



WEB BASED HOME AUTOMATION SYSTEM **USING ARDUINO**

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Submitted in partial fulfilment of the requirement for the degree of

Bachelor of Science Honours in Telecommunications

Department of Applied Physics and Telecommunications in the

Faculty of Science and Technology at the

GWERU

AUGUST, 2016

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Abstract

The aim of home automation is to control home devices from a central control point. In this paper, I present the design and implementation of a low cost but yet flexible and secure internet based home automation system. Nowadays, Internet has spread worldwide and most of the internet connections use Ethernet as media for data transfer. In industries or in home appliances, most of the time we need to monitor and control different parameters using microcontrollers. The popularity of home automation has been increasing greatly in recent years due to much higher affordability and simplicity through Smartphone and tablet connectivity. The concept of the "Internet of Things" has tied in closely with the popularization of home automation. Ethernet provides inexpensive, relatively high speed network access to individual users and low delay that can support many applications. This implementation is an attempt to connect an embedded device to an Ethernet. Using Ethernet based system we can control various home appliances from anywhere across the world. The existing system which uses the GSM,GPRS,Bluetooth, Zigbee Infrared and RFID technology which are having its own limitations notably of delays in signal propagations and limited distances associated with GSM communication ,Bluetooth and Infrared communication respectively.

DEDICATION

All honour and praises to the Almighty God for giving me not only this chance but also the strength, wisdom and courage to pursue my studies in the Telecommunications fields. To my wife Pauline and the children for all the support and belief they showed in me; yourselves are brilliant in every way. To the Church BAC for all the prayers and good wishes, AMEN.

DECLARATION

I, Chikahe Allen hereby declare that I am the sole author of this thesis. I authorize the Midlands State University to lend this thesis to other institutions or individuals for the purpose of scholarly research.

Signature _____ Date _____

APPROVAL

This dissertation/thesis entitled WEB BASED HOME AUTOMATION SYSTEM by Chikahe Allen meets the regulations governing the award of the degree of BSC TELECOMMUNICATIONS HONOURS of the Midlands State University, and is approved for its contribution to knowledge and literal presentation.

Supervisor

Date

ACKNOWLEDGEMENTS

I would like to thank Mr G Manjengwa and Mr Siyachingoma, for guiding me on throughout this research. My sincere gratitude goes to Midlands State University Department of Applied Physics and Telecommunications staff for their immense contribution towards this research. Special thanks goes to my fellow classmates who made learning enjoyable and were always available to offer social and academic support.

Special mention goes to my wife Pauline and the family for being my pillar of strength throughout my studies.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Home devices automation and control has simplified the lifestyle of many individuals worldwide. Home automation refers to the control of home appliances and domestic features by local networking or by remote control [1]. Artificial Intelligence provides us with the framework to go real-time decision and automation for Internet of Things (IoT). Rapid technological changes in the digital systems has led to a significant change in human lifestyle. It is a very simple concept where devices in our home or wherever they are, have the capability to communicate with each other or be controlled via the internet.

You can imagine home automation systems connected to the internet, which can be used to control appliances in your home like lights, air conditioning, stove and fridge through a web interface or smartphone application, and this data will be visible to you from anywhere around the world [2]. The Internet has been mostly used to connect personal computers so far, but shortly all kinds of appliances with embedded computers will exchange information over the Internet. With the use of web server like MySQL server in conjunction with the microcontroller technology use, a Web based home control system is implemented here.

Imagine an individual who leaves the house and is no longer sure whether an appliance that should be switched off is really off. This scenario does not give one any peace of mind, and in some cases disasters such as property loss or even life loss where encountered due to raging fires that were started by an electrical appliance that one forgot to switch off. In some

cases even if one remembers that the heater was left switched ON, there will not be an means of ‘righting’ this ‘wrong’ .But with a Home Automation System in place one can simply correct this situation by click of a button on the smartphone, tablet or computer. Therefore it is important for home owners to be accorded some remote controlling power of the electrical devices and appliances in the home from wherever there is internet access.

Other added advantages includes giving optimal convenience to people with reduced mobility such as the elderly and the disabled. There won’t be any need to walk to a switch on the wall to switch on the light or an appliance. Also efficient energy use is observed and the energy bill reduced since scheduling and switching on devices is possible at particular intended times.

It is this background that has inspired the research on the design and construction of an affordable Web based Home Control system.

1.2 A brief review of Home Automation Systems

The idea of home automation is not a new concept in anyway, but it has been a case of technology advancement catching up with idea [3].In 1898 Nikola Tesla managed to control a miniature boat sending electromagnetic radio waves towards it using a wireless Remote Controller

The 20th century started with the boom in domestic appliances, such as vacuum cleaner, washing machine, electric stoves, irons and toasters etc. The idea of home automation to control these devices was first flirted with around 1930s [3].It was only in 1966 when Jim Sutherland developed the first Home automation system called Echo IV which could control temperature ,make shopping list ,turn devices On and Off ,however the system was never commercialised.

In 1971 the introduction of the microprocessor came with massive price reduction of electronic components, and the Smart Home concepts was adopted by builders and architectures to have buildings’ electrical system, cooling system being controlled from a central places. Also the need to improve the lives of the elderly and the disabled around the home gave rise to the development of Domotics, which is the use of Robotic or Artificial intelligence in the domestic sphere.

There has been quite a significant increase in power and energy consumption due to many people forgetting to switch off their appliances when they leave their premises. These are

some of the major factors which gave rise to Home Automation Systems that control appliances using Infra-Red and GSM signals.

Infra-Red has a limitation of the need to be in the vicinity and in some cases line of sight with the devices to be controlled. GSM based control system utilise Short Message platform to control devices and messages can take long to deliver thereby delaying the actuation of the devices. Web based control has an advantage of operating devices real time.

1.3 Research Scope and Aim

The aim of the project is to develop a working prototype of a Web Based Home Automation System which is reliable and affordable to home owners, schools, hotels, lodges and individuals such as the elderly and the disabled.

It is without saying that the individuals of today now lead life in the fast lane, chasing the clock and deadlines. When one leaves his/her home in a rush fatalities may occur where an electrical appliance that was supposed to be switched OFF is left ON and unattended. Such a person can be empowered by this proposed system to be able to check the status of all the appliances and have peace of mind being fully aware that every switch in the house is in its proper state.

Also the need to conserve electrical power and to use it sparingly, requires one to be always in control of the power consumption either by monitoring the duration of appliances that are switched on, and sometimes switching ON or OFF the essentials. Besides averting disasters the energy bill is obviously reduced.

The proposed system enables one to control devices through a web interface remotely. It also allows one to check the status of the devices at home and toggle the status as needed

Specific objectives are to design a system that will be able to:

- ✓ Log on to the Home Automation System from anywhere where there is internet connectivity
- ✓ Model the home layout on the user web interface
- ✓ Get device status
- ✓ Toggles device status ON or OFF as required

1.4 Dissertation layout

The dissertation is structured as follows:

Chapter 2 presents the literature related to the current research and the theoretical aspects of Home Automation System.

Chapter 3 describes the research methods and techniques employed during the research. It gives a detailed account of the system design procedure and tools utilized.

Chapter 4 presents the results of the research and analysis of the results.

Chapter 5 presents the main findings and conclusion of the research. Recommendations for further research are also included.

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CHAPTER 2

LITERATURE REVIEW

Introduction

This chapter presents literature related to the current research. This involves works by other researchers and the theoretical aspects in the field of Home Automation Systems. The theory of operation of the components and modules used in the design and implementation of Home Automation system is also explored.

2.1 Literature review

Devices monitoring, automation and controlling is employed in several applications, including home automation, temperature, pressure, flow rate and other uses. A research has introduced remote wireless monitoring system applied in the building construction to get the concrete temperature [1]. M. Kassim et al. proposed web based temperature monitoring system. This is continuously monitoring the temperature condition of the room and data can be stored for future analysis [2]. B. Srinivas Raja and G. Srinivas Babu [3] proposed a system that can complete the remote access, monitoring and maintenance operations of equipment through the network with web browser. Unlike GSM based control system which utilise short Message platform to control devices, Web based control has an advantage of operating devices real time. In GSM message can take long to deliver thereby delaying the actuation of the devices.

In recent years, wireless systems like Remote Control have become more popular in home networking. Also in automation systems, the use of wireless technologies provide several advantages that could not be achieved with the use of a wired network only with some of the advantages being:

1. Reduced Installation costs

Installation costs are significantly reduced since no cabling is necessary.

2. Internet Connectivity

Control devices from anywhere in the world with use mobile phones to control smart home.

3. Scalable and Expandable

The use of Wireless network is especially useful when, due to new or changed requirements, an extension of the network is necessary.

4. Security

Easily add devices to create an integrated smart home security system and built-in security ensures integrity of smart home.

The web based system is written in PYTHON programming language, and has some PHP and HTML in it which was preferred over Visual Basic as it was simpler to implement. A basic Web based device control system basic structure is as shown in the figure below.

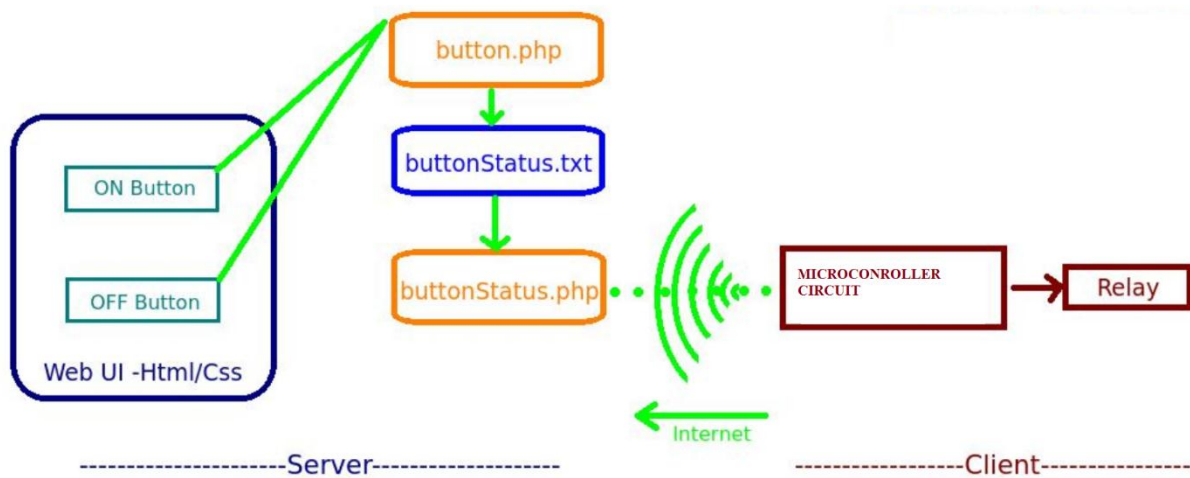


Figure 2.1.1 Basic Web Based device control system

For the remote client to be linked with the server and hence be able to monitor and control the devices, it should be on the same network with the server or both the server and remote client must be on an internet connected network. If they are on the same network, Internet Protocol (IP) addresses in the same subnet are assigned to both server and client interfaces to enable packet transfer between the two network devices. An internet cloud will allow the two devices to be linked to each other when the server and client are on an internet linked connection

In 1988 Waheed, et al, proposed the concept of using a single-chip microcontroller to control the devices in real time. This idea is the backbone of my project work. Also the wireless control of devices using Bluetooth was first proposed in 2001 by Lilakiatsakun, W. Seneviratne, A. wherein their work was limited to wireless home networking solutions. Further in 2008, Wijetunge, et al, proposed a concept of sensing and controlling through Bluetooth which could control up to five devices situated at remote locations. An Application

Programming Interface (API) was introduced as a software component to provide a development platform (for e.g. SDK) for a specific Bluetooth enabled application [15]. But since we are developing a low cost, prototype model, we chose Arduino UnoATmega328 microcontroller instead PIC. The PIC microcontroller could also be used in case, but additional circuitry such as power supply and electronic components like resistors and capacitors would be needed. Our work combines the above mentioned proposals to develop a project which not only switches ON/OFF devices but does this with some extra features. This is because industrial applications need such a type of design. We have added two extra modes of operation to facilitate the common or separate allocation of time for each process. Also since it is just a prototype, we have used open loop control instead of closed loop. The closed loop system can be used for any one or all of the set of loads hence a separate monitoring system could be implemented for each load.

2.2 IP Addressing

Each device on an IP network requires 3 different pieces of information in order to correctly communicate with other devices on the network: an IP address, a subnet mask, and a broadcast address. You will usually see each of these numbers written as four "octets" (e.g. 198.41.12.151, 255.255.255.0, and 198.41.12.255).

Every IP address is really made up of two pieces: a "network" portion, which tells routers what group of devices a packet should go to (e.g., any, a campus, etc.) and a "host" portion which tells routers what specific device among that group the packet should go to.

By examining the destination address in an IP packet that must be forwarded, and by using information that has either been statically configured or dynamically gathered from other routers, any router can determine the optimal path for forwarding packets from one group to another.

Each group of devices on an IP internet needs to have a unique network portion, and each device within that group also needs a unique host portion. In the case of the Internet, this uniqueness is made possible by indirectly getting all network portion assignments through a central clearinghouse called the Network Information Centre or "NIC." The NIC assigns blocks of addresses to Internet Service Providers (ISPs), who then assign these addresses to their customers. If your network is, or will be, connected to the Internet, you will need to get a unique network address from your ISP or network administrator.

How much of any given address is the network part and how much is the host part is determined by the "class" of the network. In each case, the part of the address not used for the network portion is left as the host portion.

Table 2.2.1.1 IP Address classes

Class	Network Portion	Hosts Allowed
A	from 1.0 to 127.0	approx. 16 million
B	from 128.0 to 191.255	65,536
C	from 192.0 to 223.255.255	255

You can always tell what class an address is by looking at the first octet and comparing it to the chart above. For instance, the address at the top of this appendix has 198 as the first octet, so it is Class C.

2.1.1 Subnet Masks

A subnet mask tells a router how much of an address it should treat as the network portion. The masks for traditional Class A, B and C networks are shown below in Table 2.1.1

Table 2.1.2 Standard IP Subnets

Class	Subnet Mask
A	255.0.0.0
B	255.255.0.0
C	255.255.255.0

Comparing the masks above to the first chart, you can see that the 255s in a mask identify the network portion of the address.

Just as the masks above specify what portion of the global IP address range a network is using, a subnet mask can also be used to subdivide a Class A, B or C network range into multiple groups of hosts, or "subnets."

This is done by telling the router that more than the traditional number of bits in the mask are to be treated as the network portion of the address. Table 2.1.1.3 shows all of the possible Class C subnet masks, and how many hosts are then allowed on each subnet. The lowest calculated address in each range (0 in the traditional C range) is not shown, cannot be used, and is skipped in the chart. The highest address in each range (255 in the traditional C range) is also not shown, and is the broadcast address for the subnet. With each mask above, the 1s in the binary value represent the network portion, and the 0s represent the host portion (128 is 10000000, 192 is 11000000, etc.).

Table 2.1.3 Subnetted Class C Host Ranges

Subnet Mask	Host Ranges
255.255.255.0	1 to 254 (traditional C)
255.255.255.128	1-126, 129-254
255.255.255.192	1-62, 65-126, 129-190, 193-254
255.255.255.224	1-30, 33-62, 65-94, 97-126, 129-158, 161-190, 193-222, 225-254
255.255.255.240	1-14, 17-30, 33-46, 49-62, 65-78, 81-94, 97-110, 113-126, 129-142, 145-158, 161-174, 177-190, 193-206, 209-222, 225-238, 241-254
255.255.255.248	1-6, etc.

As you use more bits to represent the network portion, fewer bits are left to use as host addresses.

The same idea can be extended to Class A and Class B networks.

2.2 Microcontroller

A cheap, universal integrated circuit that can be programmed and be used in any field of electronics. Technology has been developed enough as well as the market. Why not? So it happened, body and spirit were united and the first integrated circuit was designed and called the microcontroller [1].

It was during 1970 and 1971 when Intel was working on inventing the world's first microprocessor, that Gary Boone of Texas Instruments was working on quite a similar concept and invented the microcontroller. Boone designed a single integrated circuit chip that

could hold nearly all the essential circuits to form a calculator; only the display and the keypad were not incorporated. Surprisingly, this exceptional breakthrough in the field of electronics and communication was rather given a mundane name of TMS1802NC; however, the device wasn't ordinary. It had five thousand transistors providing 3000 bits of program memory and 128 bits of access memory. So, it was possible to program it to perform a range of functions.

It was during the 1990s that advanced microcontrollers with electrically erasable and programmable ROM memories such as the flash memory started flooding the electronics market. The unique feature of these microcontrollers is that they can be programmed, erased and reprogrammed with the help of just electrical signals. A lot of currently used microcontrollers such as the ones available from Atmel and Microchip use the flash memory technology.

As times changed, requirements increased and the size of the controllers (devices that control processes) decreased. As the process of miniaturization continued, those heavy controllers with additional components were etched or imprinted right onto a single microchip, often called a chip. It was like building an entire computer layer by layer on a semiconductor material such as silicon. These application specific microchips are called "Microcontrollers".

Today, in addition to the general purpose gadgets, unique microcontrollers are being created for areas like lighting, automotive, communications, and low-power driven consumer goods. The present day microcontrollers like AVR, and PIC have become smaller and sleeker yet more and more powerful. For instance, there are so tiny microcontrollers available, small and cheap enough to be used in simple products like toothbrushes and toys. Powerful and carefully chosen electronics embedded in the microcontrollers can operate independently or via input/output devices (switches, push buttons, sensors, LCD displays, relays etc.), control various processes and devices such as industrial automation, electric current, temperature, engine performance etc.

Very low prices enable them to be embedded in such devices in which, until recent time it was not worthwhile to embed anything. Thanks to that, the world is overwhelmed today with cheap automatic devices and various "smart" appliances. Prior knowledge is hardly needed for programming. It is sufficient to have a PC (software in use is not demanding at all and is easy

to learn) and a simple device (called the programmer) used for “loading” ready-to-use programs into the microcontroller.

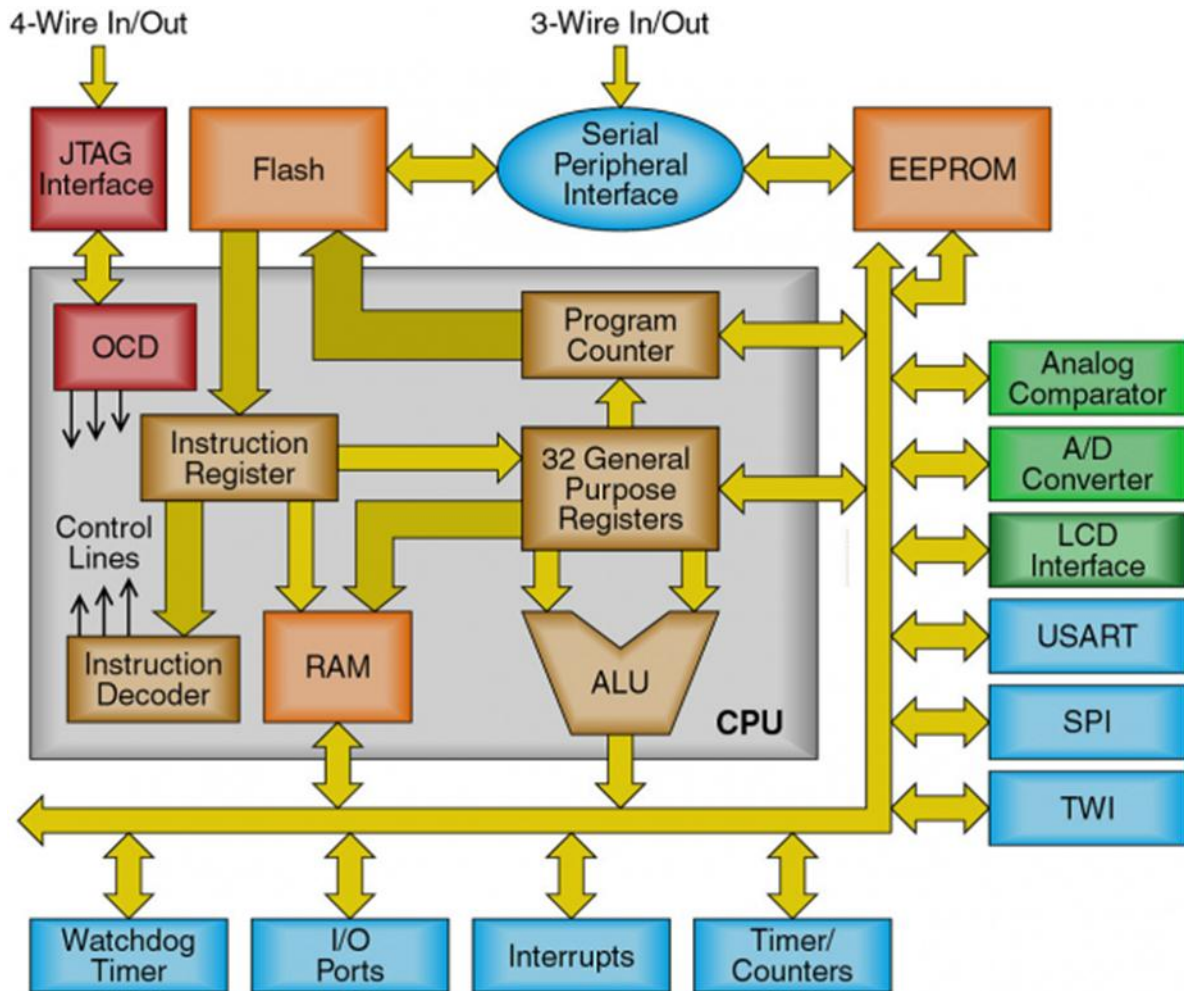


Figure 2.2.1 Block diagram of a microcontroller [4]

2.3 Relay

A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power. For example a relay is used to control the air conditioner in your home. The AC unit probably

runs off of 220VAC at around 30A. That's 6600 Watts! The coil that controls the relay may only need a few watts to pull the contacts together.

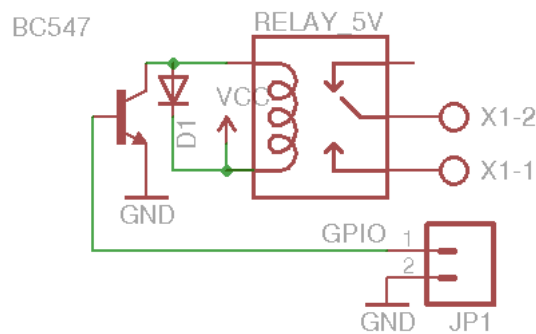


Figure 2.3.1 Relay Schematic

The output contacts are normally open (i.e. not connected). When current is passed through the input coil it creates a magnetic field that pulls the switch closed. Usually a spring will pull the switch open again once the power is removed from the coil.

2.4 Local Host Server

The localhost does need to be defined when running programs from multiple computers. For example, a network administrator might use his local machine to start a Web server on one system and use a remote access program on another. These programs would run from computers other than the localhost. A localhost is, put plainly, the standard hostname given to the address assigned to the loopback network interface. Translated into an IP address, a localhost is always designated as 127.0.0.1. This may be overwhelming, so let's look at what these things mean.

Hostname is the term for the label that is assigned to any device connected to a computer network and is used to identify the device across the web. A hostname usually consists of a single word or phrase and can be followed by a Domain Name System domain at the end. That is, a website. Used this way, the hostname is called a domain name. An example of using a hostname this way would be: hostname.domain. In short, hostname is the nickname that is given to a device connected to a computer network. A loopback network interface

sounds complicated, but is in actuality very simple. It is a virtual interface used for system management; such an interface exists but not in a real sense; it is simulated by the computer. This interface is assigned a special address that can be accessed by management over the network but lacks ties to any real device connected to the network. Applications can also use this virtual interface to send and receive packets (pieces of data) through, as opposed to using a real interface.

Back to a localhost; it is also a registered domain name. This means it is a registered name on the Internet, specifically the web that is especially reserved for a singular purpose as a localhost, to prevent confusion.

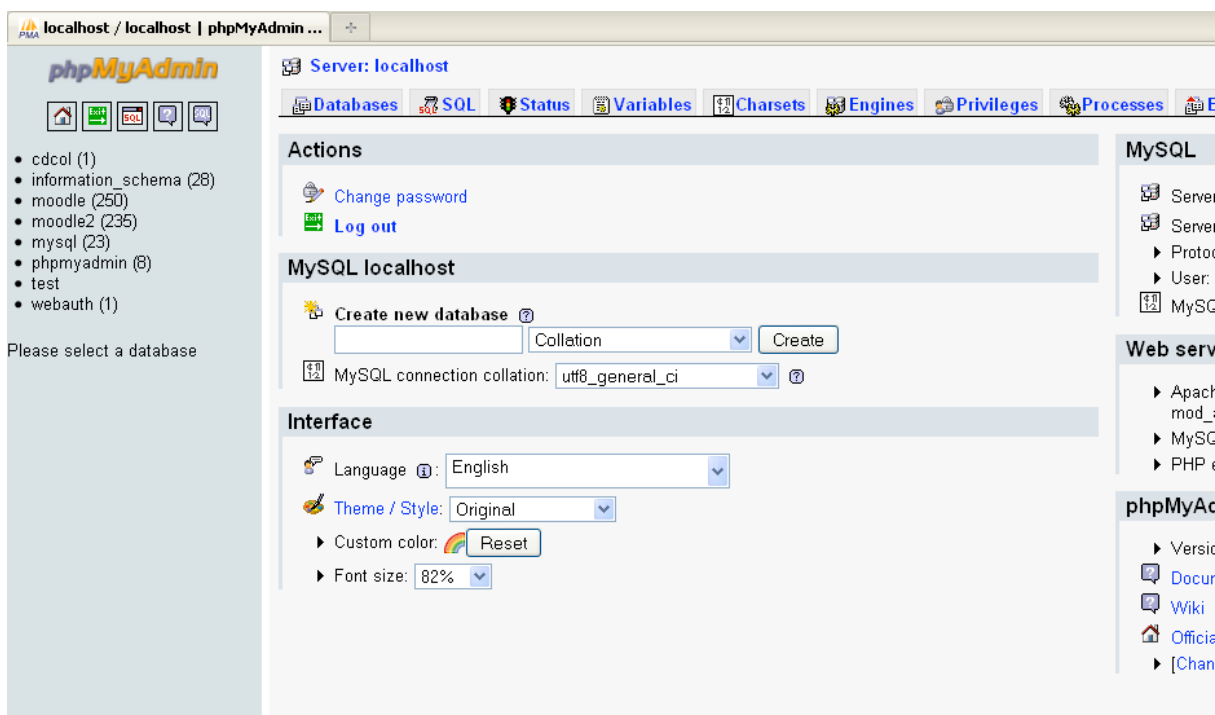


Figure 2.4.1 example of a localhost server

So why use a localhost? Not only does it make connecting to local servers, such as in a Local Area Network, extremely efficient by routing traffic through the address, allowing a direct route to any service on the server, as opposed to specifying a specific route for each service. Services being programs, games, documents, databases and others. But it also makes it easier to access services via the web, thanks to being a dedicated, registered domain name.

Computer networking can be a confusing and baffling practice, based on how much you know. Armed with this knowledge, your work can be easier and your home computing can be more robust and easy to use.

2.5 Liquid Crystal Display (LCD)

This is the example for the Parallel Port. This example doesn't use the Bi-directional feature found on newer ports, thus it should work with most, if not all Parallel Ports. It however doesn't show the use of the Status Port as an input for a 16 Character x 2 Line LCD Module to the Parallel Port. These LCD Modules are very common these days, and are quite simple to work with, as all the logic required running them is on board.

Pros:

Very compact and light

Low power consumption

No geometric distortion

Little or no flicker depending on backlight technology

Not affected by screen burn-in

No high voltage or other hazards present during repair/service

Can be made in almost any size or shape

No theoretical resolution limit

2.5.1 LCD Background:

Frequently, an 8051 program must interact with the outside world using input and output devices that communicate directly with a human being. One of the most common devices attached to an 8051 is an LCD display. Some of the most common LCDs connected to the 8051 are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Fortunately, a very popular standard exists which allows us to communicate with the vast majority of LCDs regardless of their manufacturer. The standard is referred to as HD44780U, which refers to the controller chip which receives data from an external source (in this case, the 8051) and communicates directly with the LCD.

The 44780 standard requires 3 control lines as well as either 4 or 8 I/O lines for the data bus. The user may select whether the LCD is to operate with a 4-bit data bus or an 8-bit data bus. If a 4-bit data bus is used the LCD will require a total of 7 data lines (3 control lines plus the lines for the data bus). If an 8-bit data bus is used the LCD will require a total of 11 data lines (3 control lines plus the 8 lines for the data bus).

The three control lines are referred to as EN, RS, and RW.

The EN line is called "Enable." This control line is used to tell the LCD that you are sending it data. To send data to the LCD, your program should make sure this line is low (0) and then set the other two control lines and/or put data on the data bus. When the other lines are completely ready, bring EN high (1) and wait for the minimum amount of time required by the LCD datasheet (this varies from LCD to LCD), and end by bringing it low (0) -again.

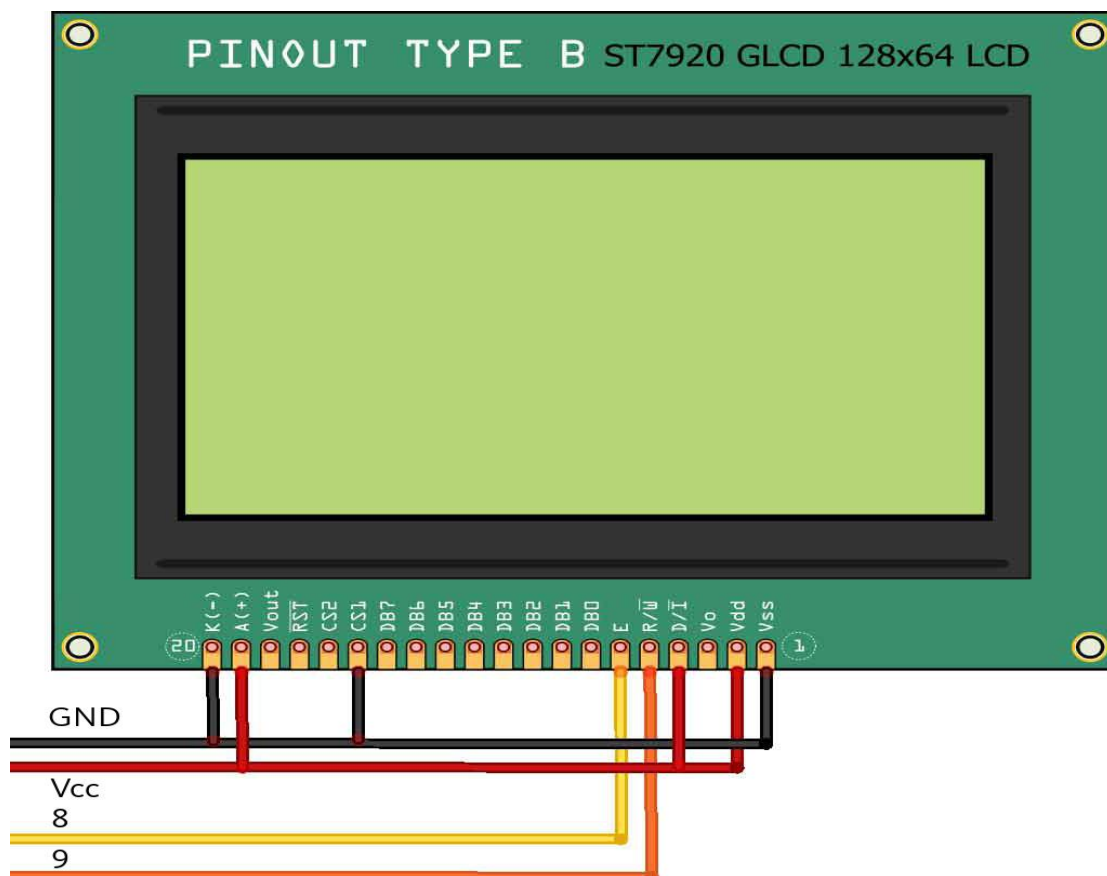


Figure 2.4.1 LCD pin configuration

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CHAPTER 3

RESEARCH METHODS AND TECHNIQUES

Introduction

This chapter presents an overview of the research methods and techniques employed in the study. Chapter 3 discusses the prototype design and the various approaches that were employed in the design and implementation of the project. This chapter also explains how the hardware and software design and interfacing was done in order to meet the overall research objectives.

3.1 Overview of the system design

This system is designed to provide the user with a smart way of monitoring and controlling different home devices by use of internet via the Web browser. The Web page is the interface with which the user have the control keys and it acts as the GUI. In this project a total of five devices are being controlled. A web page is created on the local host server which in turns is connected to a microcontroller circuitry via a serial link connection. The microcontroller circuit drives the devices changing the devices states depending on the input state received from the user through the web interface. The devices status are monitored real time on the web page from remote and device state can be changed real time to suit the user's desire via the internet cloud.

3.2 System block diagram

The block diagram below shown in figure 3.2.1 shows how different block of the system are interconnected.

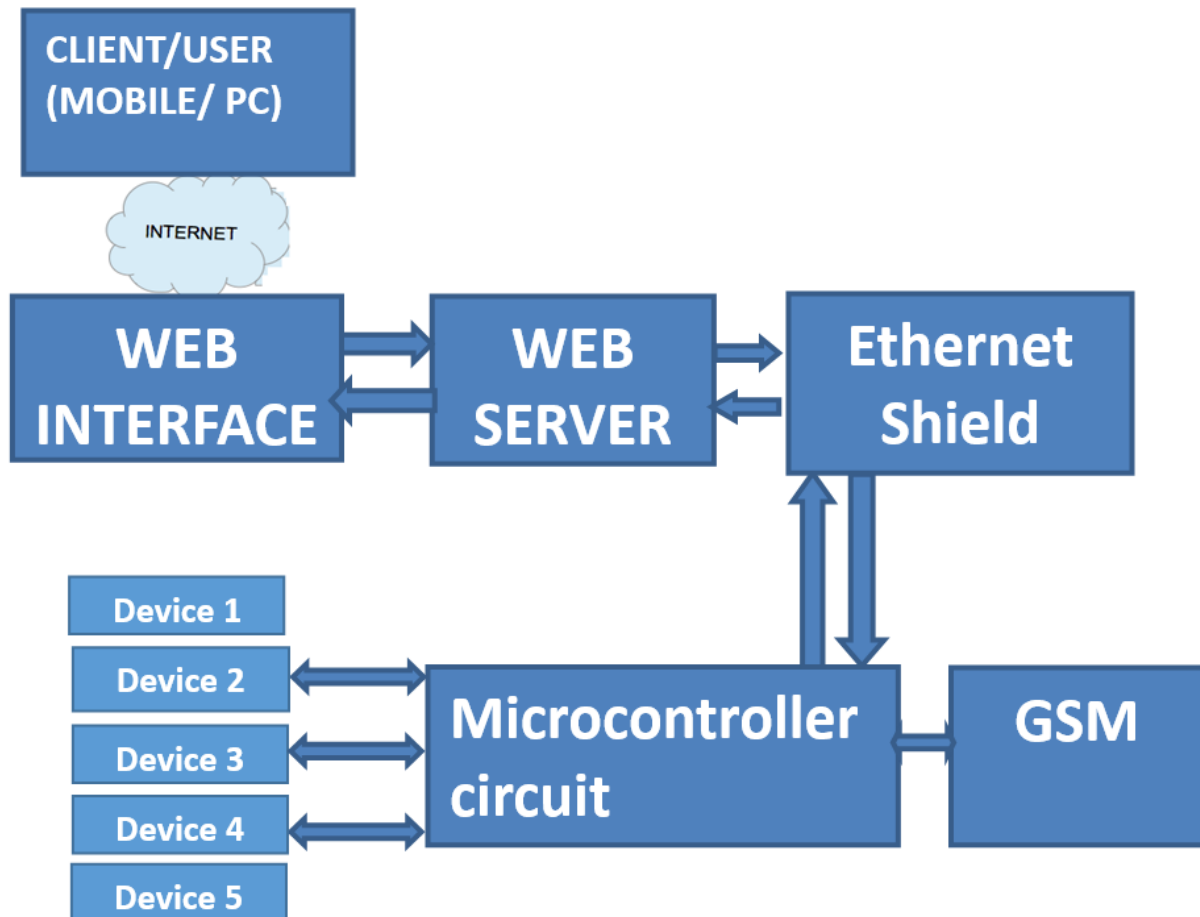


Figure 3.2.1 System block diagram.

As in Figure 3.2.1 above, the home appliance controller consists of six main blocks. Communication with remote user is established by means of internet which requires IP address to communicate. The Web server is created using Python software and the web interface is created using Dreamweaver application. The web interface which acts as the GUI to the user takes received instructions into the server data base. According to the data received from the web server database, the microcontroller sends signals to its output port tied to the driver circuit for the lights; thereby turning desired device on or off. The block for the driver circuit is responsible for amplifying the signal received from the microcontroller's

output pins to a level which can energize or de-energize a relay. According to the state of the relay, the light bulb connected to it will either be turned on or off. The power supply unit will supply the necessary regulated voltage levels to all components in the system.

3.3 Creating the Web Server

Figure 3.3.1 of the web server data base creation which was done using the Python programming language

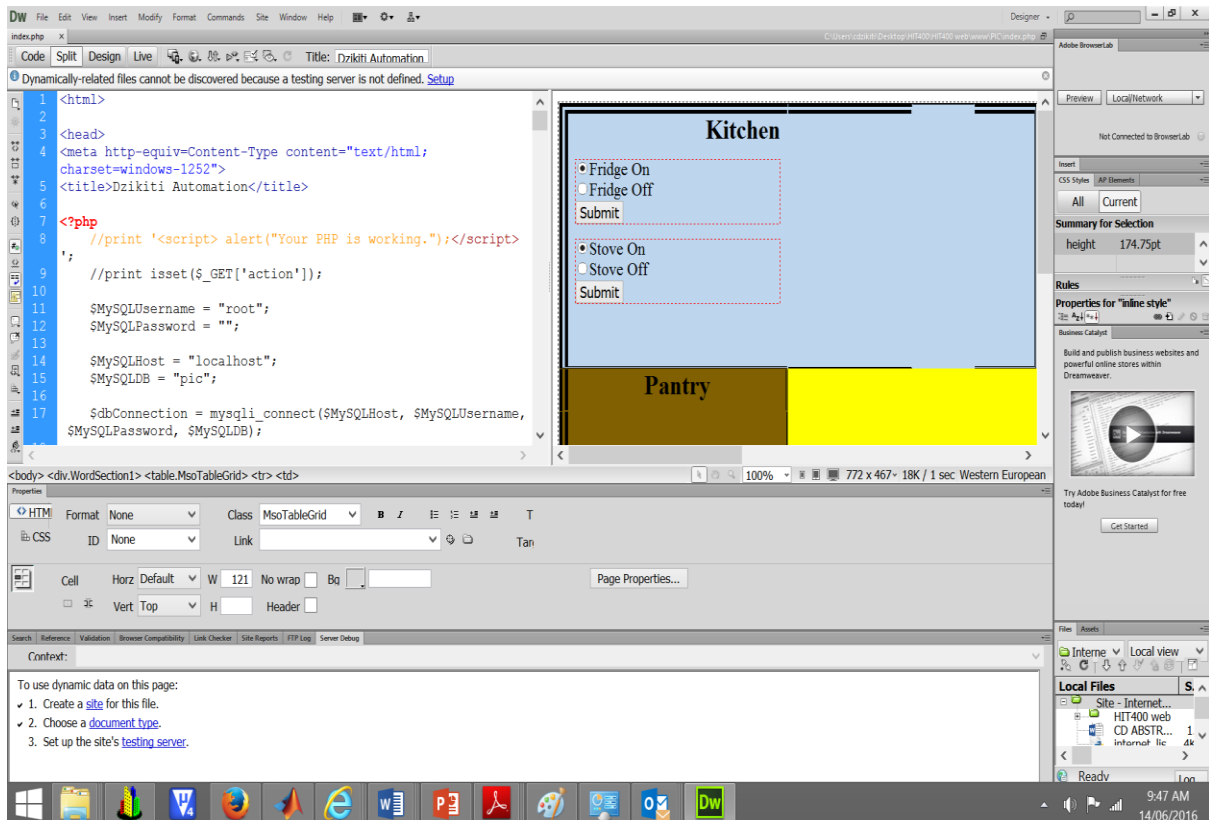


Figure 3.3.1 Snippet web server creation code

The programs listed below should be installed in the computer before starting to write any PHP program.

- The Apache Web server
- The PHP engine
- The MySQL database server

They can either install them individually or be pre-configured package for your operating system like Linux and Windows. Popular pre-configured package are XAMPP and WampServer. In this case Wamp server was chosen.

WampServer is a Windows web development environment. It allows you to create web applications with Apache2, PHP and a MySQL database. It will also provide the MySQL administrative tool PhpMyAdmin to easily manage your databases using a web browser. Now WampServer was successfully installed host computer.

3.4 Circuit design interfacing with Web server, Microcontroller, and relay driver IC

Figure 3.4.1 below shows the schematic circuit diagram for the microcontroller and relay connection

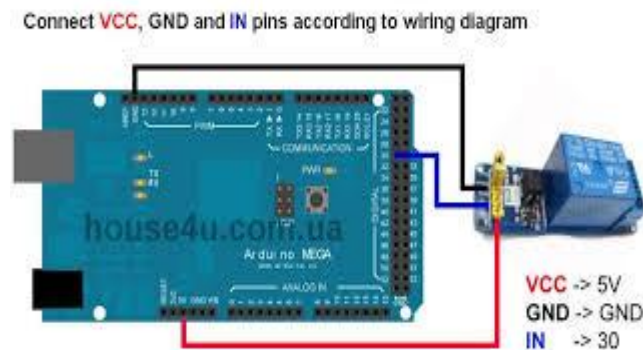


Fig 3.4.1 Arduino to Relay connection

The 5v supply is to power the microcontroller and also to drive the relays where the different loads are connected. The relays are normally open. When the coil is energized, it magnetically pulls the switch to complete the circuit between the live and neutral lines, thereby lighting up the bulb tied to it (load/appliance). The relays chosen had a coil voltage of 12 volts and were supplied by the VCC output from the power supply.

Python is a listening program that convert instructions from the computer to the Arduino module

3.4.1 Arduino Uno Microcontroller

The Arduino microcontroller is an easy to use yet powerful single board computer that has gained considerable traction in the hobby and professional market [3]. The Arduino is open-source, which means hardware is reasonably priced and development software is free. The Arduino project was started in Italy to develop low cost hardware for interaction design.

PIN FUNCTIONS:

USB To PC: It is used to communicate Arduino via Universal Serial Bus to PC for programming/sending data to Arduino serially.

7V to 12V DC Input: For external supply, the voltage range of 7V to 12V DC is recommended. The 9V battery can be used to power your Arduino Uno board.

Reset Button: It Resets the Arduino board if pressed.

ICSP: Abbreviated as In Circuit Serial Programming which consists of MOSI, MISO, SCK, RESET, VCC, and GND. It is either used to program USB or Microcontroller (For UNO, ATmega 328P-PU). ICSP allows the user to program the microcontroller when it is in circuits, In Arduino UNO it allows to program ATmega328P-PU directly with AVR instructions without using Arduino IDE.

SDA: Serial Data, It is the bidirectional data line that is used by I2C.

SCL: Serial Clock, It is used to indicate that data is ready on bidirectional data line that is used by I2C.

AREF : Analog Read Reference, It is mainly used for analog Reference() function calls, as default it is not required but to use it you have to add some voltage source between 0V to 5V in AREF Pin which will be considered as accurate reference voltage.

GND: Ground.

SCK: Serial Clock, which is used by SPI (Serial Peripheral Interface). It is clock generated by 'Master' which is used to clock the data to the 'Slave'.

MOSI: Master Out Slave In, The data is transmitted from Master to Slave. (Master -> Slave)

MISO: Master In Slave Out, The data is transmitted to Master from Slave. (Slave -> Master)

SS: Slave Select, It is used to select the 'Slave'. Make high to SS pin to deactivate & make low to activate it.

INT1 & INT0: These are hardware interrupts, it calls the ISR (Interrupt Service Routine) when the pin change occurs.

TX: Transmit, It is used to transmit TTL serial data. It is also referred as ‘outwards’ since it ‘transmits’ data from Arduino to other connected peripheral device.

RX : Receive, It is used to receive TTL serial data. IT is also referred as ‘inwards’ since it ‘receives’ data from external hardware to Arduino.

Vin: Voltage In, If you’re powering your Arduino board from USB nothing is obtained from Vin pin. But, if you’re powering the board with external supply then that supply is directly obtained from Vin pin. However, the supply obtained at Vin pin is usually lesser by 1V than voltage supplied to Power pin due to reverse polarity protection diode.

5V Pin : It is used to power external components connected to Arduino which needs 5V.

3.3V Pin : It is used to power external components connected to Arduino which needs 3.3V

IOLref : Input Output Voltage Reference, It allows shields connected to Arduino board to check whether the board is running at 3.3V or 5V.

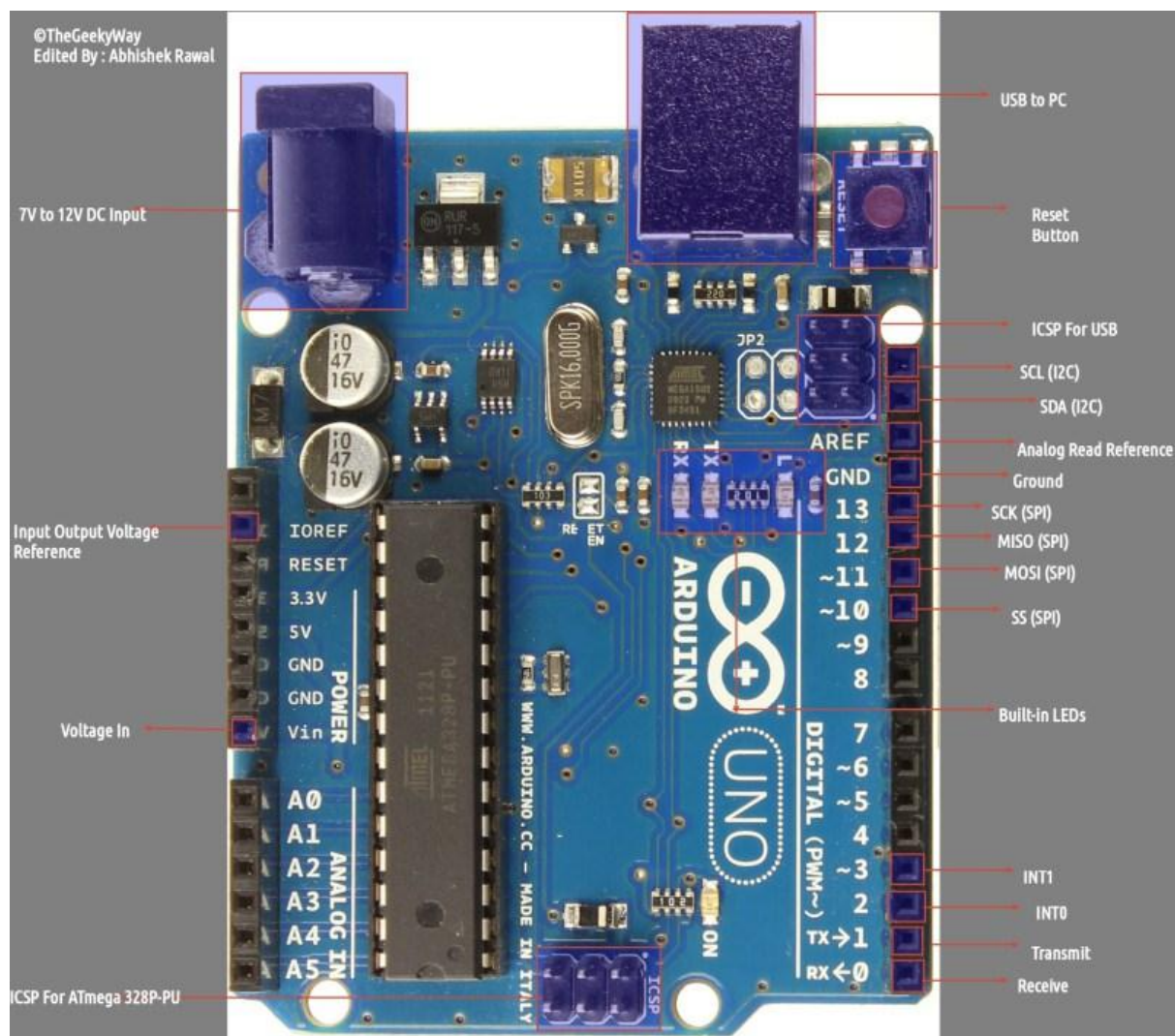


Figure 3.4.3 Arduino Uno microcontroller Pins.

3.4.3 Microcontroller Programming

In this project, we have used C Compiler for developing microcontroller program in C language. Fig. 6 below shows the flowchart of our project in brief. When the system is turned ON, the microcontroller enables its serial port and displays the keys to be pressed for different modes of operation on the LCD and waits for the command from mobile phone before executing any action. Below is an example of the C programming used in the project

3.4.4 Liquid Crystal Display (LCD)

Short for Liquid Crystal Display, a type of display used in digital watches and many portable computers. LCD displays utilize two sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. Each crystal, therefore, is like a shutter, either allowing light to pass through or blocking the light.

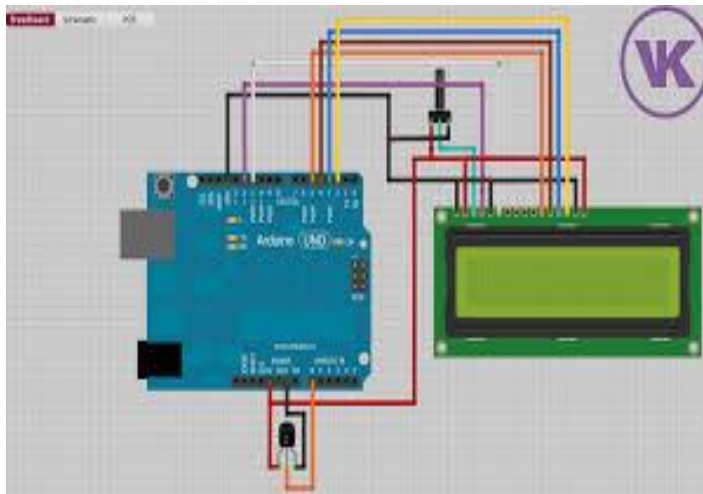


Fig 3.4.2 Arduino to LCD

3.5 Flow chart

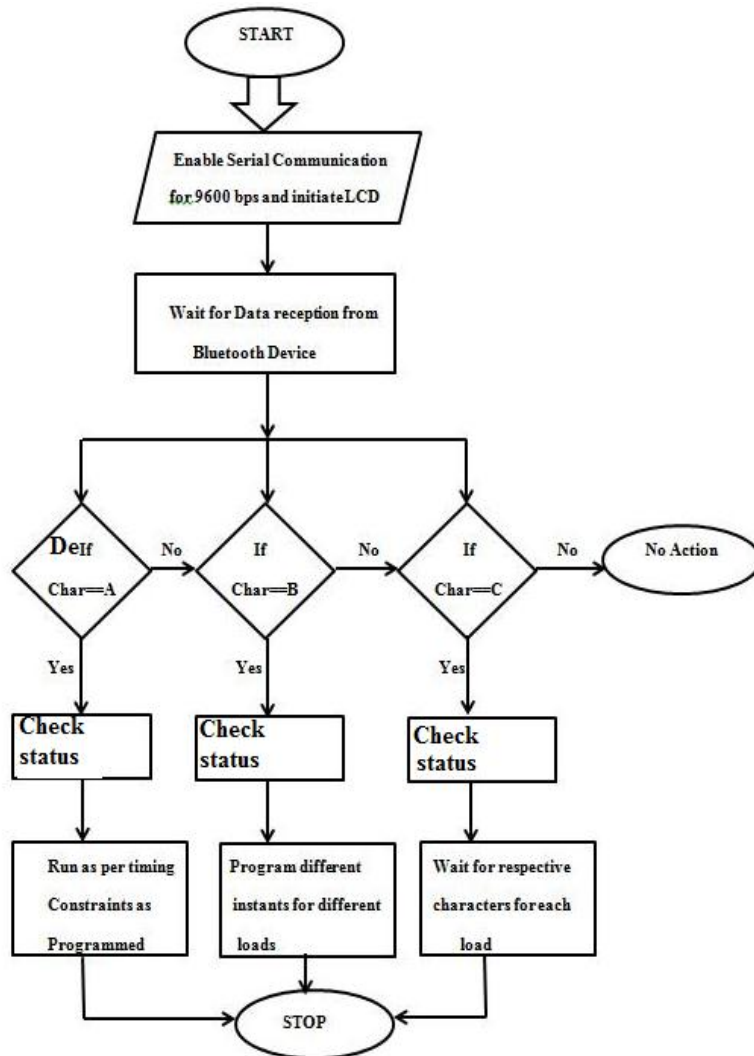


Figure 3.5.1 Flow activity diagram for the system.

3.7 Web Based application

The whole system can be said to be composed of two parts the Server and Client. In this case the server is the web interface consisting of buttons and User Interface (UI) that will allow you to turn ON/OFF a device. It consists of PHP files, Html files and a .txt file (to store

data).The server usually stores information regarding the button pressed on the page (ON/OFF) and on a .txt file. In this project the UI consists of five devices each with two buttons for ON/OFF. The clicking of the buttons will trigger the execution of a PHP file called `button.php`. This program serves as an API (Application Programming Interface) to store data on to a text file called [buttonStatus.txt](#). The data is a string: “ON”, if ON button is clicked and “OFF”, if OFF button is clicked. Thus the current button press state is recorded in the text file: `buttonStatus.txt`.

Figure 3.7.1 shows a screenshot a web page GUI opened on a mobile phone web browser connecting to the server remotely using 192.168.43.108 which the IP assigned to the server.

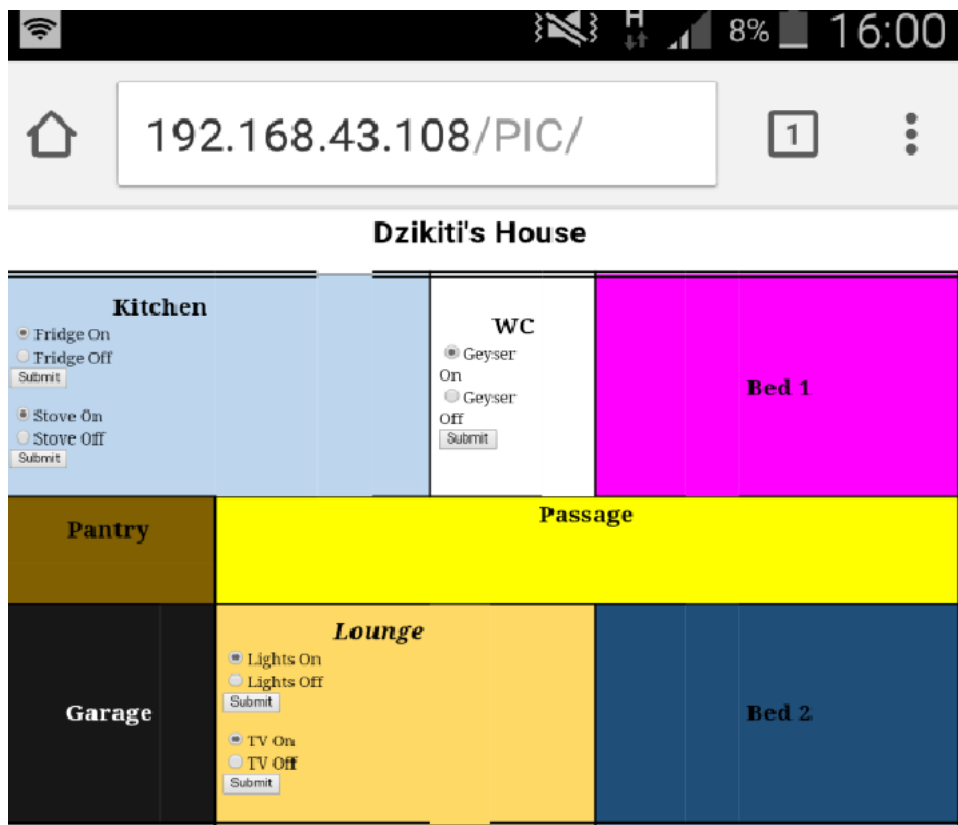


Figure 3.7.1 web page GUI as viewed from a mobile phone browser.

3.8 Physical design of the circuit on a PCB

The PCB layout shown in figure 3.8 below was designed using Eagle software

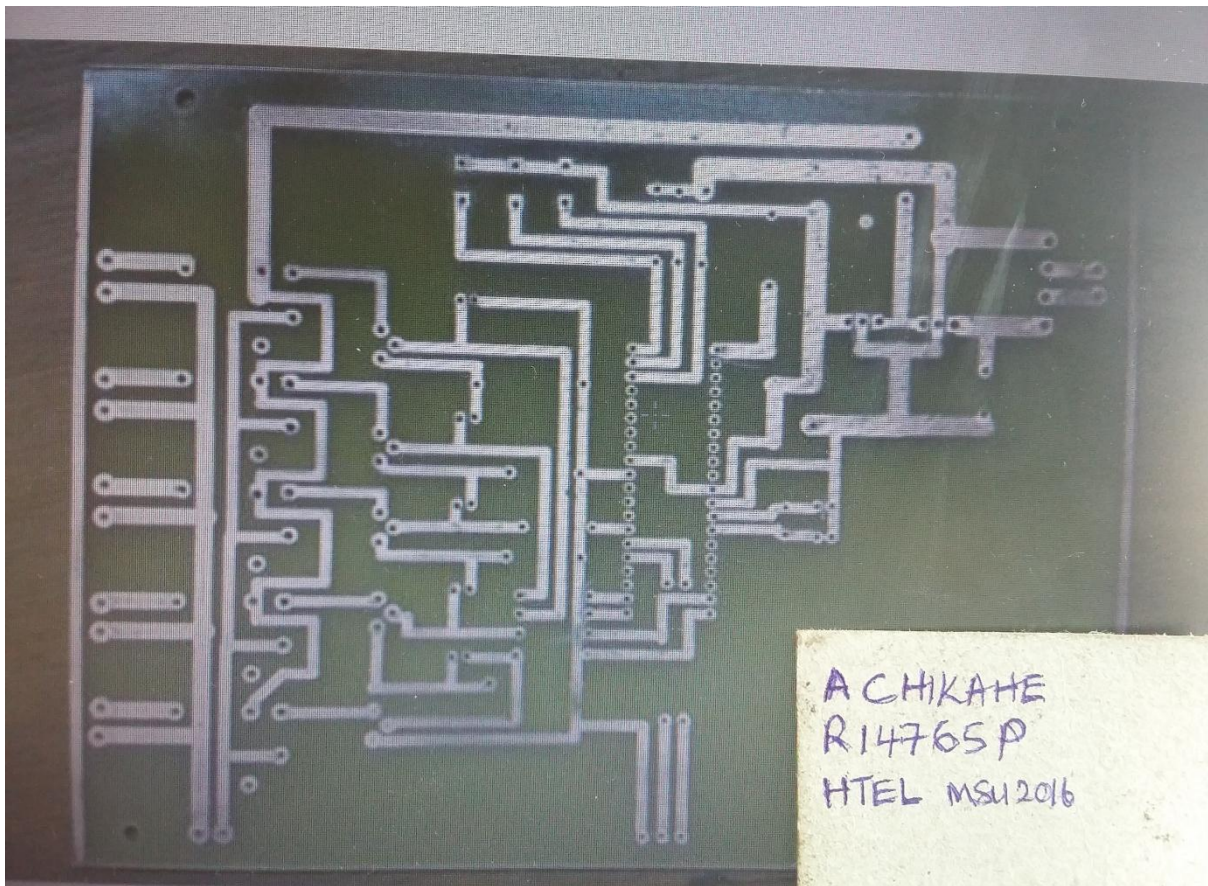


Figure 3. 8 PCB Layout

The PCB layout in figure 3.8 was printed on gloss paper using a laser printer. Hands were washed to remove any oils and care was taken not touch the laser printing. This was done to prevent oils on the gloss paper which yields poor results. The printed gloss paper was kept as flat as possible. The copper board was removed from its packaging while avoiding touching the copper side. The copper board was buffed by scrubbing it with a plastic scrubbing pad and cleaned with a slightly damp paper towel (Never use steel wool as it embeds steel into the copper).

The copper board was placed on a hard surface with the copper side facing upwards. The printed gloss paper was aligned on the copper clad. A preheated dry clothes iron was pressed firmly on the gloss paper without moving for one minute. The iron was the moved back and forth for about five minutes while applying pressure to avoid the gloss paper from sliding.

The board was allowed to cool before moving it to ensure the copper adheres to the paper and to avoid burns.

The board was placed in a bucket of cold water for five minutes. The wet paper was peeled off and the printout was checked for any missed prints or misalignment. No missed print were observed otherwise lacquer thinners and a paper towel would have been used to clean the board and start all over again.

While wearing goggles, rubber gloves and in a well-ventilated, Ferric Chloride etching solution was poured in plastic container (Never use metallic containers, sinks as they are etched away by the acid),[13]. The board was placed copper side up in the plastic container filled with the etching solution and gently wiped using a soft plastic brush. The exposed copper started to dissolve after about four minutes. Care was taken not to leave the board in the etching solution for too long otherwise the tracks would dissolve under the toner. When all the exposed copper was dissolved the board was rinsed under water for one minute and dried using a paper towel.

The residual solution was diluted in 20 litres of water and flushed down the drain. A drilling machine and carbide drilling bits were used to drill holes on the PCB.

3.9 Conclusion

An approach to solving the research problems was explored in this section. This section discussed the research methods and techniques involved in the research. The tools and techniques used in the prototype development and hardware interfacing were explored in depth.

References

- [1] B.A.Forouzan, *Data Communication and Networking*, 4thed. New Delhi: McGraw-Hill, 2002.
- [2] J.P.Bentley, *Principles of Measurement*, 4th ed. England, Pearson Education Limited, 2005.
- [3] <http://www.me.umn.edu/courses/me2011/arduino/arduinoGuide.pdf>
- [4]<http://hackaday.com/2008/07/28/how-to-etch-a-single-sided-pcb/>
- [5] <http://makezine.com/projects/cheap-friendly-and-precise-pcb-etching/>

CHAPTER 4

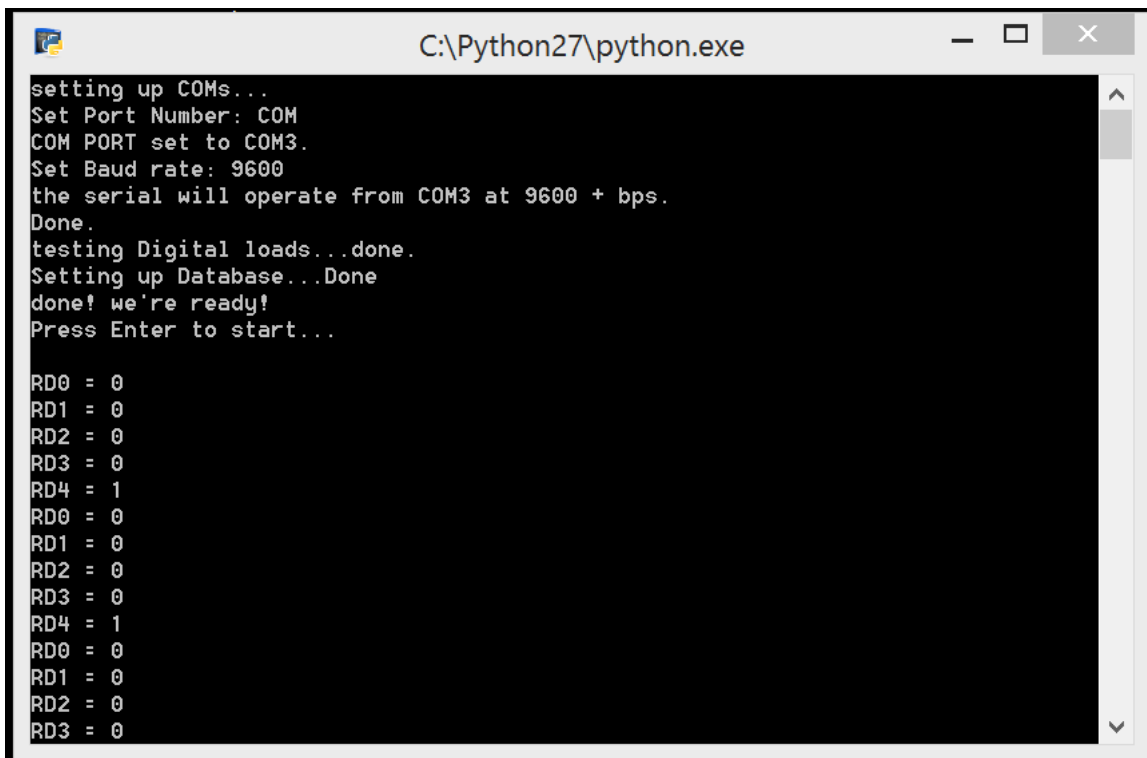
RESULTS AND ANALYSIS

4.0 Introduction

This chapter presents the results of the research. A brief analysis is also included. The behavior of the Home Automation System and the output devices are analyzed.

4.1 Analysis of the system performance

The system proved that is very efficient as all instruction send from the remote client were executed instantly on controlled devices. When comparing the polling states on the internet listening device and comparing with the hardware status all the result were correct.



```
C:\Python27\python.exe
setting up COMs...
Set Port Number: COM
COM PORT set to COM3.
Set Baud rate: 9600
the serial will operate from COM3 at 9600 + bps.
Done.
testing Digital loads...done.
Setting up Database...Done
done! we're ready!
Press Enter to start...

RD0 = 0
RD1 = 0
RD2 = 0
RD3 = 0
RD4 = 1
RD0 = 0
RD1 = 0
RD2 = 0
RD3 = 0
RD4 = 1
RD0 = 0
RD1 = 0
RD2 = 0
RD3 = 0
```

Figure 4.1.1 internet listening device polling.

With the results shown above only device number 4 was on as shown on the actual hardware in the picture in figure 4.1.2 below.

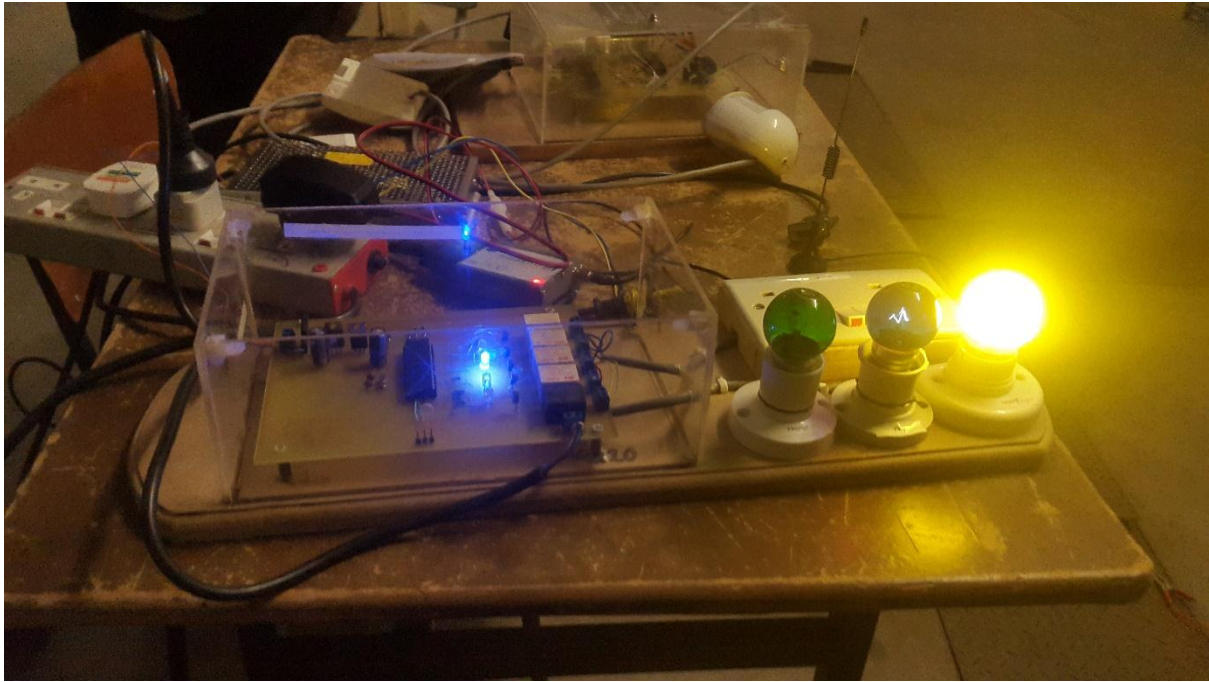


Figure 4.1.2 Hardware status when device 4 is turned on from remote

All four devices were tested for both the ON and OFF states from a web browser on a remote mobile phone and the desired result were successfully achieved.

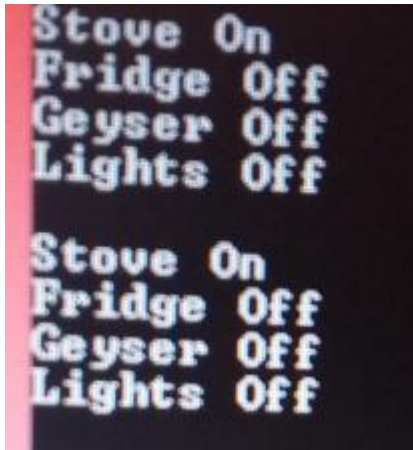


Figure 4.1.3 Hardware status from polling software and LCD display

4.2 Discussion

At the onset of this project, I drafted a proposal specifying the functionality and design of the Web/Internet based device control system. I had envisioned what the user interface would look like and how the device would behave. Looking at the final outcome of our project, I am pleased to report that all the required specifications were met and that the final system exceeded my own expectations. This system is suitable to for use in homes, offices and even the manufacturing industries since it can be integrated with other smart systems and the necessary adjustments done. It has the benefits of real-time control and can run on existing transmission infrastructure.

4.3 Conclusion

The proposed system made it possible to control home appliances remotely via the internet. The issue of geographical position and distances are addressed ,which are the limitation of many blue tooth and Wi-Fi based systems.

CHAPTER 5

CONCLUSION

5.1 Introduction

This Chapter gives a summary of the major findings of the research. Recommendations and areas of further research are also discussed.

5.2 Main findings and conclusion

The overall research objectives were met. The prototype was designed and constructed and tested, proving that the theory is feasible. The advantages of using Arduino is that it enabled the design of a simple and less costly system. Additional costs such as SMS cost in the use of GSM module are avoided. The use of Web server and IP to connect to the system enables the interaction with the system from any location in the world where there is internet connectivity.

5.3 Recommendations

Some future improvements might include incorporation of real-time circuits and scanning modules for remote operations and safety measures respectively. To improve Ethernet connectivity Ethernet shield module should be used. The user Web interface should include login page so that only authorised users can access the Home Automation System Web page.

5.4 Conclusion

The proposed system reduces the space and power consumption and ensures efficient use of the available resources. Also numbers of operators required for monitoring the system are less. Only one operator is required to issue the commands and monitor the proper working of the system. We can use any of the different modes available which best suits the industrial process application. Also since it is not possible in some cases to control or manually override/reset any machine owing to high temperature, we can control the system wirelessly over a suitable distance from the system.

References

[1] <https://www.sparkfun.com/datasheets/Sensors/Biometric/MQ-6.pdf> [March 10, 2016]

APPENDIX A: SOURCE CODE

```
void interrupt () {
  mySerial.begin(9600);
  mySerial.println("my serial here");

  pinMode(stove,OUTPUT);
  pinMode(fridge,OUTPUT);
  pinMode(geyser,OUTPUT);
  pinMode(lights,OUTPUT);
  digitalWrite(stove,HIGH);
  digitalWrite(fridge,HIGH);
  digitalWrite(geyser,HIGH);
  digitalWrite(lights,HIGH);
  delay(1000);
  digitalWrite(stove,LOW);
  digitalWrite(fridge,LOW);
  digitalWrite(geyser,LOW);
  digitalWrite(lights,LOW);
} // end interrupt
delay(500);
char inByte;
while (Serial.available()) {
  inByte = Serial.read();
  mySerial.write(inByte);
  while (buffer_pos >= buffer_size) {
    for (int8_t i = 0; i < buffer_size - 1; i++) { // if shift buff left if at end of buff
      buffer[i] = buffer[i + 1];
    }
    buffer_pos--;
  }
  buffer[buffer_pos++] = inByte;
```

```

if (strcasestr(buffer, "Stove ON")) {
    buffer_pos = 0;

    mySerial.println(buffer);
    digitalWrite(stove,HIGH);
    variable1 = "ON";
    //delay(500);
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
    }
}

else if (strcasestr(buffer, "Stove Off")) {
    mySerial.write(inByte);
    digitalWrite(stove,LOW);
    variable1 = "OFF";
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
        buffer_pos = 0;
    }
}

else if (strcasestr(buffer, "Fridge ON")) {
    mySerial.write(inByte);
    digitalWrite(fridge,HIGH);
    variable2 = "ON";
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
        buffer_pos = 0;
    }
}

else if (strcasestr(buffer, "Fridge Off")) {
    mySerial.write(inByte);
    digitalWrite(fridge,LOW);
    variable2 = "OFF";
    for (x = 0; x < buffer_size; x++){ // clear buffer

```

```

    buffer[x] = 0;
    buffer_pos = 0;
}
}
else if (strcasestr(buffer, "Geyser On")) {
    mySerial.write(inByte);
    digitalWrite(geyser,HIGH);
    variable3 = "ON";
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
        buffer_pos = 0;
    }
}
else if (strcasestr(buffer, "Geyser Off")) {
    mySerial.write(inByte);
    digitalWrite(geyser,LOW);
    variable3 = "OFF";
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
        buffer_pos = 0;
    }
}
else if (strcasestr(buffer, "Lights On")) {
    mySerial.write(inByte);
    digitalWrite(lights,HIGH);
    variable4 = "ON";
    for (x = 0; x < buffer_size; x++){ // clear buffer
        buffer[x] = 0;
        buffer_pos = 0;
    }
}
else if (strcasestr(buffer, "Lights Off")) {
    mySerial.write(inByte);
    digitalWrite(lights,LOW);

```

```
variable4 = "OFF";  
for (x = 0; x < buffer_size; x++){ // clear buffer  
    buffer[x] = 0;  
    buffer_pos = 0; }
```