

A SECURED GSM-BASED REMOTE CONTROLLED HOME AUTOMATION SYSTEM

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ABSTRACT

Home automation systems are designated electronic systems in homes and residential buildings that makes it possible for the automation of household appliances. The challenges faced by home automation systems are high cost of ownership, inflexibility, poor manageability and difficulty in achieving security. In this work, a secured global system for mobile communication-based home automation system (GSM-HAS) was designed. The proposed system has a more improved technology that enhances flexibility by using GSM technology to interconnect its component to home automation system. The system comprises of five modules namely Mobile Phone, SIM900 GSM Module, Arduino Board, Relay Module and Peripheral Devices. The system used SIM900 Module which allows users to effectively control their house/office appliances simply by sending a short message service (SMS) to the device. ATMEGA328P microcontroller was used to communicate with SIM900 module and the relay module to carry out the basic ON/OFF operations received from the user android application. The android application was implemented using Java programming language and MySql database. The performance of the system shows that the user can control the home appliances through the android application, with an additional control for activating and deactivating the sensor system at home/office. The system helps turn-on and turn-off connected home appliances as well as detect intruders and send message to the user's mobile phone. The system is designed to be highly secured, flexible, reliable and affordable.

Keyword: Appliance, Automated System, Device, GSM, Home, Mobile

INTRODUCTION

Various kind of home appliances are manually operated which at times are not well managed by busy families and individuals, many times the electrical home appliances are not turned off while leaving the house, leading to energy waste which might result in accidents due to sparks. Home automation can be defined as a system implemented at a residential house whereby the intention is to make the house intelligent so that energy is conserved and security is main-

tained (Salman and Vrindayanam, 2013; Meriam Webster, 2009). The remote controlling and monitoring of the house using Internet requires computer, which is large in size and heavy to carry around. The most available home automation systems use different wireless communication standard to exchange data and signaling between their component like Bluetooth, Zigbee, Wi-Fi, etc. System implementing ZigBee has too low bandwidth for the data communication, whereas Java Based Systems still use web

pages, which is a disadvantage if data Internet or Intranet is not available (Paul et al., 2014).

The challenges faced by home automation systems are namely high cost of ownership, inflexibility, poor manageability and difficulty in achieving security. The proposed system has a more improved technology that enhances flexibility by using GSM technology to interconnect its component to home automation server. The GSM technology uses a 200 KHz radio frequency channels that are time division multiplexed to enable up to eight users to access each carrier (Shaiju et al., 2014).

The secured global system for mobile communication based home automation system (GSM-HAS) serves as a medium of providing increased comfort, safety and security to users by creating a platform through which appliances can be remotely accessed and controlled using an Android application and a hardware circuit located in the house. This provides an effective means of controlling connected electrical home appliances while away from the house. The Android based home automation system can provide end users with simple secure and easily configurable system. The mobile application can also extend the security of the system via an implementation of the password protected application and motion sensor.

LITERATURE REVIEW

Tan et al. (2007) developed an automatic power meter reading system using GSM network to send the energy consumed to e-billing system at authorized office. The system works by integrating the GSM modem that was embedded with digital kWh power meter. It utilizes the GSM network to send power usage reading using SMS to the au-

thorized office. The authorized office collects and manage the received SMS message that contains the meter reading to generate the billing cost and send back the cost to the respective consumer through SMS.

The work presented by Wahab et al. (2007) was about the development of Integrated Water Billing System with SMS capability. The system was designed to facilitate the Water authorized to manage the monthly billing system without the use of human services. The system receives SMS from the meter to central databases. Then the information received was processed to generate current billing. The system again sends a SMS notification to the user regarding the total amount that has been billed.

Salman and Vrindayanam (2013) introduced an efficient interactive control system based on GSM technology. The system uses Atmel AT89S52 as a central microcontroller which can perform same functions as PIC microcontroller. The system allowed remote control of different appliances through SMS messages. SIM 300 Module is a triband GSM Module which can operate only in 900,1800, 1900MHZ band respectively. It has compatibility issues due to different frequencies operated by different countries.

Javale et al. (2013) proposed a home automation and security system using Android ADK. The design was based on a standalone embedded system board called Android ADK (Accessory Development Kit). The home appliances are connected to the input/output ports of the embedded system board and their status is passed to the ADK, and communication is established between the ADK and the Android mobile device or tablet. An authentication was created to the system for authorized person to access home

appliances.

Wahab et al. (2010) and Teymourzadeh et al. (2013) investigates and implemented a home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances via Short Message Service (SMS) text messages. The proposed focused on functionality of the GSM protocol, which allows the user to control the target system away from residential using the frequency bandwidths.

Ramlee et al. (2014) designed a Bluetooth remote home automation system using Android application. The wireless Bluetooth technology provides remote access from PC/laptop or smart phone. It controls electrical appliances devices with relatively low cost design, user-friendly interface and ease of installation. Bluetooth communication has comparatively high power consumption, so the batteries of devices need to be frequently recharged or replaced. It has serious security concerns such as eavesdropping and weak encryption.

A home automation system with the help of direct Wi-Fi (Wireless Federation), which fits the bill of WLAN 802.11 standard was designed by Suryayanshi et al. (2014). The design was implemented through onboard Wi-Fi, which is inbuilt in the mobile phones having an Android. It allows communication with a brief and small setup without zap wired connection. The Wi-Fi protocol failed to put into consideration the availability of data for internet connection. Whenever the user is in an environment with poor service provider, the user will not be able to access his/her appliances at home.

Paul et al. (2014) proposed a system which is aimed at controlling home appliances via

Android device using Wi-Fi as communication protocol and Raspberry Pi as server system. A user friendly interface is created for the android device which allows the user to communicate with the Raspberry Pi server. The server will be interfaced with a relay circuit board that controls the appliances running in Home. The communication with the server allows the user to select the appropriate device. The system provides a scalable and cost effective home automation system but there is inflexibility attached to the configuration of it operating system.

Guptal and Tomar (2016) proposed a system that can be used to detect burglary, leakage of cooking gas; smoke caused due to accidents and then sends a message to the device. The user can control the systems remotely (outside) through their Android device. When the system detects certain hazardous events, within a short response time, the users get notified quickly. SIM 300 was used because it is a tri-band (900, 1800, 1900MHz band) and this can be restricted to some countries based on the frequency they operate on.

Rana et al. (2013) design and implement a home security system using the GSM technology. The system is designed to detect burglary, leaking of harmful gas; smoke caused due to fire and after detecting suspicious activity, it sends an alarm message to the owner number. The whole process is controlled by an android cell phone application.

DESIGN METHODOLOGY

Architecture of a Secured Global System for Mobile Home Automation System (GSM_HAS)

The architecture of a secured global system for mobile home automation system is presented in Figure 1. The system comprises of

five components namely Mobile Phone, SIM900 GSM Module, Arduino Board, Relay Module and Peripheral Devices.

The proposed system architecture support the use of Android GUI installed on the smart phone which is used to control the home appliances. After the smart phone's apps is connected through SMS from the Android GUI to the SIM900 GSM Module in the circuit which act as a server to forward or transmit any data to/from the smart phone and the microcontroller board. The microcontroller which is the brain of the system will signal the relay module to carry out the operation required of the user (ON/OFF).

Then it will transmit a signal back to the SIM module and the user will receive an SMS alert on the current status of the appliances. The motion sensors that is connected to the microcontroller detect any kind of unauthorized movement and then notify the user through SMS alert. The notification sensor button increases the feasibility of the application and simply allows the user to activate/deactivate the sensor. This sensor need to be activated by the user before leaving the house. When the user come to the house, the sensor need to be deactivated to avoid any notification to the user while he/she is in the house.

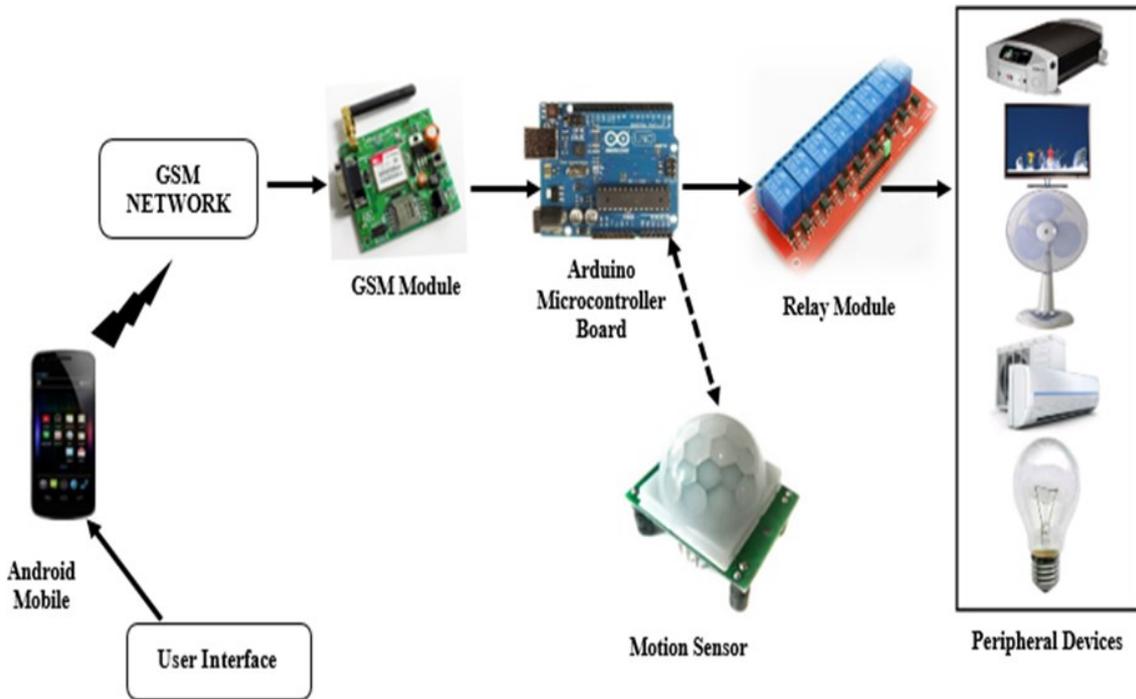


Figure 1: A secured global system for mobile home automation system

Components of the System

(a) Mobile Phone

The client device could be in form of smart mobile phones. The mobile apps is installed on the smart phone.

(i) The Mobile APP

The Mobile App on the smart device is mainly an Android native mobile app which was developed using the MIT app inventor platform that combines the functionality of Android SDK, JAVA and Scratch. The app provides opportunity of easy integration between the mobile app and the hardware device.

(b) GSM Module

SIM900 GSM Module is a cell phone with all the facilities of sending and receiving messages and calls. The GSM transmitter module which is the user cell phone and the GSM receiver module which is the cell phone module are used for the serial communication with the microcontroller. The system uses GSM signal system which allows users to effectively control their house/office appliances simply by sending a short message service (SMS) to the device. The SMS received by the device is processed by a microcontroller to perform ON/OFF operations. The type of operation performed is based on the nature of the GSM signal sent. An encoded GSM signal is generated and sent from the GSM base station to the device.

(c) Arduino Board

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. In this case, 8 of the dig-

ital pins are used for appliance controls and two others for motion sensing to detect intruders and to activate the alarm system respectively.

(i) ATMEGA328P Microcontroller Unit

It receives commands from the GSM module and thus control the ports to which the relay modules are connected based on the received commands. It has been designed in particular for monitoring and/or control tasks.

(ii) Motion Sensor

The sensor is connected to the microcontroller board which monitor motion around the appliances in the house. The indication from the sensor is able to notify the user to switch ON/OFF the appliances in the house. The home appliance on/off status is synchronized to the GUI on the smart phone. The switch status is in real time monitoring by the microcontroller.

(d) Relay Module

A relay is an electrically operated switch. An 8-channel relay module was used which has the capacity of controlling 8 home appliances and devices at the same time, turning them on/off. A higher N-channel relay module can be used to accommodate more appliances.

(e) Appliances

Appliances may refer to home appliances, computer appliances etc. The home appliances are the household appliances using electricity or some other energy input which could be electric fan, sound system, electric bulb, television set, washing machine etc. The computer appliances refer to the computing devices with a specific function and limited configuration ability which could be storage appliances, firewall and security ap-

pliances, anti-spam appliances, software appliances, virtual appliances etc. The home appliances were considered for the automation.

(f) Power Supply Unit

The Power Supply module is necessary for

the provision of regulated (step-down rectifier) DC power supply from AC to main circuit component (ICs, relay, microcontroller etc.), the maximum and minimum voltage rating of the circuit component were taken into consideration during implementation.

Flowchart of the System

Figure 2 shows the flowchart of the system

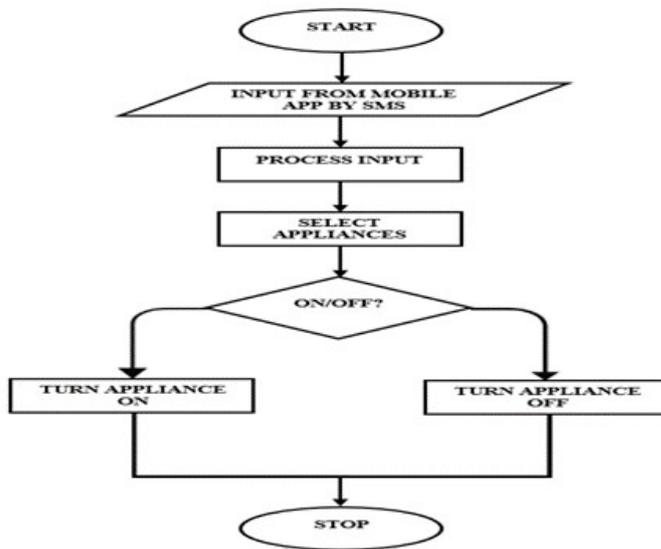


Figure 2: Flowchart of the System

IMPLEMENTATION AND RESULTS

The design was implemented using Java programming language, Mit App Inventor, Android Studio, Proteus Simulator Software and MySqlite database. Figure 3 shows an

image of the MIT App inventor development platform with the mobile app under development.

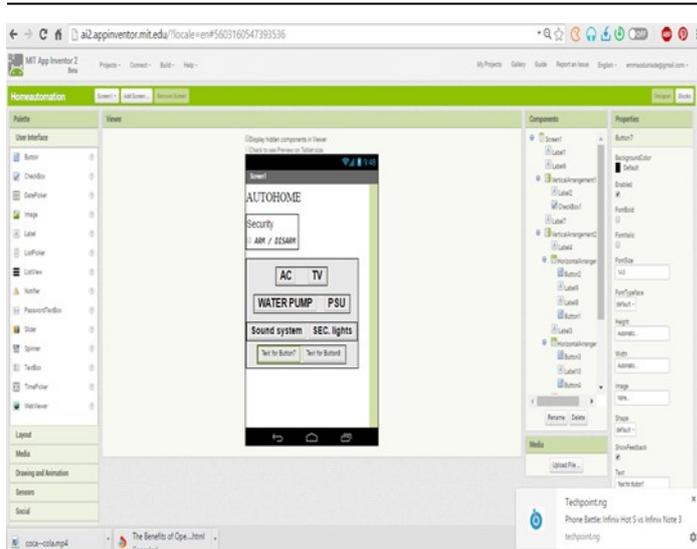


Figure 3: Image of MIT App Inventor

Figure 4 (a & b) shows the developed AUTOHOME Android application designed using Mit app inventor, functioning on a smartphone to control the designed hardware circuit. The auto home Android application has two interfaces: the home page and the credit page.

The motion sensor is activated to detect intruders through the activate/deactivate checkbox in the home page. The notification sensor button increases the feasibility of the application and simply allows the user to activate or deactivate the sensor. This sensor has to be activated by the user before leaving the house. When the user comes to the house then the sensor has to be deactivated so that it won't send any notification to the user while he/she is inside the house.

The appliances labelled 1 to 8 are the appliances connected to the GSM-HAS in the home. On clicking any appliance, a home automation menu prompts up giving the user a notification to ON, OFF or CANCEL the request for the appliance.

With this application the user can get the status of the home appliances. If he/she has accidentally left the appliance ON in the house, then it can be turned OFF using this application by simply clicking on the ON/OFF button. For instance, if he wants to turn on the Air condition before going home so that the bedroom has comfortable temperature then it can be performed through this application. The user gets a feedback message which is displays on the same interface to ascertain that the message was successfully sent to the GSM-HAS at home.



Figure 4 (a) Auto- Home android application



(b)

In setting up the hardware circuit, the Proteus simulator was used in the development of a prototype model for the hardware structure as shown in Figure 5. While figures 6 shows the image of the hardware cir-

cuit under development, Figures 7 and 8 shows the image of the hardware circuit before and after auto home application was used to control the appliance.

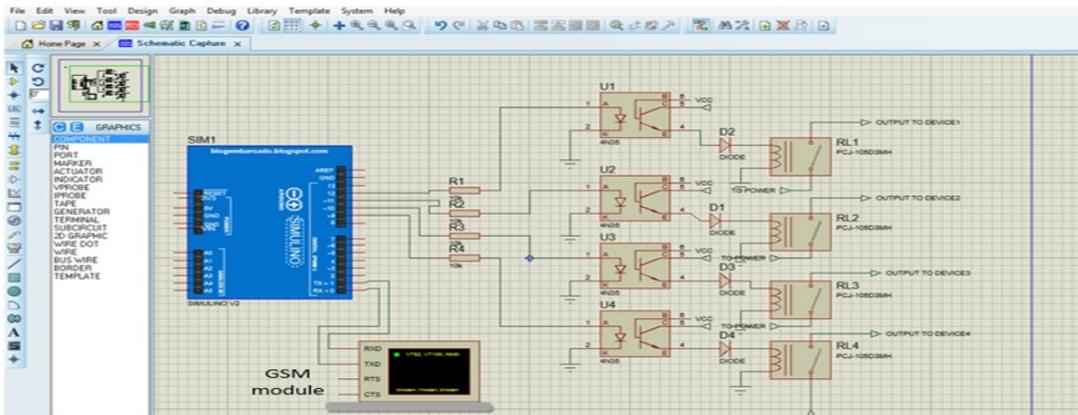


Figure 5: Image of Proteus software for circuit development



Figure 6: Image of the Hardware Circuit under Development



Figure 7: Before using GSM-HAS to control the appliance

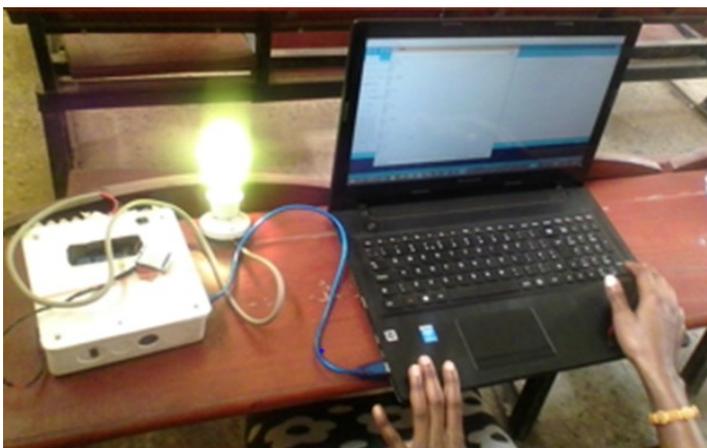


Figure 8: Using GSM-HAS to control the appliance

Table 1: Results of Time taken before turning on and off the appliance without using the Arduino application

Appliance Status	Readings			Average Time (Sec)
	1 st	2 nd	3 rd	
ON	5.40	2.65	7.20	5.08
OFF	2.73	4.90	3.48	3.70

Table 2: Results of Time taken before turning on and off the appliance using the Arduino application

Appliance Status	Readings			Average Time (Sec)
	1 st	2 nd	3 rd	
ON	7.51	4.45	7.40	6.45
OFF	8.70	4.08	6.11	6.30

By analyzing the results obtained in Table 1 above without using the Arduino application to monitor the appliance through the GSM-HAS circuit, it was found that the average time taken to turn ON and OFF the home/office appliance are 5.08 and 3.70 seconds respectively.

By analyzing the results obtained in Table 2 above by using the Arduino application to

monitor the appliance through the GSM-HAS circuit, it was found that the average time taken to turn ON and OFF the home/office appliance are 6.45 and 6.30 seconds respectively.

Figure 9 shows an image of a message interface sent from the Motion Sensor connected to the GSM-HAS to the mobile number of the Auto home application user.



Figure 9: Intruder Alert from GSM-HAS to the Auto-home user

CONCLUSION

In this work, a Secured Global System for Mobile Communication Home Automation System (GSM-HAS) was designed. The GSM-HAS system is capable of controlling any appliance in the home within the specified current ratings of the relay module which is 10 Amps, it is a rating safe enough for appliances like television, electric bulb etc. With secured GSM-HAS, home appliances are controlled to avoid electrical sparks as well as conserve energy. The technology has the advantage of a world wide range of transmission. The most prominent feature of the system is that the user can control the system through an Android application. The design presents an easy way to manage and control appliances and also provides some level of security for the home appliances using a motion sensor to detect intruder around the appliances.

In future, it might also be necessary to integrate a security camera that can control and allow the user to observe activity around the house or business environment; the extension of the Android mobile application to other platforms will be investigated and further automation to support the quantifying related values will be explored, the sensor will be connected through a Wireless Sensor Network to remove the complexity of passing the wires around the hardware.

REFERENCE

Gupta A., Tomar K. 2016. Efficient Home Automation and Security, *International Journal of Scientific and Research Publications (IJSRP)*, 6(4), 298-302.

Javale D., Mohsin M., Nandanwar S., Shingate M. 2013. Home Automation and Security System Using Android ADK, *International Journal of Electronics Communication and Computer Technology (IJECCCT)*, 3(2), 382-385.

Meriam Webster, 2009. Automation Definition. *Meriam Webster Dictionary (62nd Ed)*. Meriam Webster Publishing, USA.

Paul S., Antony, A., Aswathy B. 2014. Android Based Home Automation Using Raspberry Pi. *International Journal of Computing and Technology (IJCAT)*, 1(1),143-147.

Rana G.M., Khan A.A., Hoque M.N., Mitul A. F. 2013. Design and Implementation of a GSM Based remote home security and appliance control system. *Proceedings of 2013 2nd International Conference on Advances in Electrical Engineering (ICAE 2013)*, 291-295.

Ramlee R.A., Leong M.H., Singh R.S.S., Ismail M.M., Othman M.A, Sulaiman H.A., Misran M.H., Meor Said M.A. 2013. Bluetooth Remote Home Automation System Using Android Application, *The International Journal of Engineering and Science (IJES)*, 2(1), 149-153.

Salman M., Vrindavanam J. 2013. Efficient Interactive Control System based on GSM, *International Journal of Latest Trends in Engineering and Technology (IJLTET)*, 3(2), 50-56.

Shaiju P., Antony A., Aswathy B., 2014. Android Based Home Automation Using Raspberry Pi, *IJCAT International Journal of Computing and Technology* 1(1), 143-147.

Suryavanshi R.S., Khivensara K, Hussain G, Bansal, N., Kumar V. 2014. Home Automation System Using Android and Wi-Fi. *International Journal of Engineering and Computer Science (IJECS)* 3(10), 8792-8794

Tan H.G.R. Lee C.H.R. and Mok V.H., 2007. "Automatic Power Meter Reading Sys-

tem using GSM Network." *In Proceeding on Power Engineering Conference, 465-469.*

Teymourzadeh R, Ahmed S.A., Chan K. W., Hoong M. V. 2013. Smart GSM Based Home Automation System.

Wahab M.H.A., Muji S.Z.M., Nazir F. 2007. Integrated Billing System through

GSM Network. *In Proceeding of 3rd International Conference on Robotics, Vision, Information and Signal Processing (ROVISIP2007)*

Wahab M.H. A., AbdullahcN., Johari A., Kadir H.A. 2010. 2010 GSM Based Electrical Control System for Smart Home Application. *Journal of Convergence Information Technology* 5(1), 33-39.

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