposed to test and determine the accuracy of the prototype.

The prototypes were tested in different parameters.

1. ON/OFF status of Home Appliances
2. Sensors data
    a. PIR Motion sensor
    b. LM35 Temperature sensor

1. ON/OFF status of Home Appliances:

Following bar graphs show the ON/OFF trialed data taken from GSM and Internet based Home Automated systems.

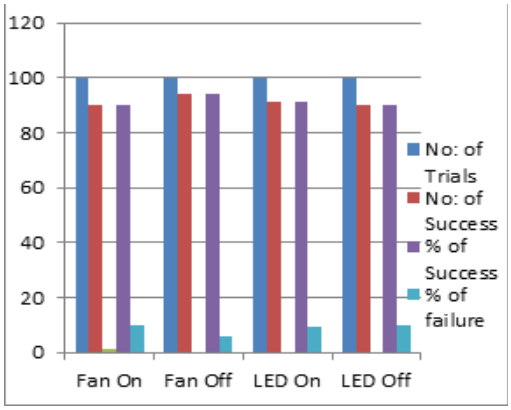

Figure 3. ON/OFF comparison of Internet system

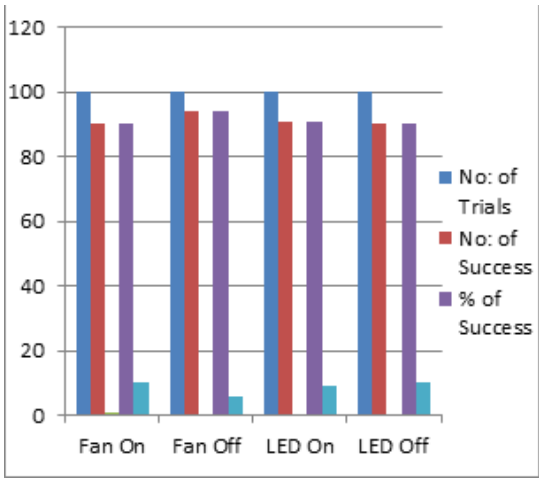

Figure 4. ON/OFF comparison of GSM system

Figure 3,4 shows ON/OFF comparison of electrical appliances(Fan and LED lights). On right side of graphs shows the graphs of Internet bas HAS and on left the graph of GSM based HAS. In which blue bars show the number of trials(initially 100 trials are taken). Whereas red and purple color bars show the number and percentage of success respectively. It can be observed that the average ON/OFF percentage out of 100 trials in Internet based Home Automation system(HAS) is 90.75%, while in GSM based HAS it is 94% for the same number of trials (100 trials).

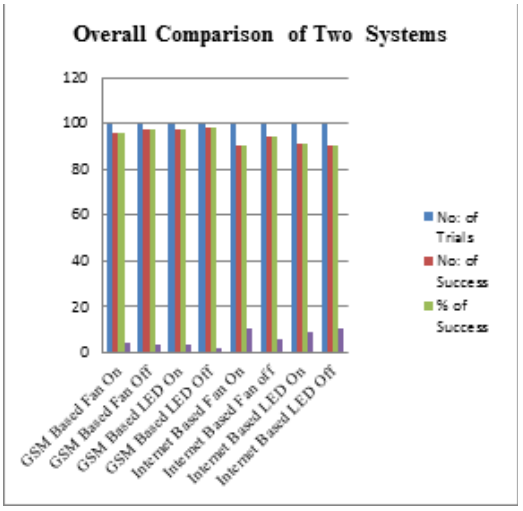

Figure 5.Overall comparison of Internet and GSM based systems

Figure 5 shows the overall comparison of GSM and Internet Based Home Automation system. In which blue color bars show number of trials for ON/OFF of Fan and LED lights. Results are based on 100 trials out of which ON/OFF percentage of Home appliances are taken. Whereas red color bars show number of success of LED lights and Fan ON. Green color bars show the percentage of successively switched ON of Fan and LED lights. It can be observed that the average percentage of success for GSM is 94% which is better than percentage of Internet based HAS which is 90.75%.

Table 1. Cost comparison table of Internet based HAS

Internet Based HAS	
COMPONENTS	COST(Rupees)
Arduino UNO	600
ESP8266 WiFi Module	400
2 Channel Relay	100
PIR Motion Sensor	250
LM35 Temp: Sensor	80
LED	100
Fan	120
Bread Board	100
Battery 9V	30
Jumper Wires	100
Net Package(Per Month)	500
TOTAL	2380

Table 2. Cost comparison table of GSM based HAS

GSM Based HAS	
COMPONENTS	COST(Rupees)
Arduino UNO	600
GSM Module	1800
2 Channel Relay	100
LED	100
Fan	120
Bread Board	100
Battery 9V	30
Jumper Wires	100
SMS Package(Per Month)	100
TOTAL	2950

Cost comparison for both Internet and GSM based HAS is given Table 1 and Table 2 respectively. It is clearly observed from Table 1 and Table 2 that the cost of GSM based HAS is higher than Internet based HAS but the running cost per month of GSM based HAS is lower than Internet based HAS.

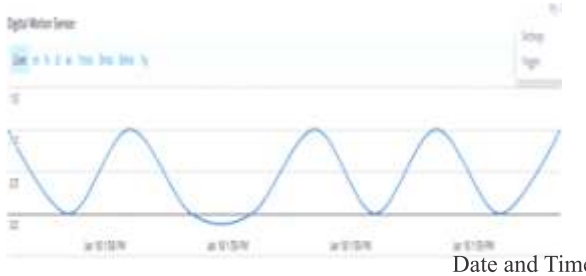

Figure 6. PIR motion sensors

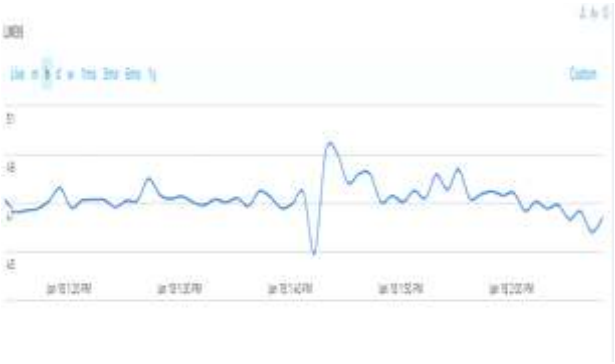

Figure 7. LM35 Temperature sensors

Figure 6,7 show graphs of PIR Motion sensor and LM35 Temperature sensor whose data is continuously been uploaded on web server (cayenne). Readings are taken during the day time on 18 Jan 2018. Readings of PIR Motion sensor goes to 0 when it detect no motion, whereas, PIR Motion sensor reading goes to 1 as it detects motion. LM35 Temperature sensors senses the temperature which is 45 degrees Fahrenheit approx. X-axis shows the Date and time on the graphs of PIR motion and LM35 Temperature sensors respectively, whereas Y-axis indicates the motion and temperature values of both PIR motion and LM35 temperature sensors respectively. We used these two sensors data and upload it on web server for real time monitoring and status of Home. With the help of this, Home appliances are also been controlled according to the environment of Home.

Figure 8. GUI of Internet based system

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Figure 8 shows the GUI of Internet based HAS and Figure 9 shows GUI of GSM based HAS. GUI of Internet based HAS shows simple and user understandable buttons of Fan and LED lights. Whereas GUI of GSM based HAS only shows the SMS format for (ON/OFF) of Fan and LED lights which is neither user friendly GUI nor simple and do not provide fast switching like Internet based HAS.

Table 3: Performance Comparison of GSM and Internet Based HAS

HAS	Cost	Security	Real Time monitoring and status	Availability	GUI	Performance
GSM	Low	High	Low	High	No	Low
Internet	High	Fair	High	Fair	Yes	High

Table 3 shows the performance parameters of both systems(GSM and Internet based HAS). Table 3 clearly shows that although GSM based HAS is low in cost and have high security but it lacks in real time monitoring, no GUI and overall performance is also low as compared to that of Internet based HAS.

V. Conclusion and Future Work:

In this research, we have successfully tested both GSM and Internet based HAS hardware and have also performed comparative analysis of both the systems. Arduino is integrated with two sensors (PIR motion and LM35 temperature) and uploaded their data to web server to check environment of home and to control home appliances according to home environment. It is clearly seen from Figures, Graphs and Tables that the Internet based HAS is more innovative and meets with the requirements of today's Home Automated System as compared to GSM based HAS is more secure but it is not capable of providing real time monitoring. The designed system can be implemented in Home to monitor real time status of home environment and control Home appliances according to environment changes. Designing and implementation of such kind of systems can improve the outcomes of automated systems. For the testing purpose initially the system is based on two appliances (FAN and LED) however, more appliances can be added into the system and is left as future work and results can be analyzed accordingly.

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