Computing, Information Systems, Development Informatics & Allied Research Journal
Vol. 9 No. 1, March, 2018 - www.cisdijournal.org

Phone Call Based Home Automation System

Odirichukwu J. C.[1], Emezi T. C.[2], Joseph .P.[3], Okereke .C.[4], Eze I. F.[5]
Department of Computer science, Federal University of Technology Owerri, Nigeria[1]
Department of Computer Science, Imo Polytechnic Umuagwo, Imo State, Nigeria[2]
JACO Innovation Hub-A subsidiary of JACOWALT CONCEPT LIMITED[3]
Managing Director and co-owner of Aspire Digital and Embedded Technologies (www.adet.com.ng)
Department of Computer Science, Imo Polytechnic Umuagwo, Imo State, Nigeria

ABSTRACT

Home automation is the processing of embedding Intelligence in electronic systems. This previous system has worked on the automation of home appliances using different technologies which has been described in the literature review. The aim of this paper is to show how home appliances could be automated and controlled with any type of Mobile phone and how this has been efficiently programmed using an innovative and easy to code language know as embedded BASIC. The home automation system is built around the dual tone multi frequency (DTMF) technology. The input signal generated at the user's phone is converted into frequency and sent across. The system receives the data and converts the data into a stream of four digit binary codes which are directly sent to Atmega32 microcontroller. The microcontroller processes the data and takes logical decisions which directly control the switching operation of the electromechanical relays driving the electrical loads in the home. The system is such that pressing 2 enables the system to switch load A while pressing 4 would ensure the switching of load B and so on.

Keywords: Home Automation System, Dual-Tone Multi Frequency (DTMF), Phone Monitoring system

CISDI Journal Reference Format
Odirichukwu J. C., Emezi T. C., Joseph .P, Okereke .C, & Eze I. F.(2018): Phone Call Based Home Automation System. Computing, Information Systems, Development Informatics & Allied Research Journal. Vol 8 No 1. Pp 76-84. Available online at www.cisdijournal.org

1. INTRODUCTION

The life cycle of modern man is evolved in such a manner that without multitasking he will lag behind the rest of the society by light ages. So, to make life of the users more comfortable, easier and faster we shall be developing the HAS system for controlling home appliances. Home automation refers to the use of computer to control home appliances. Systems can range from simple remote control of lighting through to complex computer/microcontroller-based networks with varying degrees of intelligence and automation. Home automation is adopted for reasons of ease, security and energy efficiency (Anushri, et al, 2015).

Home automation has made it possible to have what is often referred to as a' Smart home', a home that can detect and identify you, automatically adjust the lighting to your predefined taste, open doors automatically, play your favourite music, water your flowers in the morning, switch on the security lights at night and switch them off in the morning, heat water for bathe and tea, stream to you anywhere in the world via the internet a live video of what is happening in and around your house. It makes it possible to link lighting, entertainment, security, telecommunications, heating, and air conditioning into one centrally controlled system. This allows you to make your house an active partner in managing your busy life (Olufusi, 2009). In modern construction in industrialized nations, most homes have been wired for electrical power, telephones, TV outlets (cable or antenna), and a doorbell. Many household tasks were automated by the development of specialized automated appliances. For instance, automatic washing machines were developed to reduce the manual labour of cleaning clothes, and water heaters reduced the labour necessary for bathing. Home automation can also provide a remote interface to home appliances or the automation system itself, to provide control and monitoring on Smart phone efficiency (Anushri et al, 2015).

2. LITERATURE REVIEW

2.1 Home Automation System

A common definition of Home Automation is of an “electronic networking technology to integrate devices and appliances so that the entire home can be monitored and controlled centrally as a single machine” (Pragnell et al., 2000). However, the possible solutions are devised through various network technologies. Several issues affecting home automation systems such as lack of robustness, compatibility issue and acceptability among the old and disabled people are discussed (Olufusi, 2009).

2.2 Bluetooth- based Home Automation System

(Sriskanthan et al., 2002) shows the implementation of a home automation system using Bluetooth. They use a host controller implemented on a PC, which is connected to a microcontroller-based sensor and device controllers. The researchers even built a new protocol on top of the Bluetooth software stack, called Home Automation Protocol (HAP), to make the communication between devices possible. The device controller is connected to electronic devices through the I2C Bus. The system allows more than one device controller to be connected to the host controller. (Kanma et al, 2003) also developed a home automation system using Bluetooth that can be accessed remotely through GPRS. The researchers use a cellphone equipped with Bluetooth connectivity as a host controller and a GSM modem that provides Internet connectivity. Home devices are fitted with Bluetooth communication adapters so that they can communicate with the host controller phone via Bluetooth. The paper discusses remotely controlling and updating home devices along with fault diagnostics and detection. The work also talks about providing an electronics user manual on the phone using Bluetooth and Internet.

Some issues with this technology includes its maximum communication range of 100m in ideal conditions. More may be needed in a home environment. Bluetooth communication has comparatively high-power consumption, so the batteries of devices need to be frequently recharged or replaced. Bluetooth technology has advanced and improved to Bluetooth Low Energy (BTLE), which provides the same range of communication. However, it has serious security concerns such as eavesdropping and weak encryption as discussed by (M. Ryan). Bluetooth looks like an attractive communication technology for creating smart homes. It is cheap, easy, and quick to set up. People are already familiar with the technology. The hardware required for establishing Bluetooth communication is readily available. And technology also provides the necessary bandwidth for the operation in a home. But they also have serious flaws, as discussed above.

2.3 GSM Mobile-based Home Automation System

Mobile-based home automation is attractive to researchers because of the popularity of mobile phones and GSM technology. We mainly consider three options for communication in GSM, namely SMS-based home automation, GPRS-based home automation, and Dual Tone Multi Frequency (DTMF)-based home automation. Each of these three technologies is discussed below, along with their shortcomings. (Chen and Jiang, 2008) describe a remote monitoring system based on SMS of GSM. The system includes two parts which are the monitoring centre and the remote monitoring station. The monitoring centre consists of a computer and a TC35 GSM communication module. The computer and TC35 are connected by RS232. The remote monitoring station includes a TC35 GSM communication module, a MSP430F149 MCU, a display unit, various sensors, data gathering and processing unit.

(Scanaill et al., 2006) developed a Tele-monitoring system, based on short message service (SMS), to remotely monitor the long-term mobility levels of elderly people in their natural environment. Mobility is measured by an accelerometer-based portable unit, worn by each monitored subject. The portable unit houses the Analogue Devices ADuC812S microcontroller board, Falcon A2D-1 GSM modem, and a battery-based power supply. Two integrated accelerometers are connected to the portable unit through the analogue inputs of the microcontroller. Mobility level summaries are transmitted hourly, as an SMS message, directly from the portable unit to a remote server for long-term analysis. Each subject's mobility levels are monitored using custom-designed mobility alert software, and the appropriate medical personnel are alerted by SMS if the subject's mobility levels decrease.

The figure below is from the work of (Alheraish, 2004). It shows the logical diagram of how a home's sensors, electrical, and mechanical devices interact with the home network and communicates through the GSM module using a Subscriber Identity Module (SIM). The system converts the machine functions into electrical signals through a transducer, which goes into a microcontroller. A transducer converts physical quantities like sound, temperature, and humidity into some other quantity like voltage; here, a sensor does that function. For electronic devices, their reading goes directly into the microcontroller. The microcontroller analyses these signals and converts them into commands that can be understood by the GSM module. Based on the received commands, the GSM module selects the appropriate communication method (SMS, GPRS or DTMF).

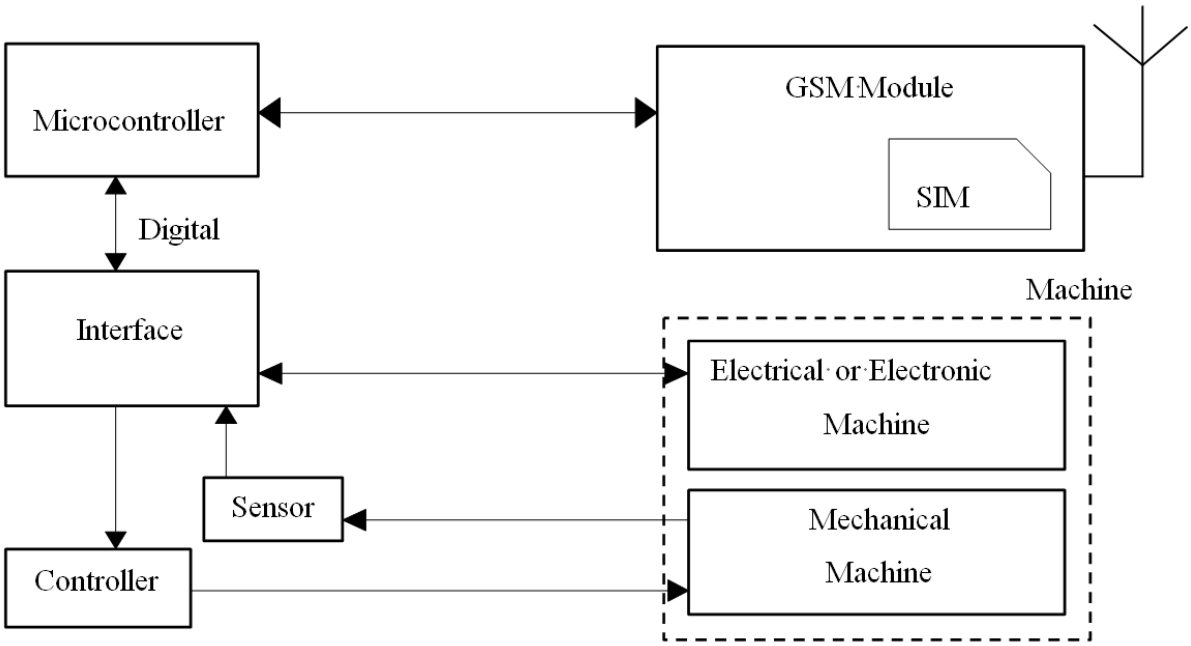

Fig.2: Mobile-based home automation from the work of (Alherash, 2004) 2004)

2.4 SMS-based Home Automation System

The work of (Alheraish, 2004) proposes a home automation system using SMS. The proposed system detects illegal intrusions at home and allows legitimate users to change the passkey for the door and control lights in the home. The illegal intrusion into the home is identified by monitoring the state of the home door, which is done using Light Emitting Diode (LED) and infrared sensors. The passkey to the door can be any 4 digits, which can be set either by using the keypad or by using SMS from a registered user's mobile number. A user can control the lights in their home remotely using SMS from their registered mobile number; by turning the lights on in different rooms at random intervals of time, one can give the impression that the home is occupied, even when it is not.

The work of (Khiyal et al., 2009*)* proposes an SMS-based home security system called SMS-based Wireless Home Appliance Control System (HACS). In their work, a homeowner can control their home using SMS messages from a preset registered mobile number. If the SMS is not from a legitimate mobile number, the system ignores the message. In the case of an intrusion, the appliance control subsystem and security subsystem in the proposed system informs the owner through SMS.

The work of (Saeed *et al*, 2010*),* also proposes an SMS-based home automation system. The system has a Java application running on the phone. Legitimate users can log in to the application using their username and password, and can select the building/floor/room/device that they wish to remotely control along with an appropriate action from the list of available user actions. The Java application will compose the appropriate SMS message and send it to the home's GSM modem. The GSM modem will receive the SMS message, decode it, and pass it to the home network to perform the action specified.

2.5 GPRS-based Home Automation System

There are a lot of home security systems implemented using GPRS. Most systems use the word security in the traditional sense, and only address the threat put forth by old fashioned intruders in home. (Danaher and Nguyen, 2002) propose a home security system using GPRS. The work uses a webcam to stream video and pictures of the home to its owner's mobile through GPRS. The webcam detects movement by comparing frames for differences, including light intensity. Video streaming in the proposed work is done using the home Internet connection, not the GSM modem.

(Wu *et al. 2007),* describes video camera surveillance using the GPRS facility in mobile phones. The camera is triggered when an intrusion is detected or the door bell is rung. The system identifies intrusions with an infrared sensor. In the case of a doorbell, the system calls the homeowner and establishes voice communication with a live video feed between the visitor and the homeowner. When an intrusion is detected, an email is sent to the user along with a picture, most likely of the intruder. Upon receiving this email the user can start monitoring the video feed on his phone.

(Ali *et al. 2004),* proposes another home and office automation system using GPRS in mobile phones. The user interacts with the home via a client/server architecture implemented at home using a PC and a micro Java application. Home devices are controlled by a device controller, which is connected to the PC's parallel port. The proposed system allows users to remotely control and inquire the status of the devices that are connected to the device controller.

2.6 DTMF-based Home Automation System

(Muhury and Habib, 2010) describes the design and implementation of a DTMF-based home automation system. The user calls a SIM number assigned to the home and presses the digits on their phone's keypad to control the home's devices by generating a DTMF tone. The tone is received and decoded by the GSM module at home using a DTMF decoder. The decoded instructions are passed to the microcontroller so that user commands can be implemented at home.

2.7 Internet-based Home Automation System

Internet or IP protocol-based communication in home automation systems is always a popular choice among researchers. The Internet is easily scalable, flexible when it comes to access and use, and very popular as a communication method in today's world, so the hardware and the network required for access is readily available, offers high bandwidth and very low communication cost, and devices can connect to and disconnect from the network easily. These are some of the features that make the Internet such an attractive choice for researchers. Utilizing the Internet as a means to access and control the home seems to be the next logical step forward for home automation systems (Jose and Reza, 2015).

From an end user's point of view, using Internet to access their home is easy, convenient, cheap, flexible, and offers no complication of an added technology to learn. User interface devices like laptops, smart phones, PCs, and tablets are easily available in the market, and these devices are already a part of people's daily lives. So, incorporating home automation into these already-popular user devices seems to be the natural progression (Jose and Reza, 2015).

(Musheng et al., 2008) developed application on remote monitoring system of reservoir based on GPRS. GPRS data terminal hardware includes the intelligent processing module, remote communication module, serial interface module and display module. Intelligent processing module contains two chips AT89C55 microcontroller and serial E2PROM X25045. AT89C55 is used to transmit data between remote communication module, A/D conversion module and display module. To ensure that data will not be lost because of power outages, serial E2PROM X25045 devices is adopted for data storage. Remote communication module includes GPRS wireless module, SIM card and serial module MAX3238. Database mainly stores various parameters of the flood accommodation procedures for the user and reservoir historical hydrological data, such as electric power generated, relation curve of water level flows, the water storage capacity curve, and discharge curve, unit's efficiency curve of different conditions, historical flood data and flood information.

The proposed system doesn't allow homeowners to access their home remotely from their mobile device. They can only control home devices through the RF remote. RF remote used here has very limited range to be successful in a home environment. Furthermore, the proposed system only allows 15 devices to be connected to the home network.

Home Router: A home automation system is connected to the Internet using a home's router. This allows the home's inhabitants to access their home from anywhere with the right credentials. Some issues with the home router are:

- When choosing a wireless router for the home, an average homeowner considers factors like the speed of the connection, range offered for communication, and cost. Usually, security is not the main concern. Moreover, most homeowners lack the technical expertise to configure their routers properly.
- Most routers don't provide software updates. Finding and fixing the security issues in the router causes the manufacturing cost to go up, so manufacturers lose their competitive edge in the market. Security is not a manufacturer's primary concern.
- The average homeowner is happy with an old router with security issues as long as it is doing the job. He is either unaware of the security issue or doesn't care about the security flaws, thinking "who is going to hack me?"

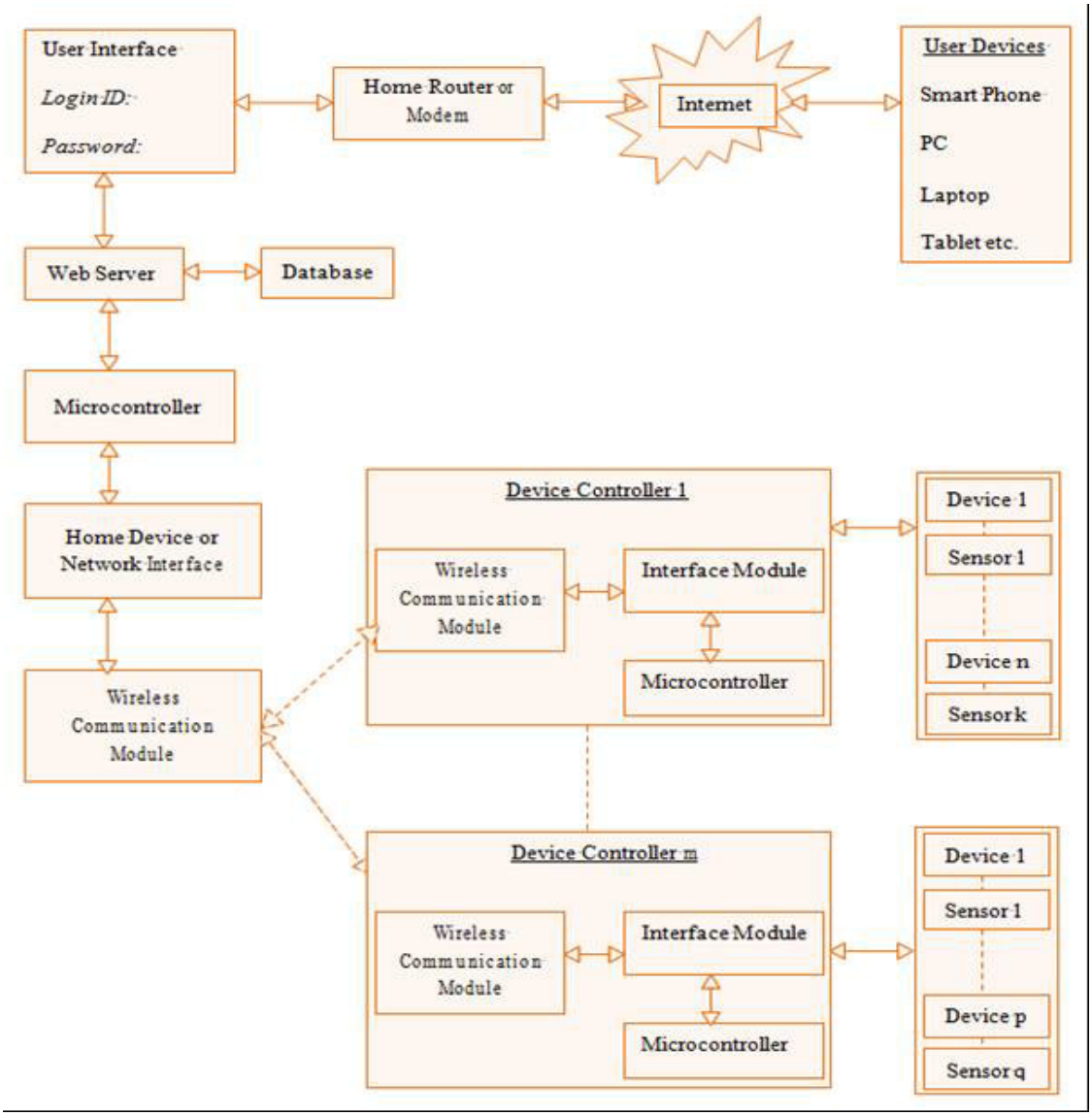

Fig .3: An internet -based home automation system

Internet: A home inhabitant can access and control his or her home from anywhere in the world if the home automation system is connected to the Internet. It has advantages, as we discussed earlier, but connecting the home to the Internet opens it up to the world, i.e. anyone with an Internet connection can try to access the home.

End User and their Portable Devices: Advancements in electronics, processing power, and a considerable reduction in size and cost allows people to own and frequently use mobile portable devices for accessing the Internet. So people use smart phones, laptops, and tablets to access their homes via the Internet. This allows a flexible and convenient way for home inhabitants to access their home on the go. They use the same device to access other applications and do their daily tasks like browsing, playing games, installing apps, and watching movies with the Internet.

2.8 Radio Frequency Identification (RFID)

Home automation systems discussed so far use a central controller or centralized approach, which has a single point of failure. In this section, we discuss another approach. (Gauger, *et al.),* Proposes a decentralized approach to home automation control. They implement the decentralized approach by integrating actuators into the WSN of the home. The authors propose a distributed control or process architecture. The information from the sensors are received and processed by one or more control nodes, which

in turn initiates the appropriate actuators to change or control the environment as previously specified by the user. The system thus eliminates the need for a central controller. The decentralized approach to home automation is an interesting concept, but it requires a lot of work from the research community to be efficiently and securely implemented in a home environment. In addition to this, the actuators discussed here require a significant increase in processing power and storage for it to be effective in a decentralized architecture.

2.9 Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) describes a system that transmits the identity of an object wirelessly using radio waves (Want, 2006). It defines a RFID tag holding information about the object carrying the tag and a RFID reader. The RFID tag transmits signals containing its data when it is scanned by the reader. The RFID tag can be either active or passive where an active tag contains a battery and the passive tag does not have a battery.
The passive tag uses the reader's magnetic field and converts it to DC voltage to power up its circuitry. Consequently, the passive tags are cheaper and have lower range when compared to active tags.

RFID systems can be categorized based on the used frequency ranges. The Low-Frequency (LF) systems use signals with a frequency between 124-135 KHz. The High-Frequency (HF) systems use a 13.56MHz and the Ultra-High-Frequency (UHF) systems use a frequency between 860-960MHz. In general, the LF RFID systems have short reading ranges and lower system costs. In case longer reading range is required, HF RFID systems can be used however their cost is higher.

RFID systems can be used in smart homes where every single object can be connected to the Home Area Network (HAN) through a virtual wireless address and unique identifier (Darianian and Michael, 2008). This can be used to keep an updated database holding information about objects' locations. Accordingly, the smart home can be asked to provide information about a specific object that you are looking for such as your car's key or your remote control. Furthermore, RFID system can be used to track smart home occupants, where a number of studies have been reported in the literature that use RFID concept to track smart home occupants (Yamazaki, 2007). By the attachment of a RFID tag to each smart home user and the deployment of RFID readers at different places in the home, the location of each user can be identified. This information can be used to adapt services in the smart home based on each user preferences.

One of the problems of using RFID tags to track people in smart homes is that the readability of RFID tags is difficult near water or a sheet of metal. The human body consists primarily of liquid which makes it difficult to scan a RFID tag attached to human body (Juels, 2006). However, researchers are looking for new ways to improve the readability of RFID tags in these difficult environments.

2.10 Smart Home Today

The Oxford Dictionary defines "smart" as both "stylish and fresh in appearance, having a quick intelligence", and "being fashionable and up market". Sony was among the first companies to attach the "smart" buzzword to a computer when, in 1982, it marketed the "Smart Sony" computer: no longer advertised simply as a "home" computer, but tried to cash in on the smart concept by selling it as a device which could "help you make smarter business decisions" (Heckman, 2008). The "smart" concept has become since a marketing catchword, still employed today, to sell a wide range of products, hence: "smart phones", "smart cameras", "smart design", "smart bombs" and "smart homes". Usually, the word define devices that are reportedly based on cutting-edge design that unite innovation with practical simplicity, However, as this would soon be demonstrated, sometimes marketing buzzwords alone cannot guarantee the sell. Xanadu was the first example of a mass-produced Smart Home. Built throughout the 1980s in the US around the original EPCOT idea, these houses were commercially built dwellings that made extensive use of Smart Home technologies. To look even more futuristic, the actual house was made entirely of polyurethane foam. The Xanadu home had a computer that monitored and controlled all its systems: the kitchen, living room, bathrooms, and bedrooms all had their own electrical and electronic devices to control the appliances present in the house. For example, the shower could be set to be turned on at a specific time and a set temperature. The ad campaign eloquently described the house as "Xanadu: the Computerized House of Tomorrow" and its peculiar appeal was set by the advertisement campaign: a "house with a brain – a house you can talk to, a house where every room adjusts automatically to match your changing moods" (Heckman, 2008).

3. MATERIALS AND METHODS

3.1 The Proposed System

Dual-Tone Multi-Frequency (DTMF) signaling is used for telephone signaling over the line in the voice-Frequency band to the call switching center. These are the tones you hear when you dial a touch tone phone. The DTMF tone is a form of one-way communication between the dialer and the telephone exchange. A complete communication consists of the tone generator and the tone decoder. In this system, Atmega32 was interfaced with 8870 decoder, the main component to decode the input dial tone to 5 digital outputs. These digital bits can be interface to a microcontroller for further application.The home automation system is

built around the dual tone multi frequency (DTMF) technology. The input signal generated at the user's phone is converted into frequency and sent across. The system receives the data and converts the data into a stream of four digit binary codes which are directly sent to Atmega32 microcontroller. The microcontroller processes the data and takes logical decisions which directly control the switching operation of the electromechanical relays driving the electrical loads in the home. The system is such that pressing 2 enables the system to switch load A while pressing 4 would ensure the switching of load B and so on.

3.1 High Level Model of the proposed System

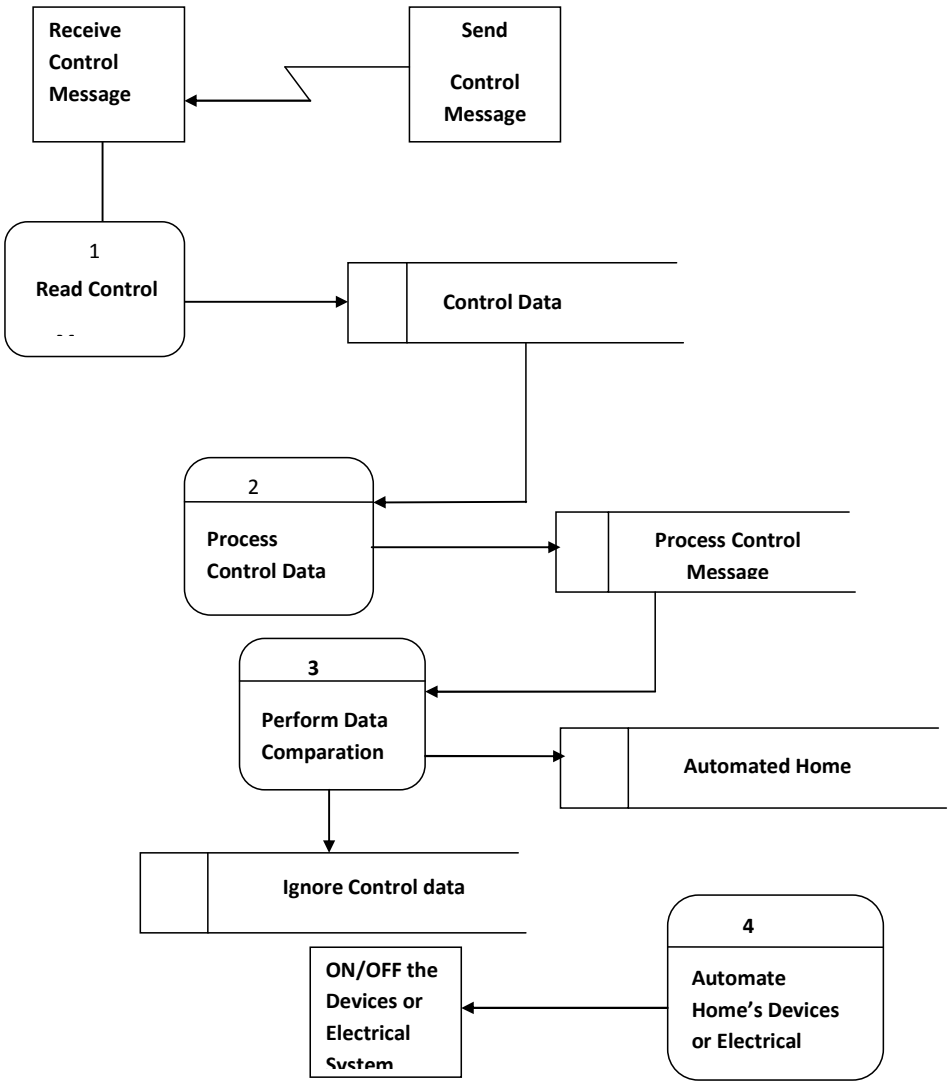

Fig 2.0: Data Flow Diagram of the Proposed System

3.2 Benefits of the Proposed System

- **Appliance Safety and Lighting Control:** Through automation, you get the ability to control appliances in your home from any location by sending short SMS. You control the lighting too. This allows you to ensure that the lights and appliances are turned off when you are not home, to save on electricity. You can also turn on the lights at specific times to make it look like you are home, thus increasing the safety of your home.
- **Saves Time:** life has become really busy these days and various household chores keep you on your toes. Imagine running back home for a few minutes just to adjust some household item or opening the door for your kids after their school ends. This system would help you manage all without having you to go home.

- **Convenience and Cost Efficiency:** This System would let you control electrical appliances making sure that they are not wasting power when not in use. It gives you the convenience to control different devices even when you are not home. This helps in reducing electric costs and helps you save money
- **Contributes to Economy:** By install this system, you use energy efficiently. This would help in contributing to the economy by utilizing only those resources that you need.
- **Allow you to be worry-free:** you don't have to obsessively worry about minute things at home as you can keep a constant check on the house, irrespective of where you are.
- **Give You Control Even When You Are out of Town:** forget about leaving the key with your neighbour when you leave town. With this particular system, you can schedule a time for them to enter your house to perform chores such a watering plants feeding pets, or you can let them in and out through your mobile phone. This will relieve you from the worry of someone having an unrestrained access to your belongings or them losing your keys. You can also make sure that the chores are being completed as requested.
- **Let's you keep a check on your children:** The safety of children is the most important thing for any parent. This proposed system can help you to keep them safe by keeping tabs on them even when you aren't home. You can open the doors, and keep the porch lit when they get back home in your absence. You can monitor when they come and go, through security cameras.

3.3 Language Justification

The System was developed using Embedded BASIC programming Language. The program written in embedded BASIC has to be converted to a form which can be executed by the Atmega32 microcontroller. The system needs a hex file which is generated after compiling the program written in embedded BASIC. This program (called hex-file) is subsequently embedded into the microcontroller to ensure that all the definitions in the embedded BASIC code are actually implemented by the microcontroller.

4. RESULT AND DISCUSSION

The Proposed System (Mobile Based Home Automation System) is very practical. It is demonstrated with the interfacing of three socket with relay. The circuitry contained Amega32 microcontroller, 8870 DMTF decoder, three relay of 12volt, 30amps and other electronics components. This system is designed for controlling the devices; it includes a cell phone which is connecting to the system via head set. To active the cellular phone part of the system a call is to be made and as the call is answered, in response the user would enter a three/four digit to access the system to control devices. As the caller press the specific digit, it results in turning ON or OFF specific device.

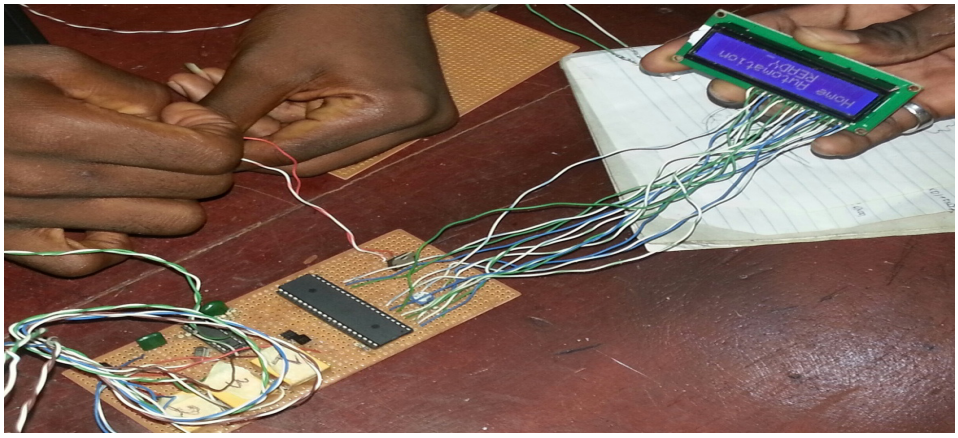

Fig.4.1: The Mobile Based Home Automation System

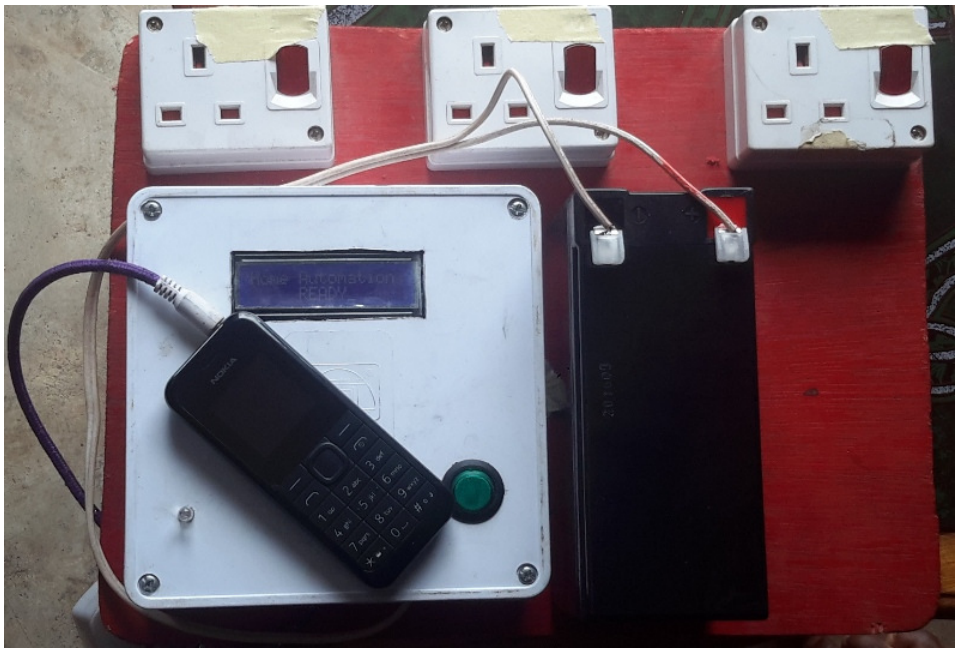

Figure 4.2 The Result

This system has proven that home appliance could be controlled using any type of mobile phone not necessary android phone at a very long distance even across the country. The work was developed using atmega32 microcontroller interface with 8870 DTMF decode. The system was programmed using an innovative and very easy programming Language know as embedded BAISC programming.

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