



Development of Smart Home System Using Arduino with Mobile Application

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Abstract. Smart home system is getting more popular and widely used in many houses worldwide. Use of human's voices to control home apparatus can be viewed as new worldview in the Home Automation System. Due to the headway of remote's innovation, there are some wireless connectivity developed, for example, global system for mobile communications (GSM), WiFi, ZigBee and Bluetooth. Each of the connectivity has their own exceptional characteristics and applications. Nowadays, the physically challenged and elderly people depends on other people to operate any appliances in the house and it is too risky for them as they can easily fall down while walking. Developing this type of system could help them to live independently and reduce the risk on elder people's life. Besides that, home automation can also reduce the amount of energy used by the client or users. The complexity of the wiring for home automation is too high and the cost will be charged higher too. The basic is to make it financially affordable and simple to arrange, allowing more individuals to gain it for their home, work places and schools. Pushed on the intelligent and sorted out methods utilized as a part of building up a smart home system and security system. At the same time, find out how the electric component that will be used in this system and ensured that the components are suitable and economics. In addition, elaborates on how the overall operation of smart home system works. Other than that, analyse and discuss the result obtained from this system. Finally, concludes the overall system process and improvement required on smart home system using with mobile application system. A point by point explanation is given to the made outline and a future progress that may be directed under this field is recorded.

Keywords— *Home automation; Smart home system; Arduino; GSM; Wireless; Smartphone; Bluetooth; Voice control*

INTRODUCTION

Home automation is one of the significant developing businesses that can change the way individuals live. Home automation is specially designed for the elderly and physically challenged people. Remote Home Automation System (RHAS) gives those unique needs with a framework that can react to voice changes and control the power of electrical gadgets, for example; lights, fans, and doors in the house. The framework needs to be sensibly modest, simple to design, and simple to run [1-2]. Use of voice to control home apparatuses can be viewed as a new worldview in the Home Automation System. Due to the headway of remote's innovation, there are some wireless connectivity developed, for example, global system for mobile communications (GSM), WiFi, ZigBee and Bluetooth. Each of the connectivity has their own exceptional characteristics and applications. Due to the headway of remote's innovation,

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there are a few connectivity presented, for example, global system for mobile communications (GSM), WiFi, ZigBee and Bluetooth. Each of the connectivity has their own exceptional particulars and applications [3]. These days, everybody can't be separate from their cell phones. Various five thousand people from USA, UK, South Korea, India, China, South Africa, Indonesia and Brazil took a review in regard to which was finished by Time magazine. The outcome of the survey shows greater part of them is inseparable from their cell phones, 84% cannot be without their cell phones. Figure 1 shows that seventy five percent of the market value is Android and a sum of one hundred and six million android cell phone were dispatched in the second half of 2014. Android cell phone turned into the top operating system in the market in the present time worldwide and it turned into the most famous operating system [4].

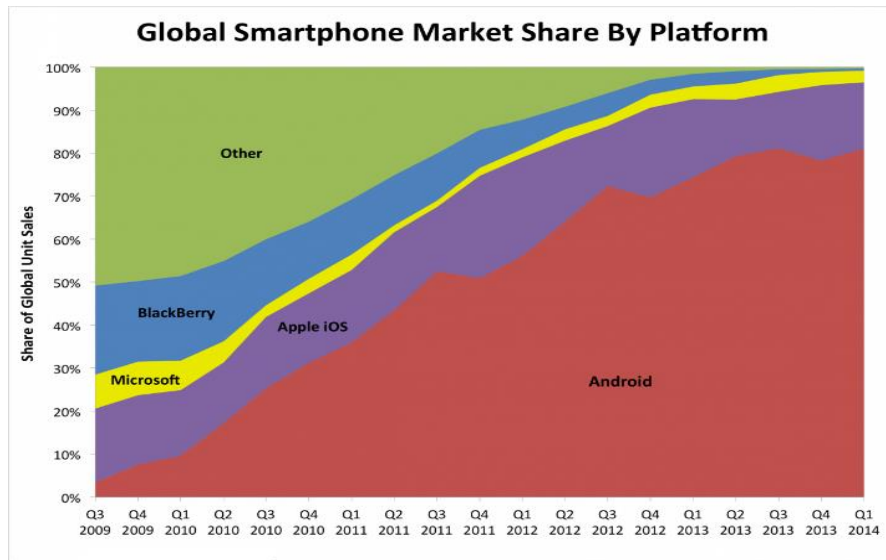


FIGURE 1. Global Smartphone Market

DESIGN OVERVIEW

A. System traits

The system design consists of Arduino Mega and Uno; that acts as the main controller, Bluetooth module HC-05 acts as the interface between the Android applications and the Arduino. The Android apps “Voice Function App” and “Arduino Bluetooth ON OFF Function App” are the main applications for implementing the system. The relays, lamp, fan and door lock magnet used for various control purposes. Figure 2 depicts the overview of the system architecture.

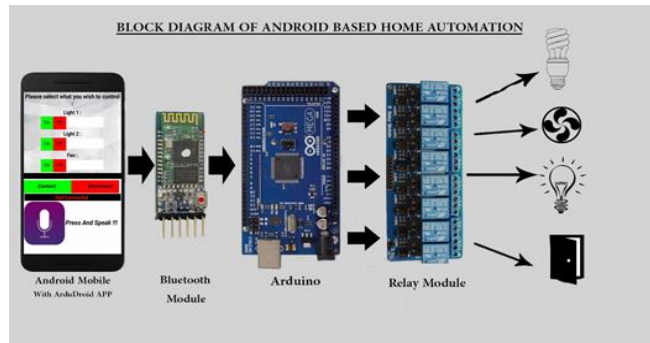


FIGURE 2. The design of the Smart Home System.

B. Hardware approach

In this project there are two Arduino boards will be used as shown in Figure 3. This microcontroller consists of built-in digital pins.

1) Block diagram of the system

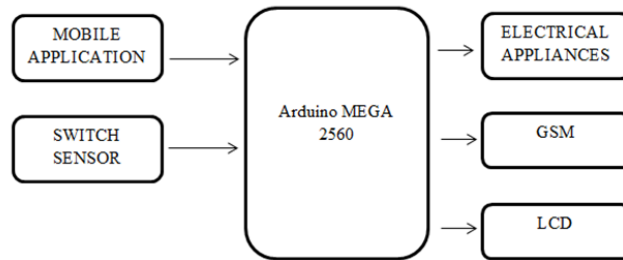


FIGURE 3. Block diagram of the smart home system

From this figure, Arduino is connected to all the electrical appliances and Bluetooth. On the other hand, Arduino is connected to GSM system and worked as security for home. When someone break into the house, the switch sensor immediately send signal to Arduino and then the Arduino trigger the GSM to send SMS to the house owner for security purpose. At the same time, the LCD show the activity of the switch sensor.

2) Arduino Microcontroller

A microcontroller is an integration of CPU, storage, RAM, ROM, and input/output peripherals. Microcontrollers are proposed for extended installed application to easily finish the project work and reducing the time compared to the composed integrated circuit [5]. The example of microcontroller is such as; Arduino, PIC, Raspberry Pi and others. This kind of microcontroller has an explanation behind its possessed specification and various qualifications with respect to RAM, design, clock’s speed, programming language and other particular conditions [6].



FIGURE 4. Arduino Mega & Uno

3) Wireless Data Communication

Wireless data communication is a sort of correspondence that uses the radio range as opposed to a physical medium range. It might convey simple or computerized flags and can be utilized in LANs or WANs as a part of an arranges. It is also known as a communication between two different physical devices.

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In the made microcontroller-based checking relationship, there must be a framework going about as the information conveyor which the data is the pace furthermore, zone information to and from the watching base station. This character of data conveyor is supported in light of the way that it is about the widest correspondence framework in whatever country, moreover to produce the structure versatile for future advancements. One of the incredibly significant properties of GSM frameworks is the Short Messaging Systems as known as SMS [7-8]. GSM is a cell framework, which infers that portable telephones interface with it through examining for mobile phones in the speedy area. The GSM framework used by cell phones gives a simplicity, long accomplish remote correspondence channel for applications that call for accessibility rather than high data rates. Equipment, for instance, present day refrigerators and coolers, HVAC, sweet machines, vehicle organization could benefit by being related with a GSM structure. Constructed up along the mechanical ability and the given vehicle, uniquely crafted organization between times can be set. A section of the organization assentation is the begin of a GSM modem in the vehicle as demonstrated Figure 5. On board organization application can then prompt the garage when the vehicle draws near its organization interval. The organization division will arrange a course of action and exhort the customer [8]. The customer will profit by an attempted also, genuine and all around updated vehicle at any rate cost. The garage then again can offer awesome customer reinforce, vehicle estimations, viable work arranging, and minimum stocks.



FIGURE 5. GSM module.

4) Bluetooth

Bluetooth used as remote advancement level for trading data over short separation utilizing ISM band. ISM band stays for mechanical, logical, and medicinal radio gatherings. It describes and holds radio repeat for mechanical, investigative, and restorative purposes. Bluetooth uses a repeat bouncing arrangement as a piece of demand to limit the blocks with various advancements and applications, for instance, 802.11, microwave grills, cordless phones, etcetera.

The affiliation extent of off-the-rack Bluetooth contraptions move from 10 meters to 100 meters. Each Bluetooth contraption has an exhaustively stand-out 48bit Mac address. The initially 24 bits of the Bluetooth area is shipper specific [9]. Before two Bluetooth devices can develop an affiliation and send data to each other, they have to encounter a mixing technique, which is fundamentally a methodology for making a commonplace key for confirmation and encryption between two Bluetooth gadgets. Connection of Bluetooth is show in Figure 6.

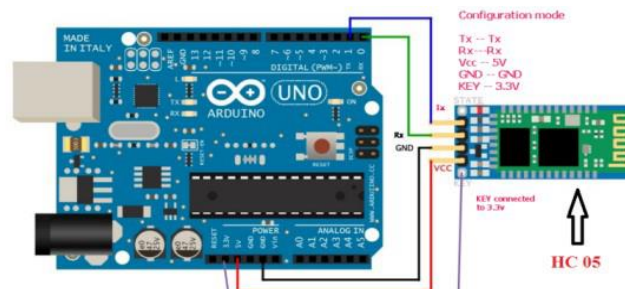


FIGURE 6. Bluetooth Module HC-05 [7].

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5) *Switch Sensor*

Figure 7 shows a switch sensor with 3 pin outlet which are supply (VCC), ground (GND) and output (OUT). Figure 8 demonstrates schematic diagram of switch sensor and it helps to understand how the sensor module integrates itself to detect when someone break the front and back door. If there is a motion detected by the sensor, the output of the module is low. But the output will be high when no motion detected by the module as a result shown in Table 1 [10].



FIGURE 7. Switch Sensor

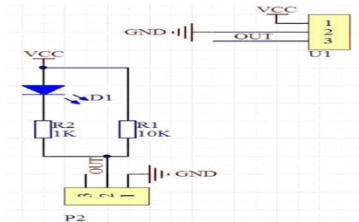


FIGURE 8. Schematic diagram of switch sensor

TABLE 1. Output value of sensor module

Break Detection	Output
Yes	5V Send signal to Arduino and GSM
No	0V system in standby condition

C. *Software approach*

1) *Graphical user interface For Android*

Figure 8 and 9 shows the GUI created for smart phone to control all the electrical appliances. This interface was created using MIT App Inventor 2. Figure 2.5 is for ON/OFF function and another figure is the voice control function.

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FIGURE 8. ON/ OFF function



FIGURE 9. Voice function

2) Flow chart

Figure 10 shows that the Arduino starts to communicate with the output when the signal is sent from the smart phone. At the same time, when the switch sensor is triggered, the switch sensor will send signal to Arduino and GSM will start to send the SMS.

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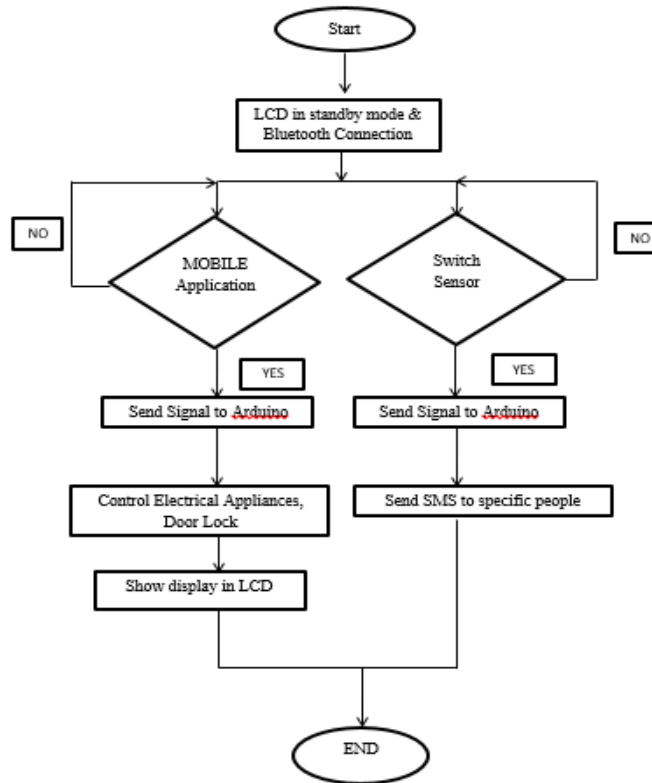


FIGURE 10. Flow chart of the system

RESULT AND DISCUSSION

For this type of system, data is collected from the prototype of smart home system using Arduino with mobile application. The data are taken from different distance of places to examine the accuracy and consistency of the system. Table and Figure are used to interpret the data collected from the prototype of smart home system using Arduino with mobile application.

TABLE 2. Results for each input using the touch screen button

Input Button	Output in Application	Digital Read	Output
Light 1 ON	Light 1 Turn ON	49	Light 1 ON
Light 1 OFF	Light 1 Turn OFF	50	Light 1 OFF
Light 2 ON	Light 2 Turn ON	51	Light 2 ON
Light 2 OFF	Light 2 Turn OFF	52	Light 2 OFF
Fan ON	Fan Turn ON	53	Fan ON
Fan OFF	Fan Turn OFF	54	Fan OFF
Door ON	Door Turn ON	55	Door ON
Door OFF	Door Turn OFF	56	Door OFF
All Application ON	All Application Turn ON	47	All Application ON
All Application OFF	All Application Turn OFF	58	All Application OFF

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Table 2 display the real output of the hardware and software when the whole system worked using smartphone. After that, the same error checking process was made for voice recognition application to make sure the google talk can detect human voice correctly and send to Arduino to process the output and displayed in Table 3. In this project use more than one command to check the sensitivity of the system.

TABLE 3. Result for each input using control using voice

Command Voice	Output in Application	Digital Read	Output
“Light ON”	Light 1 Turn ON	-	Light 1 ON
“Light OFF”	Light 1 Turn OFF	-	Light 1 OFF
“TV ON”	Light 2 Turn ON	-	Light 2 ON
“TV OFF”	Light 2 Turn OFF	-	Light 2 OFF
“Fan ON”	Fan Turn ON	-	Fan ON
“Fan OFF”	Fan Turn OFF	-	Fan OFF
“Lock ON”	Door Turn ON	-	Door ON
“Lock OFF”	Door Turn OFF	-	Door OFF
“All ON”	All Application Turn ON	-	All Application ON
“All OFF”	All Application Turn OFF	-	All Application OFF

Voice Detection is a program to make sure the voice of human can be detected and send to Arduino for further action. The GUI in Android application is created for voice recognition function to control the whole system by single spoken command. Google talk is used to analyses the output from the voice and the speed of voice detection. Example of the output in the Google Talk is such as “Fan ON”, “Fan OFF”, “All ON” and “All OFF”. Arduino will capture the word sent by Google Talk and proceed to controlling the appliances. Smart home system appliances functions based on command received from Google Talk and program at Arduino. The program at Arduino should be same with the output of voice detection. Sometimes voice detection is very sensitive to background noise, child screaming, dog noise and others. This kind of noises can affect the output of the Google Talk that is sent to the Arduino board. The potential of Bluetooth signal ability to send and receive data is analyses as shown in Table 4. The results for the analysis was taken from indoor to outdoor.

TABLE 4. Distance of Bluetooth potential to send and receive data

Distance (m)	Ability Send Data	Speed Response by Arduino	Time Response by Arduino (s)
5	Success	Fast	<1.0
10	Success	Fast	<1.0
15	Success	Fast	<1.0
20	Success	Slow	1.0
25	Failed	No Response	-

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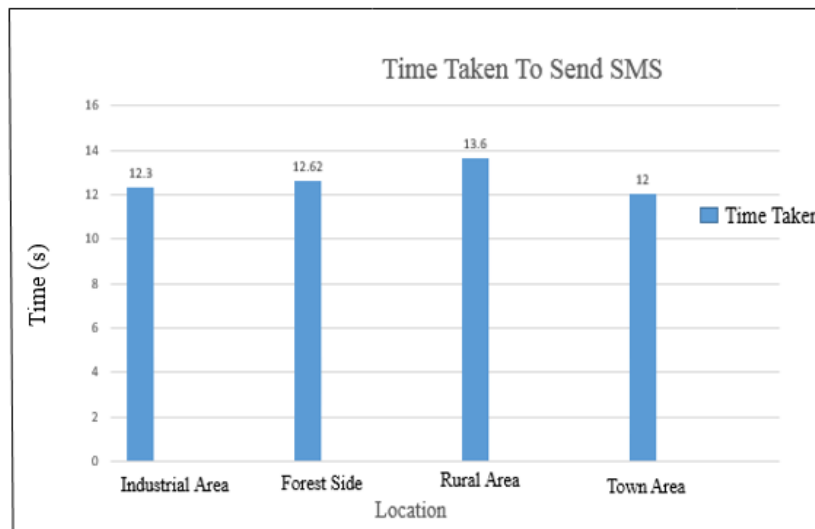


FIGURE 11. Variation of Time taken with the location

Time taken to send SMS has been collected from 4 different strengths of signal places to measure the efficiency of the system as shown in Figure 11. Each place collects 4 different data to calculate the average time taken for SMS to be send to the particular location. Rural area requires more time, which is 13.6 sec to send SMS compared to other location. This is because, rural areas normally covered with weak signal compared to other location. While, the residential area near to the town only takes 12 sec, which is less than other due to the high strength signal. In residential area near to the forest and industrial side take almost the same time to send SMS, which is 12.3 sec and 12.62 sec respectively.

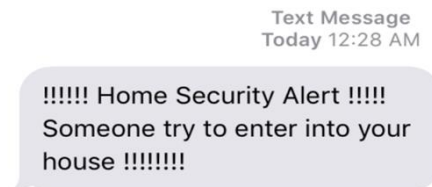


FIGURE 12. Message Receive by Owner

The switch sensor will sense when the button is released from the side window, front and back door. Whenever the sensor is active, it will send high input to the Arduino mega (microcontroller) to inform that burglary activities had occurred. Then, the microcontroller will give alerts signal to GSM. Then, SMS is sent to the house owner or emergency contact. The received SMS will consist the house details as shown in Figure 12.

Conclusion

As a conclusion, the smart home system successfully described the entire process and functionality about the development of smart home system using mobile application. Smart home system using mobile application was developed and the system act as a helper to human and disable people in the house without depending on others. Besides that, this system is also very useful to house owner to avoid burglar activities occurring at their home. Global system for mobile communication (GSM) module is used to send alert via (SMS) to the owner. So that, when the



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house owner receives that kind of alert the owner can easily contact the police or take further action to avoid the burglar activities. The efficiency of the system during an emergency was successfully analysed at various places. The speed of SMS received by the owner was taken at various places that depends on the environment such as industrial area, rural area, forest side and town area. Finally, this system can be implement in our house because it increases the safety who stay alone. The owner can easily get the correct information regarding the burglar activities and can avoid it immediately.

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