A Multi-User Home Automation System: An Application of Ideal Smart Home

Md. Razu Ahmed[1, 2*], Mohammad Osiur Rahman[1]

[1] *Department of Computer Science and Engineering, University of Chittagong, Chattogram 4331, Bangladesh*
[2]*Department of Electronic and Telecommunication Engineering, International Islamic University Chittagong, Chattogram, Bangladesh*
Corresponding author: razu17@iiuc.ac.bd

Keywords	Abstract
Ideal Smart Home *Framework* *Ecosystem* *Security* *Macro Cell* *Central Database*	Smart Home is one of the most trending topics of research in the world right now. It makes people's life easy, enjoyable, safe, and secure as it has numerous features to do so. Besides, using smart home technologies users can monitor and control their home remotely. The existing research relevant to smart home depict that researchers concentrated on particular issues of total smart home system. Therefore, it is a matter of demand to research on a complete ideal smart home system. In this article, an android-based ideal smart home control system prototype has been proposed to ensure tight security in operating all types of household appliances due to the consumer demand for home protection and automation. An enhanced and cost-effective use of different devices of ideal smart home system has been ensured. The system is made user friendly by using four different types of switching. Cost analysis proves the device to be cost-effective concerning its enhanced performance. Finally, Simulation and implementation of the work are presented with satisfactory results.

1. INTRODUCTION

Smart home is a framework for automation that can be operated remotely [1]. Smart home technology can track and manage all appliances and electrical parts of the home. We know, homes are usually regulated in a traditional manner. People are uncertain of the information while they are outside of the home, and thus it is possible to manage and track the home in their absence [2]. Low-power consumption, environmentally, proper management system, safety protection esurience, and use of artificial intelligence for security systems is the key characteristic of smart home technology as shown in Fig. 1. All these features are related to people's daily life. Home monitoring and controlling, video conferencing, telemedicine, stranger recognition, environment adaption, safety assurance are some technologies that will help in achieving the features [1], [3].

Smart Home technique enables wireless access to household appliances, and residents can take decisive action in the event of an emergency [1], [2], [4]. The smart home system can handle the adjusting of the home environment to the outside environment. The room light is switched on automatically in the evening or the window shutter can be opened in the morning sunlight. Also, if any unwanted gas leakage is detected, an alert system will be activated, and the alert message will be sent to the home resident and a fire station.

There are a few cabbalistic features of smart home technology that can be split into various segments, such as new powerful features integration, command systems, communication systems from D2D (device to device) or device to the internet, security enhancement, artificial intelligence, mobile application development [2]. A significant feature of smart home technology is D2D or device to user communication, which can occur whether in a wired or wireless communication system. For reliable connectivity and stability, cabled communication systems like Optical Fiber, Power Line Communication, Ethernet, HomePNA, Lo-RaWAN are preferable [1]. These are not cost effective, and the installation method is not simple and fast [5]. In the case of wireless networking, the installation process is superior to a smart home. The applicants for wireless technology are Bluetooth, GSM, WiMax, Wi-Fi, ZigBee, LTE, and Wireless Mobile Communication (5G). The 5G will come with a massive opportunity in smart home technology. It will deliver a high data rate so that homes can connect in real-time.

To recognition of non-inhabitants is one of the most complicated concerns for smart home technology, and it is causally linked to the performance of smart home technology in the level of security protection. The activity

monitoring method [6] and the accelerator sensing method [7] are well-known non-inhabitant identifying method. In smart home technology, networking and data protection are the most important factors since all home appliances will be connected to the smart city. Different technologies are linked to smart city communications infrastructure such as IoTs, UAVs, smart water systems, smart grids, etc. [8]. In [8], an effective network model is suggested. To create a robust network, different types of sensor nodes have been recommended: Home Area Network (HAN), Neighbouring Area Network (NAN), WAN, WSN, BAN, WLAN [9]. HAN is for home connectivity, and NAN is for smart home connectivity in the smart city network [10]. NAN will link to the City Area Network (CAN). The CAN will serve as the networking framework controller. Encryption techniques and authentication protocols can be established to protect the home data of the user. Sicher firewall is proposed to be used as a data protection protocol [3]. For data encryption using a dual-layer encryption system where RSA and AES algorithms are included[11].
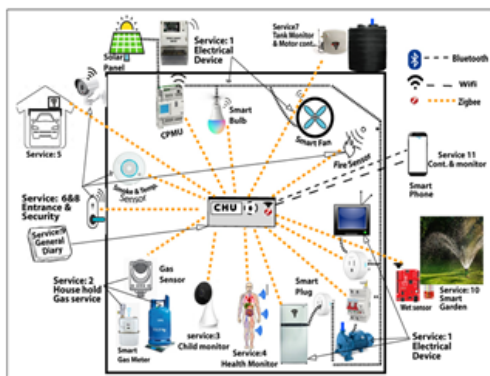

Figure 1. Basic diagram of an Ideal Smart Home

To manage tasks by Smart Home itself, artificial intelligence technology should be integrated. In emergency cases, when inhabitants can't send a command, but the operation must be taken, the smart home system takes precise decisions and exempts inhabitants. There are so many features of Artificial Intelligence, including System Management, Resource Management, Intelligent Interaction, Healthcare, Security, etc. [3]. In [12], a sensor-based communication system in home automation was introduced, in which ZigBee is the key network technology for reducing power consumption. However, the communication system has limitations on the range and transmission rate [12]. Wi-Fi can play a significant role in linking sensors. The sensors transmit random data within a short time to the smart home controller. Data collection from the sensor will be sent to the central database to inform the user or in the absence of the user, decide a prior instruction [13].

IoT is most preferable to connect the home appliance with the inhabitants. A web-based smart home has been developed and the system can control the home appliances remotely [13]. Inhabitants will monitor and control light, temperature, air-condition, security system, inner environ-

ment, and so on [14]. However, the controlling and monitoring features cannot define the IoT fully. IoT covers AI as well as deep learning. IoT develops the system as it learns the home data and will take decisions based on previous activity [15]. Data mining in a smart home is another significant issue. It is a process of deep learning and it helps to take decisions by the controller in the absence of inhabitants [16].

Smart home energy management has certain characteristics, including smart metering, smart plug system, information exchange between users of NANO Grid, energy currency, energy sharing, etc. [17]. A recent development in data storage technology is cloud computing. Nowadays, consumers are more concerned about remotely accessing data. Therefore, cloud computing has gained prominence among everyone. Smart home technology will become IoT-based [15], [18], and IoT will be part of cloud computing. Since a large volume of data will have to be stored, and the customer will access the data within a short time, cloud computing is very responsible for fulfilling customer needs. In recent years, Fog computing has also been demanding, however. It may also be known as a cloud storage sub cell. If cloud storage has more data, some of the data is moved to fog to unload [14].

There are several commands inserted into the smart home. The most suitable command system is the Android-based application since it offers a user interface that can be used by anyone with the authorization of the residents, by remote access [18]. Though the security issue is a hazard to smartphone devices, such as the loss of devices and hacking capabilities. Voice commanding system is another dynamic command technique in smart home technology. Users will not have to carry with them and the annoyance of any additional parts at home [19]. Although voice recognition, isn't reliable with everyone particularly for speech-impaired individuals. Because this technique is not being established as planned concerning the identification of all forms of speech or linguistic accents. Another input command method in a smart home is the motion sensor, but that should be need more improved.

The core hardware device of home automation is one of the most significant components. In-home automation, a central device will manage all information and commands. It is programmable and attached to the client command mood. Most research scholars have suggested designing the prototypes using the Arduino Microcontroller module because it is simple to provide instruction and has good resources on various online platforms. Numerous home automation projects work done by using the processor. It allows us to connect via Bluetooth, Wi-Fi, LAN, sensors, etc. [18]–[20]. Some basic services for the smart home are discussed in Table 1. Our switching technique makes our daily activities easier some electric device turns on or turns off automatically. Home automation also increased our home safety and security home automation creates a more hospitable environment.

Table 1. Services of Ideal Smart Home System

Services	Technology / Method	Purpose	Remarks
Home appliances Control and Monitoring 1. Light ON/OFF 2. Fan Speed Control 3. AC Control 4. Refrigerator Monitoring and Control 5. Gas Leakage Monitoring and Control 6. Water Leakage Monitoring and Control 7. Personal Health Care 8. Smart Lighting Control 9. Water Pump Monitor	*ZigBee*	In Ideal Smart Home for Internal of Home Connectivity	Advantages: ✓ It's a shorter operating duration that contributes to saving energy and correspondence energy consumption. ✓ A significant number of nodes accept the Zigbee. ✓ The battery performance is very long. ✓ It is acceptable for HAN. Disadvantages: ✓ Need Extra Communication infrastructure. ✓ Low data rate.
	Wi-Fi	Connect the group of ISH with Macro Cell (MC)	Advantages: ✓ Availability. ✓ Reliable for Medium range distance. ✓ Acting as an alternate communication in MC. ✓ Easy to access. Disadvantages: ✓ Coverage area is under 100m. ✓ Environment affect. ✓ Data security.
	Bluetooth	Connecting the Mobile with Central Home Unit when users are at home.	Advantages: ✓ Don't need internet. So, home can be controlled in emergency when internet will not available. ✓ Availability in every smart phone. Disadvantages: ✓ Coverage area limitations. ✓ Low data rate. ✓ Data security issues.
	Wireless Mobile Communication (5G)	Connecting the ISH with MC. Communication between MC and CD.	Advantages: ✓ Robustness. ✓ Low latency. ✓ Real Time Communication. ✓ High Throughput. Disadvantages: ✓ ISH should have 5G supported antenna and other equipment.
	Optical Fibber Communication	Use in the channel of MC to CD.	Advantages: ✓ High Security. ✓ Reliable Throughput is high. ✓ MC to CD connection needs all time reliable connectivity. Disadvantages: ✓ Heavy infrastructure.
Smart Meter	*Power Line Communication*	The communication can be used for transferring the data of smart plug to smart meter.	Advantages: ✓ No need any extra infrastructure. ✓ More secure.

Table 1. Services of Ideal Smart Home System

Services	Technology / Method	Purpose	Remarks
Home Security Entrance	*Camera Sensing*	Camera with wireless sensor will collect the inhabitant's data.	Advantages: ✓ Non inhabitant's activity can be monitored and take actions. Disadvantages: ✓ Taking more time to train up. ✓ It can be serving wrong information if it has no proper data.
	Sensor IoT	Effective methods are proposed to identify the non-inhabitants in [27] and [29]. The methods collect the data from sensor and analyse with previous inhabitant's data.	✓ The strategy suggested in [27] is to use a sequential relationship approach to identify non-residents. The method contrasts the activity detected with the activity observed by the resident. ✓ The Elgar Framework has been proposed in [29]. It connects the system with IoT. ✓ The proposed method of [27] is efficient to identify non-inhabitants. The identification can be connected with IoT by the Elgar Framework.
Data Security	*RSA algorithm for Data Security*	The algorithm can be used in smart home system. It secures the data by using asymmetric cryptography system.	A modern computer system to encode and decode data used the RSA (Rivest–Shamir–Adleman) algorithm. It's an asymmetric cryptographic algorithm. It is also known as public-key cryptography since it is possible to give everyone one of the keys and keep the other key confidential.
Security	*Access to Server*	User access to the server of both MC and CD	User only connect with the Central Home Unit. All the activities of the servers will pass through the CHU. So, user won't get the access of the database of MC and CD.
Simple Connectivity / Networking	*Home Area Network (HAN)*	All the home appliance will connect with Central Home Unit (CHU) under the network	The network aggregates the data from all appliance of a CHU.
	Neighbor Area Network (NAN)	Establishing network among the ISHs and MC.	There are several numbers of Ideal Smart Homes will join with a Macro Cell using NAN.
	City Area Network (CAN)	It connects all the MC with a Central Database.	The network connects all the Smart Home Users in a common point. So, everyone will come to a network system.

Automatic User Behaviour Monitoring	*Data Mining and Deep Learning Artificial Intelligence*	AI will identify the proper user of a home.
		    Home Security
		    Home Environment
		    Energy Management
		    Health Care/Health Monitoring
			✓ MC will maintain the data sharing among the smart homes by using AI.
			✓ AI will be exploited in absence of user instruction and emergency situation.
			✓ AI system will be learned the MC and CD from the regular data of smart home.
			✓ Home Security.

Table 1. Services of Ideal Smart Home System

Services	Technology / Method	Purpose	Remarks
Energy Management and Environmental Monitoring and Control	*Wireless Sensor*	Name of Services [3] ✓ Energy Management ✓ Environmental Monitoring ✓ Healthcare ✓ Home Automation ✓ Home Security ✓ Location Recognition ✓ Smart LED Lighting ✓ Smart Socket ✓ Smart Switch	Sensors [3] ✓ Light, Humidity, Temperature, PIR, Carbon Monoxide ✓ Image, Video ✓ Gas, Magnetic ✓ IR, Camera ✓ CDS, Motion, Touch
	Smart Devices	Smart Plug and Smart Meter Provides the power consumption	✓ Smart Plug will provide the exact power consumption amount of an appliance. ✓ Smart Meter will collect the data from smart plug and send it to MC and CPMU.
	Energy Information	✓ MC allows to share energy among the users. ✓ MC will also provide suggestion of using energy for a particular appliance by analysing other user's data.	Advantages: ✓ A total energy information of a smart city will be gotten. ✓ Electrical energy will stand as a currency.
Data Storage and Analysis	*Fog Computing*	Macro Cell (MC)	Macro Cell store the sharing information in a NAN. Fog computing release the central database from huge data load.
	Cloud Computing	Central Database (CD).	✓ CD store the identification of user and ISH. Then it verifies the regular and new user in a smart home. ✓ All Fog store will connect with the cloud.
User friendly Control	*Mobile Application*	Monitor and Control the home.	✓ User can access the home remotely. ✓ Users open the mobile application by using username and password.
	Voice Command	The mobile apps will allow google assistant for voice commanding.	To command the system conveniently when they will at home.
Low-Cost Hardware	*Arduino*	Central Home Unit (CHU) programmed by Arduino processor.	The most researchers proposed Arduino for smart home central unit.

Turn on AC before you reach home so that you get a cool home. Control access to a device like TV, AC, and Wi-Fi, etc. In the evening, outside lamps switching on automatically and switching off at dawn. Just switching on lamps if there is motion, otherwise switching off is also beneficial for energy saving. This automation technique saves our electric bills from 8% to 18%. This switching technique is cost-efficient, design efficient, energy-efficient and this technique is also user-friendly to control our home appliance.

Energy wastes problem also in common our country for the uses of the streetlight. Usually, street light remains on in the morning time due to a manual operation which causes loss of energy and power, this switching is very beneficial for saving power and energy, saving time by automatic control, its help to smart life and low maintenance. Automatic light control and fire alarm enhance our home safety efficiency from unwanted fire; and also, able to remote monitoring. This switching technique is also user-friendly because it can be controlled easily from a small device such as a smartphone, tablet, and laptop, Security efficient by setting a new password in the Bluetooth module instant of a default password. To solve this, it has been used PIC16F877A which is very cheap and available in the marketplace and also used ULN-2003A IC to drive relay instant of relay module it's also cost-effective than use relay module. Overall, entire circuits required for this system have been integrated efficiently with low cost in mind. Arduino Uno based Controlling lamp, fan, and other devices by voice and voice recognition [21]. Home automation and security interface with an Android phone using Bluetooth and GSM [22]. IoT based smart home using Wi-Fi network, internet, and mobile device [23]. IoT based home automation depending on the cellular network and microwave server with IP connectivity [24]. Temperature and smoke detector using TC-351 sensor by GSM module Design remotely home appliance control using GSM module [25]. Arduino-based Home Automation System is designed and prototyped, in this system PWM technique is used to control the DC motor speed [26]. The smart home controlling system using Bluetooth, internet, SMS, and email-based on android phone and Arduino [27]. Remotely electrical appliance controlling, monitoring, or accessing based on android application and microcontroller [28]. Bluetooth based wireless home automation system by using a cell phone [29]. A light controlling system depending on light sensor [2].

There were severe problems faced by smart home system users when there was no alternate switch available as well as few control commands. To solve this problem, a switching technique has been designed in the proposed system to control the home appliance through a weird or wireless connection. Moreover, this switching technique has been designed in such a way that it combines four individual switching stations. For this switching four inputs logic, the EX-OR gate has been used to four ways an individual user can operate as per requirement. The wired connection is

performed by the manual switch and AVR Kit which is usually used to control our home appliance by voice command. People appreciate with wireless lifestyle and used Bluetooth and GSM technology for wireless communication.

2. OVERVIEW OF THE SYSTEM

The fundamental motive of this research is to design a multiuser control smart home appliance by the implementation of logic Ex-OR gate. Home appliance control by android apps, it has much useful application in our practical life, and it also makes our life so accessible by the remote controlling electric device. We use an android app and HC-05 Bluetooth module. To ensure security, set a new password "ISMAIL" instead of the default password "1234" which enhances our smart home security as shown in Fig. 2.

Figure 2. Security Based Password System

Without setting a new password, any unauthorized person can take control of the home appliance. To establish a new password, used putty software and AT command. This android based controlling system gives another option to pre-set time delay by setting this delay option we can set the timing option to on or off an electrical device after a certain period as shown in Fig. 3.
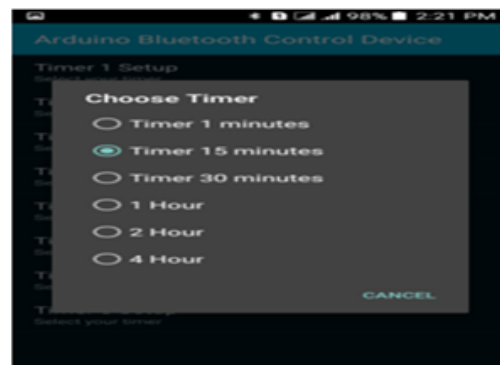

Figure 3. Automatic Switching System Depends on Present Time

Voice-enabled device switching system using the human voice. This VR kit is physically connected with the microcontroller, the VR kit takes its input signal from the microphone, and this voice command sent to the PIC16f877A. After analyzing control, its take decision electrical device turns on or off. There are two investigation are performed, first one is an experiment among people according to their age which is shown in the Table 2 and second one is an

experiment according to the on-off command as shown in Table 3.

Table 2. Output Accuracy According to Their Age

Age	Correct Output	Incorrect Output
15 – 25	97	03
26 – 40	95	05
41 – 60	93	07
60 – 80	90	10
81 and Above	85	15

Table 3. Output Accuracy According to On-Off Command

Device Name	On Command	Off Command
Device 1	Door	X
Device 2	Light	B
Device 3	Fan	K
Device 4	TV	Z

There are many smart homes designed in the previous paper, but they have no mention about physical switching for all who cannot use the smart device or who don't know the turn on/off command or for the emergency case. To include an additional physical switching option, a logic Ex-OR gate has been used by toggling any one of four individual controlling system Android apps, Voice command, manual switching, GSM via SMS system can control our home appliance. Multiuser execution mode shows in Fig .4.
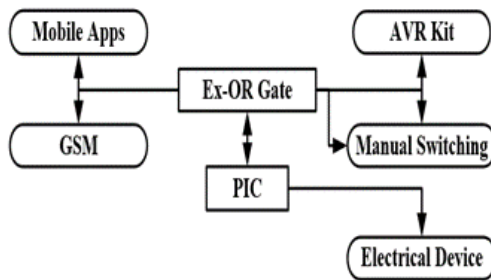
Figure 4. Multiuser Control Mode Device

Another specialty of this project is the PIC microcontroller program build in EEPROM. So that if the electricity cut-off from the electric power station or occurs load shedding, then the electrical device will on automatically or if the electrical device remains off the device remain off by using this EEPROM program the electrical device will on-off as their previous command. To increase the EEPROM space of the PIC16f877A microcontroller we added external EEPROM 4GB external memory. The PIC PIC16f877A has only 256 bytes ROM space and it can Electrical erase able by 1, 25,000 times after over 1,25,000 the device didn't work. By adding this external 4GB memory our project extended its working ability.

Automatic water pump control depends on the water-level. A seven-segment display and a PIC 16f877A microcontroller has been used. Interface with ULN-2003 IC

and Relay. This system saves our water from overflow and ensure the storage of water at all time.

The automatic fire alarm is widespread for home safety. The temperature sensor LM35 senses the temperature if a fire concourse accidentally from the circuit breaker or gash burned. Firstly, its buzzer will be on, and at the same time, it also sends a message to the authorized person or fire station by using a GSM module.

Automatic light control systems using LDR it reduces our electricity waste. A calculation for 100 watts' bulb has been done if this bulb remains on 1or 2 hours per day. By implementing this automatic lighting system, substantial electricity can be saved also. To operate the entire electrical device amplification using this IC, our project will be very cheap. Overall, our plan is a very compact circuit.

3. SOFTWARE DESCRIPTION

PROTEUS, MICRO C, PIC2 and PUTTY software are used in this research project work. Proteus software is used to design and simulation and Micro C software is used to build up the PIC microcontroller program. PIC2 software used to load a building program in hex formats and putty software are used to reconfigure the Bluetooth module specially to change the password and baud rate.

4. PROPOSED HARDWARE EQUIPMENTS DESCRIPTION

A. PIC Microcontroller

The architecture of PIC16F877A is shown in Fig. 5. The PIC Microcontroller is formed by a central processing unit (CPU), Basic utility system (BUS), Input/Output port, Serial communication unit, Timer Unit, Watchdog, Analog to Digital Converter, Oscillator, Program, Basic microcontroller architecture [11].
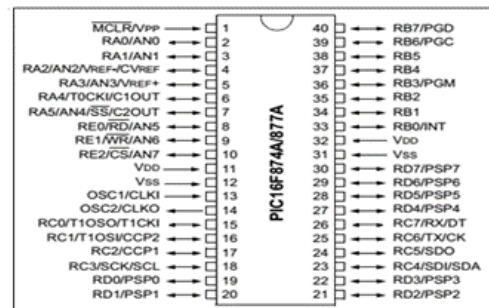
Figure 5. Architecture of PIC16F877A

B. Temperature Sensor

In this system, temperature measuring used the device LM35. This temperature measuring device can measure -55°C to 150°C and its operating voltage is 4V to 30V. When the heat passes from a defined level or critical level,

the process automatically gives a positive pulse to the microcontroller analog input pin then the microcontroller also sent information through the GSM module to the user [11].

C. HC-05-Bluetooth

Bluetooth is a standard feature of a cellular mobile phone. In this system, a Bluetooth module HC-05 has been used for wireless communication. After configuring Bluetooth module, a new password has been set to ensure better security in our home appliance controlling system. The Bluetooth is merely password immune. A Bluetooth device can scan and detect other devices quickly. It can check whether devices are working correctly or not [11].

D. EX-OR Gate

There are many applications of EX-OR gate such as Arithmetic Operations. The EX-OR gate is also called modulo two adders. In this research work, output has been achieved by the combination of an EX-OR input. When two input of an EX-OR gate is high then the output will be low on the other hand if anyone input is low then the output will be low. In our circuit, the EX-OR gate has been used to design a multiuser controlling switching station. By toggling between positive to negative or negative to positive any one input of an EX-OR gate can turn on or turn off any electrical device which is connected across this EX-OR gate output [12].

E. GSM

GSM module is used to wide communication in our mobile communication system. SIM900A GSM module used in this research work, which operated at 900/1800 MHz frequency bands. GSM module communicates through a mobile network with the nearest base station. By sending an SMS, switching of our home appliance device can be selected and GSM module sent a text message if there occurs fire [12].

F. Relay

Relay operated by DC 12 Volts 1 Amp current and relay switches 220 volts, AC Current. By sending an SMS, switching our home appliance device can be chosen and the GSM module sent a text message if there occurs fire [13].

G. ULN2003A 7-Channel Darlington Array

In this research project, a ULN2003A IC has been used instead of using a relay module. The ULN2003A IC is capable to run with high voltage and high current. The output voltage of the microcontroller is 5 volts, and the output current is only 25 mA so a relay cannot run by this voltage and current. The ULN-2003A IC can produce 12 volts and the current rating of the Darlington pair is 500mA [13].

5. EXPERIMENT SET UP

A. Hardware Implementation

The system has wired sensor components to PIC16F877A connected by jumper cables. For GSM, PIC, EX-OR Gate, and Sensors used a 5V DC power supply. Also, used a 12V DC power supply for ULN-2003. A voltage regulator used to control the power of the equipment. When the specified condition is exceeding, relays are used to turn the fan and light. The GSM module is used to remotely switching in our home appliance device by sending a via SMS.

B. Software Implementation

For a software implementation, the Arduino Bluetooth control device used on smartphone. A PIC 16F877A used for measuring the temperature and switching the intelligent home appliance.

6. RESULT AND DISCUSSION

Home appliance control is designed with a wired and wireless connection. The wired connection is performed by the manual switch and AVR Kit which is usually used to control our home appliance by voice command. A manual switch and AVR Kit are both connected to the EX-OR logic gate through the wire. For wireless communication used the Bluetooth module and interface with android apps through laptop/PC, Smart Phone. For more remote control of home appliance used GSM technology where a user has to a sent SMS to control their home appliance. Bluetooth module and GSM module both connected to the two individual PIC16F877A microcontrollers and final output of that microcontroller connected to the EX-OR logic gate. In this research article, a switching technique has been developed by the combination of four individual switching stations. A manual switch, microcontroller output of AVR kit, microcontroller output of android apps which interface with Bluetooth module and the output of microcontroller which used for remotely control by GSM module, all are the output of four individual switching techniques are used as different input of the EX-OR logic gate. The output of the EX-OR logic gate is used to control our home electrical device. The output of the EX-OR logic gate is connected to the relay and the electrical device is also connected to the relay. ULN-2003A IC used to drive relay instant of relay module it's also cost-effective than use relay module.

Two additional functions have also been included in our paper to enhance our home safety and to reduce the loss of electricity. Automatic light control depends on (LDR) brightness of the light; it's also saved our power and works automatically by the comparison of light and dark. Another function is an automatic fire alarm; temperature sensor LM-35 has been used when its sense of fire then sent an SMS. Another GSM module and a PIC microcontroller has also been used. PIC16F877A has been used which is very cheap and available in the marketplace. Overall, a best effort has been made to integrate all circuits with low-cost in mind.
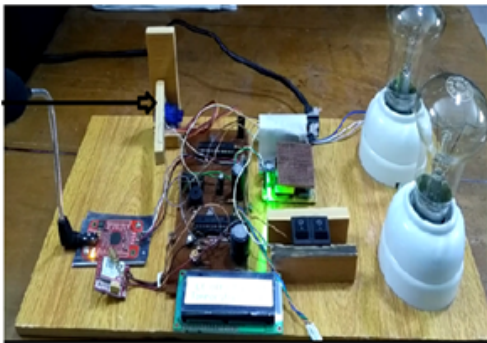
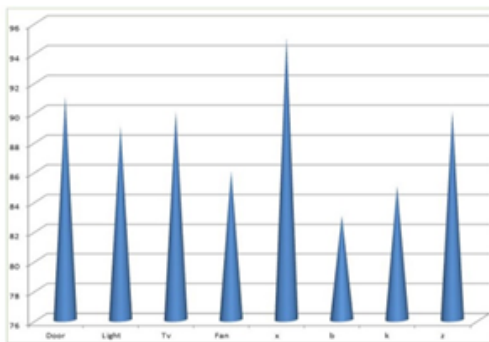**Figure 6.** Interface with AVR Kit

Figure 7. Voice Accuracy Graphical Curve

A voice control option has been added so that the physically disabled person can control all the home appliance devices. In this Research Project, an Android apps has been developed especially for those who are smart people. Voice command by VR kit especially for handless people.

Figure 8. Proposed Solution

Manually switching to everyone or emergency case who cannot use a smartphone or don't know the device controlling command. The last essential features are the GSM module by sending an SMS we can control our home appliance from any place through cellular communication. Fig. 7 Shows voice accuracy graphical curve where Fig. 8 shows the overall experimental set up. In the below, added a picture of the Architecture of the proposed solution in Fig. 9.

For making most comfortable our practical life, a manual switching device has been used. By using this manual option, a home appliance to be controlled for which a per-
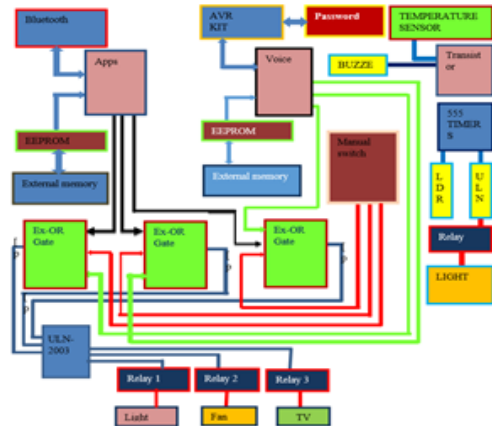

Figure 9. The Architecture of the Proposed Solution

son cannot use smartphone apps or the person who cannot talk. An automatic on/off depends on the user's pre-fixed temperature from an external keypad, this process saves our electricity and enhance our flexibility especially this option more uses for controlling air-condition (AC).

Automatic light control depends on (LDR) brightness of the light; it's also saved our electricity and makes some work automatically. An automatic fire alarm and SMS sender has been added by using a GSM module. PIC16F877A has been used which is very cheap and available in the marketplace.

In Table 4 show the comparison with our project work and existing project works. In table 5 shows the total cost analysis of our proposed system.

Table 4. Comparison of this Project with Recent Work

Ref. No	Manual Switching (Who can't use Smart Phone)	Physical Disable Person (AVR KIT)	Bluetooth Password Protection (Smart People)	Program Set in EEPROM	GSM	Automatic Light Control	Fire Alarm System and sending message Through GSM Module	Continuous Operation of System
[1]		✓	✓					Not possible
[3]		✓			✓		✓	Not possible
[4]			✓					Not possible
[5]			✓	✓	✓			Not possible
[6]			✓			✓		Not possible
[7]			✓			✓		Not possible
[8]		✓		✓				Not possible
[9]		✓						Not possible
This project	✓	✓	✓	✓	✓	✓	✓	Possible

7. CONCLUSION AND SCOPE FOR FUTURE WORK

Security cameras using in this framework will help to get an alert, and if there is movement sensed at our front door, the video recording will start or taking a snapshot at any

Table 5. Cost Analysis of the Proposed System

S. L.	Equipments Name	Quantity	Amount (BDT)	Total (BDT)
1.	Transformer -220V	1	150	150
2.	Rectifier Bridge IC	1	15	15
3.	Capacitor	5	5	25
4.	Voltage Regulator	2	10	20
5	Heat Sink	2	15	30
6.	PIC-16f877A	2	180	360
7.	LED	10	1	10
8.	Resistor	20	.25	05
9.	Ex-OR Gate	2	25	50
10.	ULN-2003A IC	1	25	25
11.	Relay	6	20	120
12.	Switch	6	10	60
13.	Crystal oscillator	2	10	20
14.	IC-Based	4	5	20
15.	Bluetooth Module	2	300	600
16.	Thermistor	1	50	50
17.	Variable Resistance	3	10	30
18.	Buzzer	2	10	20
19.	LDR	3	10	30
20.	555-timer	2	10	20
	Total cost	In BDT		1640/-
		In USD		$19.75

time, and the person knocking the door can be seen. This application may further use for hotel management in case of controlling devices automatically without memorizing manually controlling all fans and lights. It has been set all equipments with particular symbols on a smartphone via a smartphone app. The security door lock system may further improve by using unique entry codes for everyone in the house or may use more feathers in the front door.

REFERENCES

[1] V. D. Vaidya and P. Vishwakarma, "A comparative analysis on smart home system to control, monitor and secure home, based on technologies like GSM," in *2018 International Conference on Smart City and Emerging Technology (ICSCET)*, Mumbai, 2018, pp. 1–4. DOI: 10.1109/ICSCET.2018.8537381.

[2] M. R. Ahmed, M. O. Rahman, and M. J. Hoque, "Smart home: An empirical analysis of communication technological challenges," *EJERS, European Journal of Engineering Research and Science*, vol. 5, no. ue 5, pp. 571–575, 2020, DOI: DOI: 10.24018/ejers.2020.5.5.1905.

[3] S. Rehman and V. Gruhn, "An approach to secure smart homes in cyber-physical systems/internet-of-things," in *2018 Fifth International Conference on Software Defined Systems (SDS)*, Barcelona, 2018, pp. 126–129. DOI: 10.1109/SDS.2018.8370433.

[4] B. R. Stojkoska and K. Trivodaliev, "Enabling internet of things for smart homes through fog computing," in *25th Telecommunication Forum (TELFOR)*, Belgrade, 2017, pp. 1–4. DOI: 10.1109/TELFOR.2017.8249316.

[5] M. Kuzlu, M. Pipattanasomporn, and S. Rahman, "Review of communication technologies for smart homes/building applications," in *2015 IEEE Innovative Smart Grid Technologies - Asia (ISGT ASIA)*, Bangkok, 2015, pp. 1–6. DOI: 10.1109/ISGT-Asia.2015.7437036.

[6] M. Adipradhana, I. G. B. B. Nugraha, and S. H. Supangkat, "Intervention of non-inhabitant activities detection in smart home environment," in *International Conference on ICT for Smart Society*, Jakarta, 2013, pp. 1–5. DOI: 10.1109/ICTSS.2013.6588116.

[7] T. Perumal, Y. L. Chui, M. A. B. Ahmadon, and S. Yamaguchi, "IoT based activity recognition among smart home residents," in *2017 IEEE 6th Global Conference on Consumer Electronics (GCCE)*, Nagoya, 2017, pp. 1–2. DOI: 10.1109/GCCE.2017.8229478.

[8] I. Jawhar, N. Mohamed, and J. Al-Jaroodi, "Networking and communication for smart city systems," in *2017 IEEE SmartWorld, Ubiquitous Intelligence & Computing, Advanced & Trusted Computed, Scalable Computing & Communications, Cloud & Big Data Computing, Internet of People and Smart City Innovation (SmartWorld / SCALCOM / UIC / ATC / CBDCom / IOP / SCI)*, San Francisco, CA, 2017, pp. 1–7. DOI: 10.1109/UIC-ATC.2017.8397563.

[9] D. Dobrilović, "Networking technologies for smart cities: An overview," *Interdisciplinary Description of Complex Systems - scientific journal, Croatian Interdisciplinary Society Provider Homepage*, vol. 16, no. 3-A, pp. 408–416, 2018. [Online]. Available: http://indecs.eu.

[10] I. Parvez, A. Sundararajan, and A. I. Sarwat, "Frequency band for HAN and NAN communication in smart grid," in *2014 IEEE Symposium on Computational Intelligence Applications in Smart Grid (CIASG)*, Orlando, FL, 2014, pp. 1–5. DOI: 10.1109/CIASG.2014.7011571.

[11] T. Adiono, S. Harimurti, B. A. Manangkalangi, and W. Adijarto, "Design of smart home mobile application with high security and automatic features," in *3rd International Conference on Intelligent Green Building and Smart Grid (IGBSG)*, Yi-Lan, 2018, pp. 1–4. DOI: 10.1109/IGBSG.2018.8393574.

[12] H. Wei-Dong and Z. Bo-Xuan, "Smart home wireless system using ZigBee and IEEE802.15.4," in *2016 Sixth International Conference on Instrumentation & Measurement, Computer, Communication and Control (IMCCC)*, Harbin, 2016, pp. 858–863. DOI: 10.1109/IMCCC.2016.168.

[13] J. Zhu, X. Jia, and X. Q. Mei, "Smart home control system based on internet of things," in *Sensors, Measurement, Intelligent Materials and Technologies III, ser. Applied Mechanics and Materials*, vol. 738, Trans Tech Publications Ltd, 2015, pp. 233–237.

[14] T. Malche and P. Maheshwary, "Internet of things (IoT) for building smart home system," in *International Conference on IoT in Social, Mobile, Analytics and Cloud (I-SMAC)*, Palladam, 2017, pp. 65–70. DOI: 10.1109/I-SMAC.2017.8058258.

[15] V. Govindraj, M. Sathiyanarayanan, and B. Abubakar, "Customary homes to smart homes using internet of things (IoT) and mobile application," in *International Conference on Smart Technologies For Smart Nation (SmartTechCon)*, Bangalore, 2017, pp. 1059–1063. DOI: 10.1109/SmartTechCon.2017.8358532.

[16] J. Y. Kim, H. Lee, J. Son, and J. Park, "Smart home web of objects-based IoT management model and methods for home data mining," in *17th Asia-Pacific Network Operations and Management Symposium (APNOMS)*, Busan, 2015, pp. 327–331. DOI: 10.1109/APNOMS.2015.7275448.

[17] M. S. Hoosain and B. S. Paul, "Smart homes: A domestic demand response and demand side energy management system for future smart grids," in *2017 International Conference on the Domestic Use of Energy (DUE)*, Cape Town, 2017, pp. 285–291. DOI: 10.23919/DUE.2017.7931852.

[18] S. Kumar and S. R. Lee, "Android based smart home system with control via bluetooth and internet connectivity," in *The 18th IEEE International Symposium on Consumer Electronics (ISCE 2014)*, JeJu Island, 2014, pp. 1–2. DOI: 10.1109/ISCE.2014.6884302.

[19] A. A. Arriany and M. S. Musbah, "Applying voice recognition technology for smart home networks," in *2016 International Conference on Engineering & MIS (ICEMIS)*, Agadir, 2016, pp. 1–6. DOI: 10.1109/ICEMIS.2016.7745292.

[20] J. Waleed, A. M. Abduldaim, T. M. Hasan, and Q. S. Mohaisin, "Smart home as a new trend, a simplicity led to revolution," in *2018 1st International Scientific Conference of Engineering Sciences - 3rd Scientific Conference of Engineering Science (ISCES)*, Diyala, 2018, pp. 30–33. DOI: 10.1109/ISCES.2018.8340523.

[21] N. Hassan, M. R. M. Rejab, and N. H. Sapar, "Implementation of the speech recognition home control system using arduino," *Journal of Engineering and Applied Sciences*, vol. 10, no. 23, pp. 17492–17498, 2015.

[22] S. R. Khan and F. S. Dristy, *Android-based security and home automation system*, 2015.

[23] F. K. Santoso and N. C. H. Vun, "Securing IoT for smart home system," in *2015 International Symposium on Consumer Electronics (ISCE)*, Madrid, 2015, pp. 1–2. DOI: 10.1109/ISCE.2015.7177843.

[24] R. Piyare and S. R. Lee, "Smart home-control and monitoring system using smart phone," *ICCA, ASTL*, vol. 24, pp. 83–86, 2013.

[25] M. D. Albakhait, M. S. Hasan, and A. A. Hajer, "Bluetooth based smart home automation system using arduino uno microcontroller," *Journal of Engineering and Applied Sciences*, vol. 14, pp. 6352–6357, 2019.

[26] M. A. E.-L. Mowad, A. Fathy, and A. Hafez, "Smart home automated control system using android application and microcontroller," *International Journal of Scientific & Engineering Research*, vol. 5, no. 5, pp. 935–939, 2014.

[27] S. Kumar and S. R. Lee, "Android based smart home system with control via bluetooth and internet connectivity," in *The 18th IEEE International Symposium on Consumer Electronics (ISCE 2014)*, JeJu Island, 2014, pp. 1–2. DOI: 10.1109/ISCE.2014.6884302.

[28] R. Piyare and M. Tazil, "Bluetooth based home automation system using cell phone," in *2011 IEEE 15th International Symposium on Consumer Electronics (ISCE)*, Singapore, 2011, pp. 192–195. DOI: 10.1109/ISCE.2011.5973811.

[29] K. S. Sudhakar, "Automatic street light control system," *International Journal of Emerging Technology and Advanced Engineering*, vol. 3, no. 5, pp. 188–189, 2013.