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Collage of Engineering

Electrical Engineering Department

HomeAutomation

التحكم الآلي للمنزل

A project in Partial Fulfillment for the Requirement of the Degree of B.Sc. (Honor) In Electrical Engineering

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الآية

قالتعالي :

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" قَالُواْ سُبْحَانَكَ لاَ عِلْمَ لَنَا إِلاَّ مَا عَلَّمْتَنَا إِنَّكَ أَنتَ الْعَلِيمُ الْحَكِيمُ "

سورة البقرة (32)

DEDICATION

To our parents for all their love and support and putting us through the best education possible. We appreciate their sacrifices and we wouldn't have been able to get to this stage without them. To all our respective teachers whom supported, guided and provided us with all the knowledge's during the last five years. Itis difficult to express our gratitude toward them, but we shall try our best to do so.

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There have been many who have walked alongside us during this project .they have guided us ,placed opportunities in front of us and showed as the door that might be useful to open . We would like to thank each and every one of them. Especially MohammedJamal and Hassan Abdallah at Smokier Lap for all theirtechnicalsupport. Alsowe would like to express our deepest gratitude to our supervisor Galal Abdalrahman Mohammed For his unwavering support, collegiality and mentorship throughout this project.

ABSTRACT

Today we are living in the twenty first century where automation is playing important role in human life. Home automation allows us to control household appliance like light, door, fan, Ac…etc. and to protect the home appliance from over and under voltage .Home automation not only refer to reduce human efforts but also energy efficiency and time saving. The main objective of home automation is to help handicapped and old aged people which will enable them to control home appliances. The system has four components: anautomatic voltage regulator (AVR) for over and under voltage protection, Arduino microcontroller for connecting the appliances, a Bluetooth module for signal transfer, and a smartphone running the Android application. The project focuses on the features and design of the proposed system. The design is based on a standalone Arduino-Uno boardit is power supply is connected through the AVR and the home appliances are connected to this Arduino-Unoboard using relays. The smartphone interacts with the Arduino via Bluetooth. The main aim of the system development is to be low cost and scalable according to the requirements. Password protection is being used for authentication.

المستخلص

اليوم نحن نعيش في القرن الواحد و العشرون حيث تلعب اجهزة التحكم الالي دورا هاما في حياة الانسان. نظام التحكم الالي للمنزل يسمح لنا بالسيطرة علنا لأجهزة المنزلية مثلا لإضاءة الأبواب، المراوح،...الخ وحماية الأجهزة المنزلية من الزيادة أو النقصان المفاجئ للجهد . نظام التحكم الآلي للمنزل ليس فقط يشير إلى تقليل الجهود البشرية ولكن أيضا يزيد من كفاءة الطاقة وتوفيرالوقت. والهدف الرئيسي من نظام التحكم الآلي للمنزل هو مساعدة المعوقين والمسنين وتمكينهم من السيطرة على الأجهزة المنزلية. النظام يحتوي على ثلاثة مكونات: منظم جهد لحماية الأجهزة المنزلية، متحكم اردوينو لربط الأجهزة، وحدة بلوتوث لنقل الإشارات، والهاتف الذكي لتشغيل تطبيق الاندرويد.ويركزالمشروع على ميزات وتصميم النظام المقترح. ويستند التصميم على لوح الاردوينو وترتبط الأجهزة المنزلية إلى هذا اللوح باستخدام الريليهات (القواطع). الهاتف الذكي يتفاعل مع اردوينو عن طريق البلوتوث. والهدف الرئيسي من تطوير النظام هو أن يكون منخفض التكلفة وقابل للتطوير وفقا للمتطلبات. يتم استخدام كلمة المرورللمصادقة.

TABLE OF CONTENTS

LIST OF FIGUIRES

LIST OF ABBREVATIONS

AVR	Automatic Voltage Regulator
HVAC	Heating, Ventilation and Air Conditioning
TV	Television
WHAS	Wireless Home Automation system
CPU	Central Processing Unit
RAM	Random Access Memory
ROM	Read Only Memory
EEPROM	Electrically Erasable Read Only Memory
EPROM	Erasable Read Only Memory
LCD	Liquid Crystal Display
LED	Light Emitting Diode
ADC	Analoge to Digital Converter
DAC	Digital to Analoge Converter
DC	Direct Current
PC	Personal Computer
PDA	Personal Digital Assistants
OBEX	Object Exchange
GPS	Global Positioning System
KVA	KILO Volt Ampere
GSU	Generator step-up transformers
AC	Alternative Current
CFL	Compact Fluorescent
HPS	High Pressure Sodium
NDK	Novel Developer Kit
GUI	Graphical User Interface
TDM	Time Division Multiplexing

CHAPTER ONE

INTRODUCION

1.1 GENERAL CONCEPT

Recently, man's work and life are increasingly tight with the rapid growth in communications and information technology. The information society has changed human being's way of life as well as challenged the traditional residence. Followed by the rapid economic expansion, living standard keeps raising up day by day that people have a higher requirement for dwelling functions. The intellectualized society brings diversified information where safe, economic, comfortable and convenient life has become the ideal for every modern family. It is will know that the concept of smart home has focused the attention of researchers, lifestyle practitioners, and the consumers to be directed forward the usage of the recent Technology. Considerable efforts have been made to the development of remote control systems for home automation. Home automation is automation of the home, housework or household activity. Home automation may include centralized control of lighting, HVAC appliances, and other systems, to provide improved convenience, comfort, energy efficiency and security.Home automation for the elderly and disabled can provide increased quality of life for persons who might otherwise require caregivers or institutional care. It can also provide a remote interface to home appliances or the automation system itself, via telephone line, wireless transmission or the internet, to provide control and monitoring via a smart phone or web browser. This project will describe the approach which we are implementing to control various home appliances with Android smart phone.

1.2 PROBLEM STATEMENT

In the present day home automation is becoming essential for the purpose of improving our life condition. Convenience and ease of using home appliances is what home automation is offering. Home automation offers a futuristic way of life in which an individual gets to control his entire house using a smart phone, from turning on a TV to locking/unlocking doors; it also offers an efficient use of energy. But to get or acquire such system installed will cost a lot of money and that is the majorreason of why home automation has not received much demand and attention, adding to that alsothe complexity of installing it and configuring it. Thus it is essential to make it cost effective andeasy to configure, if this is granted to people then they will be willing to acquire it in theirhomes, offices and schools. In other words, a system modification for the home automation isrequired in order to lower the price of applying it to houses. Also home automation offers ease ofmind and body to handicapped and/or elders in their houses by just one click to do what theywant as stated above.

1.3 OBJECTIVE

The main objectives of this study are to:

- ❖ Construct a wireless home automation system controlled by a smart phone specifically an android device.
- ❖ Design and implement cost effective home automation system yet an efficient one.
- ❖ Design a user friendly and a safe system to control home appliances especially aimed to aid the elders and handicapped.

1.4 METHODOLOGY

All the previous study about home automation has been studied, the block and wiring diagram has been draw and a simulation program has been used to simulate the project prototype. At the end the home automation prototype has been designed.

1.5 PROJECT LAYOUT

This project consists of five chapters: Chapter One gives an introduction about the principles of the project, in addition its reasons, motivation and objectives. Chapter Two discusses the theoretical background of Control Systems, Home Automation, MicrocontrollerSystem, Bluetooth Module, Transformer, Relays and Lamps. Chapter Three describes the circuit design, module of the circuit and the circuit component. Chapter Fourshows the System Simulation, Implementation also shows the practical results. Finally, Chapter five provides the conclusions and recommendations.

CHAPTER TWO

BACKGROUND AND LITREATURE REVIEW

2.1 Introduction:

With advancement of Automation technology, life is getting simpler and easier in all aspects. In today's world Automatic systems are being preferred over manual system it can complete tasks while you are busy with other activities. Wireless Home Automation system(WHAS) using Bluetooth is a system that uses computers or mobile devices to control basic home functions and features automatically through phones from anywhere around the home, an automated home is sometimes called a smart home. It is meant to save the electric power and human energy [1].

2.2Home Automation

A home automation system is a product or service that brings some level of action or message to the home environment and allow users to control electric appliances of varying kind without the homeowner's direct intervention. Many existing, well-established home automation systems are based on wired communication.

2.3 Control System

Automatic control has played a vital role in the advance of engineering and science. In addition to its extreme importance space-vehicle systems, missile-guidance systems, robotic systems, and the like, automatic control has become an important and integral part of modern manufacturing and industrial processes. For example, automatic control is essential in the

numerical control of machine tools in the manufacturing industries, in the design of autopilot systems in the aerospace industries, and in the design of cars and trucks in the automobile industries. It is also essential in such industrial operations as controlling pressure, temperature, humidity, viscosity, and flow in the process industries. Since advances in the theory and practice of automatic control provide the means for attaining optimal performance of dynamic systems, improving productivity, relieving the drudgery of many routine repetitive manual operations, and more, most engineers and scientists must now have a good understanding of this field.

The first significant work in automatic control was James Watt's centrifugal governor for the speed control of a steam engine in the eighteenth century. Other significant works in the early stages of development of control theory were due to Minorsky, Hazen, and Nyquist, among many others. In nineteen twenty two, Minorsky worked on automatic controllers for steering ships and showed how stability could be determined from the differential equations describing the system. In nineteen thirty two, Nyquist developed a relatively simple procedure for determining the stability of closed-loop systems on the basis of open-loop response to steady-state sinusoidal inputs. In nineteen thirty four, Hazen, who introduced the term servomechanisms for position control systems, discussed the design of relay servomechanisms capable of closely following a changing input. During the decade of the nineteen forty , frequency-response methods (especially the Bode diagram methods due to Bode) made it possible for engineers to design linear closed-loop control systems that satisfied performance requirements. From the end of the nineteen forty's to the early nineteen fifties, the root-locus method due to Evans was fully developed. The frequency response and root-locus

methods, which are the core of classical control theory, lead to systems that are stable and satisfy a set of more or less arbitrary performance requirements. Such systems are, in general, acceptable but not optimal in any meaningful sense. Since the late nineteen fifty's, the emphasis in control design problems has been shifted from the design of one of many systems that work to the design of one optimal system in some meaningful sense. As modern plants with many inputs and outputs become more and more complex, the description of a modern control system requires a large number of equations. Classical control theory, which deals only with single-input-single-output systems, becomes powerless for multiple-input-multiple-output systems. Since about nineteen sixty, because the availability of digital computers made possible time domain analysis of complex systems, modern control theory, based on time-domain analysis and synthesis using state variables, has been developed to cope with the increased complexity of modern plants and the stringent requirements on accuracy, weight, and cost in military, space, and industrial applications. During the years from nineteen sixty to nineteen eighty, optimal control of both deterministic and stochastic systems, as well as adaptive and learning control of complex systems, were fully investigated. From nineteen eighty to the present, developments in modern control theory centered around robust control, H, control, and associated topics. Now that digital computers have become cheaper and more compact, they are used as integral parts of control systems. Recent applications of modern control theory include such nonengineering systems as biological, biomedical, economic, and socioeconomic systems. Before we can discuss control systems, some basic terminologies must be defined [3].

2.3.1Controlled Variable and Manipulated Variable

The controlled variable is the quantity or condition that is measured and controlled. The manipulated variable is the quantity or condition that is varied by the controller so as to affect the value of the controlled variable. Normally, the controlled variable is the output of the system. Control means measuring the value of the controlled variable of the system and applying the manipulated variable to the system to correct or limit deviation of the measured value from a desired value. In studying control engineering, we need to define additional terms that are necessary to describe control systems [3].

2.3.2Plants.

A plant may be a piece of equipment, perhaps just a set of machine parts functioning together, the purpose of which is to perform a particular operation. In this book, we shall call any physical object to be controlled (such as a mechanical device, a heating furnace, a chemical reactor, or a spacecraft) a plant [3] .

2.3.3Processes

The Merriam-Webster Dictionary defines a process to be a natural, progressively continuing operation or development marked by a series of gradual changes that succeed one another in a relatively fixed way and lead toward a particular result or end; or an artificial or voluntary, progressively continuing operation that consists of a series of controlled actions or movements systematically directed toward a particular result or end. In this book we shall call any operation to be controlled a process. Examples are chemical, economic, and biological processes [3] .

2.3.4 Systems

A system is a combination of components that act together and perform a certain objective. A system is not limited to physical ones. The concept of the system can be applied to abstract, dynamic phenomena such as those encountered in economics. The word system should, therefore, be interpreted to imply physical, biological, economic, and the like, systems [3].

2.3.5 Disturbances

A disturbance is a signal that tends to adversely affect the value of the output of a system. If a disturbance is generated within the system, it is called internal, while an external disturbance is generated outside the system and is an input [3] .

2.3.6 Open-loop control systems

A system in which the output has no effect on the control action is known as an open loop control system. For a given input the system produces a certain output. If there are any disturbances, the output changes and there is no adjustment of the input to bring back the output to the original value. A perfect calibration is required to get good accuracy and the system should be free from any external disturbances. No measurements are made at the output. A traffic control system is a good example of an open loop system [3].

2.3.2 Closed-Loop control systems

These are also known as feedback control systems. A system which maintains a prescribed relationship between the controlled variable and the reference input, and uses the difference between them as a signal to activate

the control, is known as a feedback control system. The output or the controlled variable is measured and compared with the reference input and an error signal is generated. This is the activating signal to the controller which, by its action, tries to reduce the error [3].

2.4 Microcontroller

Microcontroller is a highly integrated chip that contains Central Processing Unit (CPU), Random Access Memory (RAM), Read Only Memory (ROM) and Input/output I/O ports. Unlike general-purpose computer, which also includes all of these components, microcontroller is designed for a very specific task to control a particular system. As a result, the parts can be simplified and reduced, which cuts down on production cost [4].

2.4.1 Microcontroller components

A microcontroller basically contains one or more following components:

- ✓ Central Processing Unit (CPU):is the brain of a microcontroller. CPU is responsible for fetching the instruction, decode it, and then executed. CPU connects every part of a microcontroller into a single system. The primary function of CPU is fetching and decoding instructions. Instruction fetched from program memory must be decoded by the CPU.
- ✓ Memory: memory in a microcontroller is same as microprocessor. It is used to store data and program. A microcontroller usually has a certain amount of RAM and ROM (EEPROM, EPROM, etc.) or flash memories for storing program source codes.
- ✓ Parallel input/output ports: are mainly used to drive/interface various devices such as LCD'S, LED'S, printers, memories, etc. to a microcontroller.

- ✓ Serial interfacing ports: Serial ports provide various serial interfaces between microcontroller and other peripherals like parallel ports.
- ✓ Timers and counters:A microcontroller may have more than one timer and counters. The timers and counters provide all timing and counting functions inside the microcontroller. The major operations of this section are perform clock functions, modulations, pulse generations, frequency measuring, making oscillations, etc. This also can be used for counting external pulses.
- ✓ Analog to Digital Converter (ADC) converters are: used for converting the analog signal to digital form. The input signal in this converter should be in analog form (e.g. sensor output) and the output from this unit is in digital form. The digital output can be used for various digital applications (e.g. measurement devices).
- ✓ Digital to Analog Converter (DAC): it is perform reversal operation of ADC conversion. DAC convert the digital signal into analog format. It usually used for controlling analog devices like DC motors, various drives, etc.

2.4.2 Microcontroller application

Microcontrollers are widely used in modern electronic equipment. Some basic applications of microcontroller are given below:

- ❖ Used in biomedical instruments.
- ❖ Used as peripheral controller in Personal Computer (PC).
- ❖ Used in robotics.
- ❖ Used in automobile fields.
- ❖ Household appliances (microwave, washing machine, coffee machine…etc.)

- telecommunication (mobile phones)
- aerospace industry
- industrial automation

2.5 Bluetooth

Bluetooth is a standard used in links of radio of short scope, destined to replace wired connections between electronic devices like cellular telephones, Personal Digital Assistants (PDA), computers, and many other devices. Bluetooth technology can be used at home, in the office, in the car, etc. This technology allows to the users instantaneous connections of voice and information between several devices in real time. The way of transmission used assures protection against interferences and safety in the sending of information [5] .

Some of its applications:

- Wireless control of and communication between a mobile phone and a hands-free headset. This was one of the earliest applications to become popular.
- Wireless networking between PCs in a confined space and where little bandwidth is required.
- Wireless communications with PC input and output devices, the most common being the mouse, keyboard and printer.
- Transfer of files between devices with OBEX (a kind of communications protocol).
- Replacement of traditional wired serial communications in test equipment, GPS receivers, medical equipment, bar code scanners, and traffic control devices.
- For controls where infrared was traditionally used.

- ❖ Sending small advertisements from Bluetooth enabled advertising hoardings to other, discoverable, Bluetooth devices.

2.6 Transformer

Transformers are passive devices for transforming voltage and current. They are among the most efficient machines, 95 percent efficiency being common and 99 percent being achievable. There is practically no upper limit to their power handling capability, and the lower limit set only by the allowable no load loss.Transformers and inductors perform fundamental circuit functions. They are a necessary component in electrical systems as diverse as distribution terminals for multi-megawatt power generating stations to handheld radio transceivers operating on a fraction of a watt. Transformers are the largest, heaviest, and often costliest of circuit components. The geometry of the magnetic circuit is three dimensional. Transformers are indispensable for voltage transformation in power application. Their ability to isolate circuits and to alter ground conventionscan often be matched in no other covenant manner. They are needed in frequency selected circuit whose operation depends on the response of inductances. They are rugged, being capable of withstanding severe environmental conditions. Transformers are essentially single application devices. Designed for specific requirements, they do not offer optimum performance over a wide range of operation. They are not outstanding performers in applications requiring high-fidelityreproduction of audio or video signals. Transformers do not perform well in circuits which apply dc magnetization to the core. They are a problem in equipment in which size and weight must be kept to a minimum Transformers can sometimes be eliminated by circuit artifices. A bridge

rectifier directly across the power line can replace a power transformer and rectifier if the voltage level and ground isolation can be accommodated. This is often done to obtain dc voltage for inverter circuits. Needed voltage transformation is then done at high frequency with a much smaller transformer. The direct coupling of semiconductor devices to loads eliminates audio transformers. Operation of driving circuits at voltages which will provide the desired output voltage by direct coupling may eliminate the need for voltage transformation at the output Closely related in both theory and construction to transformers are other magnetic devices which include inductors, storable reactors. And magnetic amplifiers. Much of the discussion on transformers is applicable to them [6].

2.6.1 Power transformers

Are defined as transformers rated 500 kVA and larger. Larger transformers are oil-filled for insulation and cooling; a typical GSU transformer may contain several thousand gallons of oil. One must always be aware of the possibility of spills, leaks, fires, and environmental risks this oil poses [7].

2.6.2 Distribution transformers

Transformers smaller than 500 kVA are generally called distribution transformers. Pole-top and small, pad-mounted transformers that serve residences and small businesses are typically distribution transformers [7].

2.6.3 Step-up transformers

Used in Reclamation power plants, receive electrical energy at generator voltage and increase it to a higher voltage for transmission lines [7].

2.6.4 Step-down transformer

A step-down transformer receives energy at a higher voltage and delivers it at a lower voltage for distribution to various loads [7].

Applications of Transformers:

- Transformers have many applications in power transmission and electronics:
- They may be used to minimize energy losses due to voltage drop in transmitting electricity over long distances.
- They match loads with internal resistance so that there is maximum power transfer.
- They couple signals between electronic stages.

2.7 Relay

The electric relay is one of the most frequently used devices in modern technological systems. It can be found in cars, washing machines, microwave ovens, and medical equipment, as well as in tanks, aircraft, and ships. Practically no industry would function without relays. In some complex automatic control systems in industry, the number of relays is estimated in hundreds and even thousands. In the power-generation industry, no power device is allowed to operate without special protection relays. Certain electrical equipment, such as power transformers, may be protected by several different kinds of relays, each controlling different functions. Because relays are so widely used and there are so many types, the broad population of engineers is unfamiliar with most of them. Generally speaking, engineers in a specific technical field are usually only familiar with relays that are applicable for specific devices. The same is true of specialists

involved in the design and production of relays. Therefore, obtaining information on relays is a problem both for students whose future profession involves relay application, and for teachers in technical colleges or extension courses, who need up-to-date information about relays for their students. Where can we find extensive publications that equally meet the needs of engineers, teachers, and students? Various publications and books about relays currently on the market can be divided into two groups. One is generally called ‘‘Low Power Relays’’ or ‘‘Power Relays’’ (both terms mean the same, that is, a low-power electromagnetic relay with a switching current not exceeding 30 A). The second group is ‘‘Protective Relaying’’ (protective relays for protection of power networks), where the emphasis is placed not on a description of the principles and construction of relays, but on schematic principles of protection of electrical networks and calculation of their operating modes. On the one hand, dividing the entire ‘‘world of electric relays’’ into two groups excludes some important relay implementations, for example relays with a switching current of hundreds of amperes, high-voltage relays, mercury relays, reed switch relays, solid-state relays, electric thermal relays, time-delay relays, safety relays, and many others. On the other hand, such an artificial division within the same field frequently results in separate treatment of common questions regarding relays which may be of different kinds, but are actually related and should be dealt with together. Experience accumulated for one type of relay is not always taken into account regarding other types of relays, even if the analogy is obvious. Moreover, modern protection relays usually contain electromagnetic, reed switch, or solid-state relays as output elements and experts in relay protection must be aware of their idiosyncrasies. In addition, in many particularly powerful and high-voltage modern electronic systems

(power supplies, powerful lasers, radars, etc.) experts face challenges of providing protection against emergency states (overload, overcurrent, etc.), similar to challenges encountered by specialists in relay protection. Another disadvantage of current publications is that they rarely meet the full range of engineering requirements. Some are intended mainly for experts and are abundant in equations and calculations for relays; others emphasize standards, methods of quality control, and other issues concerning production of relays; and still others are for engineers and technicians who are not experts in relays but only use relays in their equipment.[8].

2.7.1Types of relays

- ✓ Electromagnetic Relays: These relays are constructed from electrical, mechanical and magnetic components, and possess operating coil and mechanical contacts. Therefore, when a coil gets activated by a power supply source, these mechanical contacts get opened or closed. The type of supply can be AC or DC.
- ✓ Solid State or Electronic Relays:Solid State uses solid state components to perform the switching operation with one or more semiconductor switching devices like a power transistor, thyristor and TRIAC without moving any parts. Since the control energy required is much lower, compared to the output power to be controlled by this relay.
- ✓ High Voltage Relays:These relays are quite similar in function to that of low voltage relays, but the major difference is the contacts which are designed to operate at high voltages. Therefore, a high insulation is provided between the contacts.

- ✓ Time Delay Relays: The time-delay relays are used for performing timedelayed switching operations such as starting, protecting and controlling circuits applications.
- ✓ Thermal Relay:These relays are based on the effects of heat, which means – the rise in the ambient temperature from the limit, directs the contacts to switch from one position to another.

Some applications of Relays:

- ❖ Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers.
- ❖ Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile.
- ❖ Detect and isolate faults on transmission and distribution lines by opening and closing the circuit breakers.
- ❖ Time delay functions. Relays can be modified to delay opening or delay closing set of contacts. A very-short delay uses a copper disk between the armature and moving blade assembly [8] .

2.8 Electric light

The electric light, one of the everyday conveniences that most affects our lives, was not “invented” in the traditional sense in eighteen seventy nine by Thomas Alva Edison, although he could be said to have created the first commercially practical incandescent light. He was neither the first nor the only person trying to invent an incandescent light bulb. In fact, some historians claim there were over 20 inventors of incandescent lamps prior to Edison’s version. However, Edison is often credited with the invention because his version was able to outstrip the earlier versions because of a

combination of three factors: an effective incandescent material, a higher vacuum than others were able to achieve and a high resistance that made power distribution from a centralized source economically viable.
In eighteen two, Humphry Davy invented the first electric light. He experimented with electricity and invented an electric battery. When he connected wires to his battery and a piece of carbon, the carbon glowed, producing light. His invention was known as the Electric Arc lamp. And while it produced light, it didn't produce it for long and was much too bright for practical use.

Over the next seven decades, other inventors also created "light bulbs" but no designs emerged for commercial application. More notably, in eighteen forty, British scientist Warren de la Rue enclosed a coiled platinum filament in a vacuum tube and passed an electric current through it. The design was based on the concept that the high melting point of platinum would allow it to operate at high temperatures and that the evacuated chamber would contain fewer gas molecules to react with the platinum, improving its longevity. Although an efficient design, the cost of the platinum made it impractical for commercial production.

In eighteen fifty an English physicist named Joseph Wilson Swan created a "light bulb" by enclosing carbonized paper filaments in an evacuated glass bulb. And by eighteen sixty he had a working prototype, but the lack of a good vacuum and an adequate supply of electricity resulted in a bulb whose lifetime was much too short to be considered an effective producer of light. However, in the eighteen seventy better vacuum pumps became available and Swan continued experiments on light bulbs. In eighteen seventy eight,

Swan developed a longer lasting light bulb using a treated cotton thread that also removed the problem of early bulb blackening.

On July twenty forth, eighteen seventy four a Canadian patent was filed by a Toronto medical electriciannamed Henry Woodward and a colleague Mathew Evans. They built their lamps with different sizes and shapes of carbon rods held between electrodes in glass cylinders filled with nitrogen. Woodward and Evans attempted to commercialize their lamp, but were unsuccessful. They eventually sold their patent to Edison in eighteen seventy nine In eighteen seventy eight, Thomas Edison began serious research into developing a practical incandescent lamp and on October fourteenth, eighteen seventy eight, Edison filed his first patent application for "Improvement in Electric Lights". However, he continued to test several types of material for metal filaments to improve upon his original design and by Nov fourth, eighteen seventy nine, he filed another U.S. patent for an electric lamp using "a carbon filament or strip coiled and connected ... to patina contact wires."

Although the patent described several ways of creating the carbon filament including using "cotton and linen thread, wood splints, papers coiled in various ways," it was not until several months after the patent was granted that Edison and his team discovered that a carbonized bamboo filament could last over 1200 hours.

This discovery marked the beginning of commercially manufactured light bulbs and in eighteen eighties, Thomas Edison’s company, Edison Electric Light Company begin marketing its new product[9] .

2.8.1Types of Lights

- ✓ Indoor Lighting:Some of the most common indoor light bulbs are incandescent bulbs, which look like a traditional light bulb. Generally, the input for these bulbs is either 40W or 60W. But there are other kinds of indoor light bulbs as well.
- ✓ Incandescent Bulbs:The incandescent light bulb has had the same design for over 100 years since Thomas Edison invented it! It produces light when a thin wire called a tungsten filament is heated by electricity running through it making it so hot that it starts to glow brightly.
- ✓ Compact Fluorescent Light Bulbs (CFL):These spiraled light bulbs are far more efficient than the standard incandescent bulb. Compact Fluorescent Light bulbs (CFLs) work by running electricity through gas inside the coils, exciting that gas, and producing light.
- ✓ Light Emitting Diode (LED):Unlike incandescent and CFL bulbs, LED bulbs have moved into the technological age. LEDs that produce white light work in a rather complicated way.
- ✓ Outdoor Lighting:Outdoor lights are usually different from those bulbs used indoors because they need to be much brighter and last longer.
- ✓ Halogen Bulbs Halogen bulbs are often found in homes as spotlights or floodlights.
- ✓ Metal Halide:Metal halide lamps are commonly used in streetlights.
- ✓ High Pressure Sodium (HPS):The high pressure sodium lamp (HPS) is the most commonly used street light throughout the world. It produces light by running electricity through a mixture of gases.

2.9Fans

Any device that produces a current of air by the movement of broad surfaces can be called a fan. Fans fall under the general classification of “turbo machinery” Fans fall under the general classification of turbo machinery and have a rotating impeller at least partially encased in a stationary housing. Fans are similar in many respects to pumps. Both are turbo machines that transfer energy to a flowing fluid [10].

2.9.1Fan Types

Fans are classified according to the direction of flow through the impeller:

- ✓ Axial Flow:Air flows through the impeller parallel to, and at a constant distance from the axis. The pressure rise is provided by the direct action of the blades
- ✓ Centrifugal or radial flow:Air enters parallel to the axis of the fan and turns through 900and is discharged radically through the blades. The blade force is tangential causing the air to spin with the blades and the main pressure is attributed to this centrifugal force
- ✓ Mixed flow:Air enters parallel to the axis of the fan and turns through an angle which may range from 300to 900. The pressure rise is partially by direct blade action and partially by centrifugal action
- ✓ Cross Flow:Air enters the impeller at one part of the outer periphery flows inward and exits at another part of the outer periphery

2.10 Automatic Voltage Regulator

An automatic voltage regulator, AVR for short, is a device that is designed to automatically control, adjust or maintain a constant voltage level .Voltage regulator may use a simple feed-forward design or may include negative

feedback. It may use an electromechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the DC voltages used by the processor and other elements. In automobile alternators and central power station generator plants, voltage regulators control the output of the plant. In an electric power distribution system, voltage regulators may be installed at a substation or along distribution lines so that all customers receive steady voltage independent of how much power is drawn from the line.The ultimate reason for using voltage regulation is financial – to avoid the costs associated with equipment damage and downtime caused by poor voltage levels [11] .

Category of Voltage Regulatorare:

- Feed-forward design or negative feedback control loops
- Mechanical voltage regulator or electronic voltage regulator
- Active regulators or shunt regulator
- Switching regulators
- Linear regulator

The main functions of an AVR are as follows:

- It controls the voltage of the system and has the operation of the machine nearer to the steady state stability.
- It divides the reactive load between the alternators operating in parallel.
- The automatic voltage regulators reduce the over voltages which occur because of the sudden loss of load on the system.

- It increases the excitation of the system under fault conditions so that the maximum synchronizing power exists at the time of clearance of the fault.

CHAPTER THREE

HARDWARE IMPLEMENTATION

3.1 Introduction

This part describes the implementation of the whole system, from Arduino board tothe appliances. This system is integrated using Arduino Uno board, Bluetooth module, relays modules, protection regulator, an android device, an android app to control the Arduino board, and other electronics components. TodevelopaBluetoothbasedhome automationsystemwithArduino-Uno BoardandanAndroidapplication.Remotecontrolledhomeautomation system providesasimplersolutionwithAndroidapplicationtechnology. As shown in Figure 3.1.

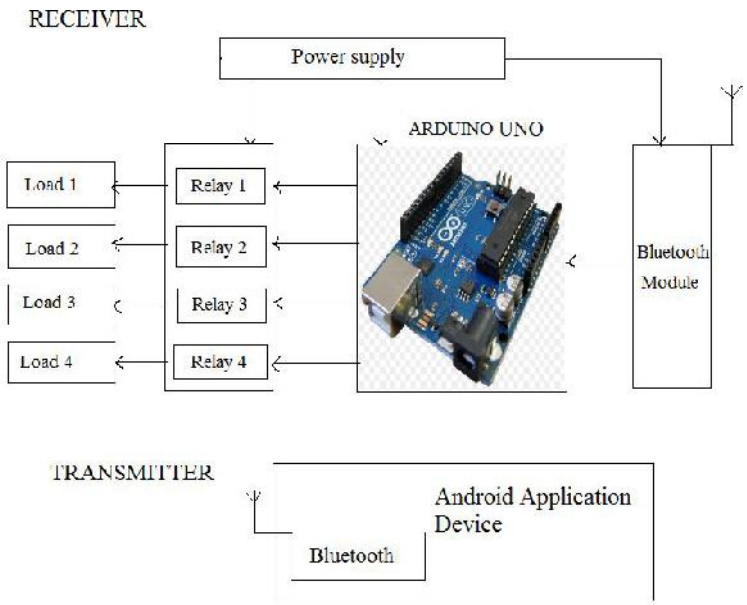

Figure 3.1: Block diagram of home controlled by Bluetooth

Remote operation is achieved by any Smartphone/ Tablet,withAndroid, IOS software and upona graphical user interface (GUI) basedtouchscreenoperation.Smart home provides a single system approach to the management of an extensive array of prestige electronics and controls. Like a talented conductor guiding and overseeing theVirtuosos in an orchestra, Smart room Smart Homes Control Systems are designed to direct The various individual smart home technologies and reduce their management to a single,

User-friendly system that can incorporate:

- ❖ Multi room audio and video distribution
- ❖ Automated gates and locks
- ❖ Intercom, CCTV and security systems
- ❖ Multiple scene lighting design
- ❖ Motorized blinds and curtains
- ❖ Environmental controls &High voltage AC (HVAC)

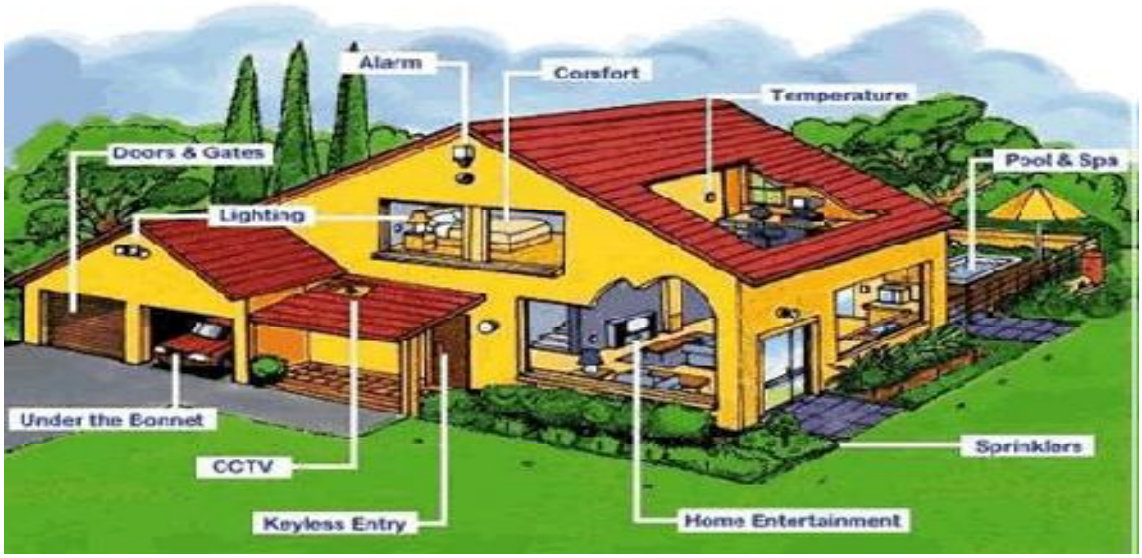

Figure 3.2: Home automation system

3.2 Circuit Components

The components used to design project circuits are:

- Arduino- Uno board.
- Android Mobile Device.
- Bluetooth Module HC-06.
- Automatic Voltage Regulator (AVR).
- Breadboard.
- Bridge Rectifier.
- Novel developer kit (NDK) Control Transformer.
- Relay Module.
- Smoothing Circuit.
- Jumper Wires.

3.3 Arduino- Uno

The Arduino Uno is a microcontroller board based on the ATmega328Datasheet. It has 14 digital input/output pins (of which 6 can be used as pulse width modulation (PWM) outputs), 6 analog inputs, A 16 MHz ceramic resonator, USB connection, power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Table 3.1: Arduino specifications

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

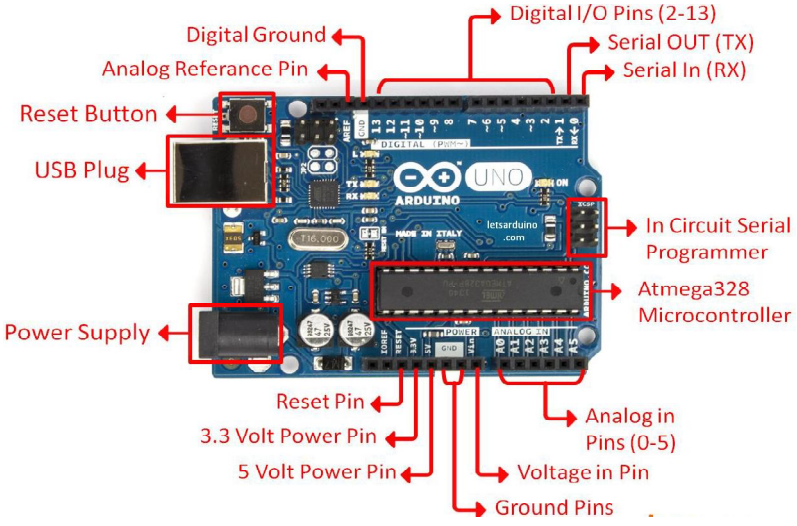

Figure 3.3: Arduino-Uno board

3.4Android Mobile Device

Android is an Operating System for smart phone devices on which we can run our application. Android provides healthy array of connectivity options including Bluetooth and wireless data over a cellular connection. Android provides access to a wide range of useful libraries and tools that can be used to build rich applications.

To design our system we use Android latest version **5.0.2**, which supports Application of our system without creating any problem. It is a design with increased use of grid-based layouts, responsive animations and transitions, padding, depth effects such as lighting and shadows. It provides some major new platform features for developers, with over 5,000 new APIs added for use by application. As shown in Figure 3.4.

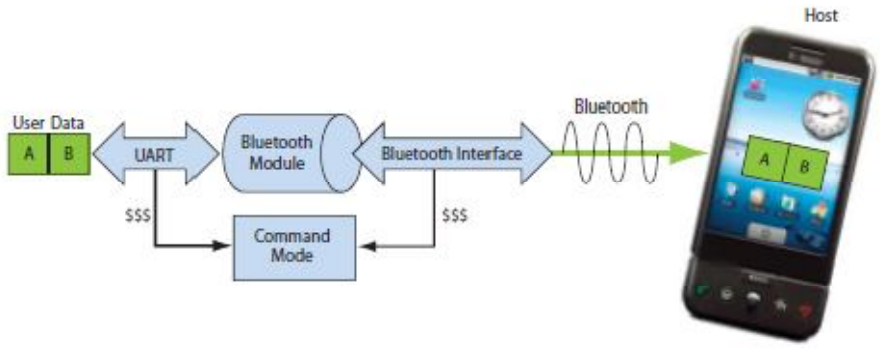

Figure3.4: Smart phone connected to Bluetooth

3.5Bluetooth Module HC-06

The HC-06 is a class 2 slave Bluetooth module designed for transparent wireless serial communication. Once it is paired to a master Bluetooth device such as PC, smart phones and tablet, its operation becomes transparent to the user. A Blue- tooth module supports both point to point and point to multi-point connections. It provides the physical layer and a low-level communication protocol. Bluetooth uses a quick frequency-hopping (1600 hops per second) packet-switched protocol in order to minimize interference. Short data packets maximize throughout during in deference. A TDM (Time Division multiplexing) technique divides the channel into 625 PS slots. Transmission occurs in packets that occupy an odd number of slots (up to 5). Each packet is transmitted on a different hop frequency with a maximum frequency hopping rate of 1600 hops/s. Bluetooth version V1.06, KEY is JY–MCU. Commercial series is Bluetooth module board series with Light emitting diode (LED) indicator light with VCC, GND, RXD, TXD pins with operation voltage of 3.3V,signal coverage is about 30ft. Input voltage value is between 3.3-6V.As shown Figure 3.5.

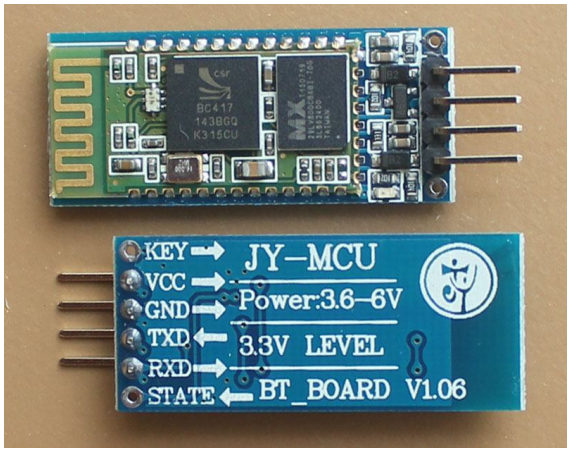

Figure3.5: Bluetooth module specification

The TXD and RXD of the Bluetooth module are connected to Arduino board through Serial out (TX) and Series in (RX), respectively.GND and VCC of Bluetooth Module connected to GND and 5V pins, respectively. It Receives command from the mobile phone application and send it to the Arduino. As shown in Figure 3.6.

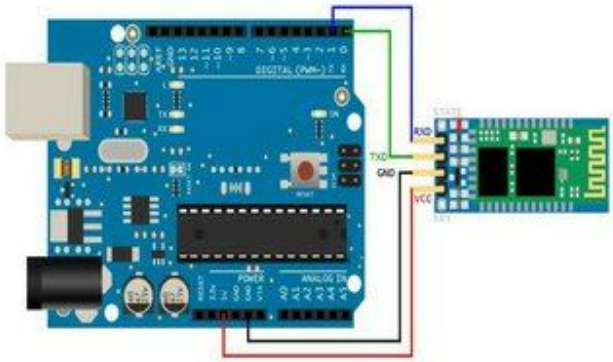

Figure 3.6: Bluetooth module connection

3.6 Automatic Voltage Regulator (AVR)

The automatic voltage regulator is used to regulate the voltage. It takes the fluctuate voltage and changes them into a constant voltage. The fluctuation in the voltage mainly occurs due to the variation in load on the supply system. The variation in voltage damages the equipment of the power system. The variation in the voltage can be controlled by installing the voltage control equipment.

It works on the principle of detection of errors. The output voltage of an AC generator obtained through a potential transformer and then it is rectified, filtered and compared with a reference. The difference between the actual voltage and the reference voltage is known as the error voltage. This error voltage is amplified by an amplifier and then supplied to the main exciter or pilot exciter.

In this IC, we have an inverting terminal and a non-inverting terminal. The voltages at the inverting terminal and the non-inverting terminal are 6.0v and 6.8v respectively. When the input AC voltage exceeds 240v, the voltage at the non-inverting terminal increases. So now if the voltage at the non-inverting terminal increases more than 6.8v then the output of the operational amplifier is pulled high. So the electrical appliance is turned off by means of a relay connected to the output pin of the op-amp. Thus the electrical appliance is now protected against over voltage. Now let us consider under voltage condition. When the line voltage is below 180v, the voltage at the inverting terminal is less than the voltage at the non-inverting terminal. Thus the output of the operational amplifier now goes high and the AC supply gets disconnected and the electrical appliance also turns off. Thus, the appliance is now protected against undervoltage. As shown in Figure 3.7below.

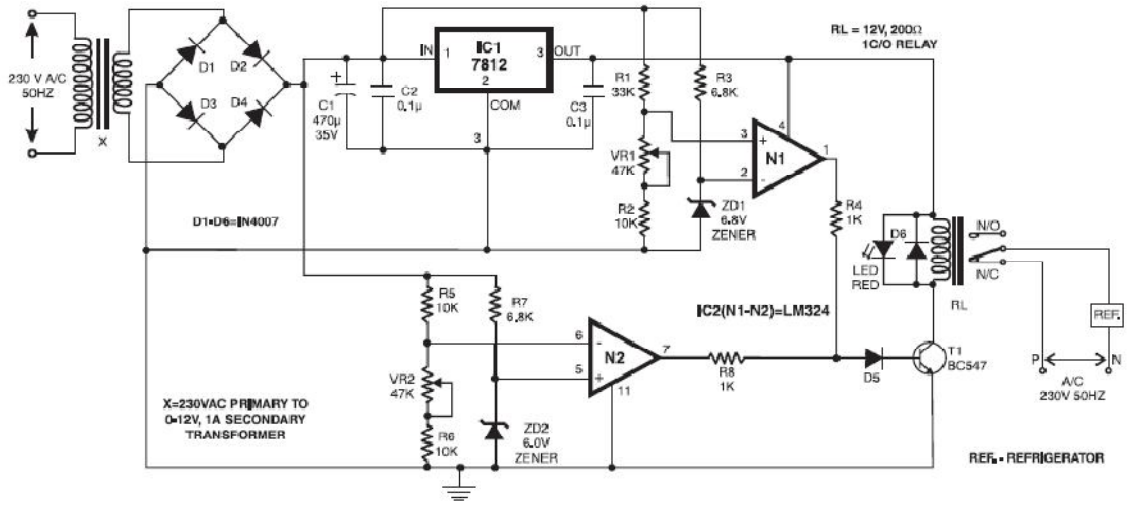

Figure3.7: AVR circuit

The AVR input is connected to the rectifier bridge and its output is connected to the protection relay coil.

The AVR protects the control system as well as other electrical appliances from over and under voltage. By the name itself we can say that if the input voltage is more or less than the required voltage then the electrical appliance is turned off by relay action.

3.7 Breadboard

A breadboard is a construction base for prototyping of electronics. Originally it was literally a bread board, a polished piece of wood used for slicing bread. In the nineteen seventeen's the solderless breadboard (plug board, a terminal array board) became available and nowadays the term "breadboard" is commonly used to refer to these. A modern solderless breadboard socket consists of a perforated block of plastic with numerous tin plated phosphor bronze or nickel silver alloy sprig clips under the perforations. Bus strips used to provide power

to the electronic components. A bus strip usually contains two rows: one for ground and one for a supply voltage. As shown in Figure 3.8.

Figure3.8: Breadboard

3.8 Novel Developer Kit (NDK) Control Transformer

A control transformer is an isolation transformer that provides good voltage regulation and used to convert mains voltage to low voltage to power electronic devices.

The control transformer Model is NDK-50, with capacity of 50VA Rated input voltage is between 230- 415 voltage ,rated output voltage can be one of the following values 6, 12, 24, 36, 110, 127, 230, 400 Voltage, A frequency either 50 or 60 HZ and the main dimensions are mounting dimensions (A×C)70×58 mm mounting holes(K×J) 6×10 mm .As shown below in Figure 3.9

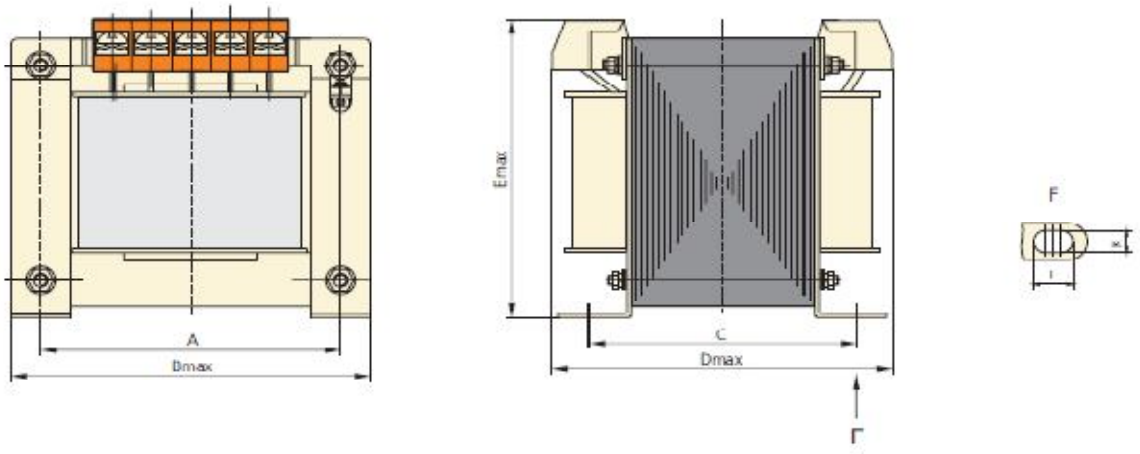

Figure 3.9: Dimension of control transformer

When a magnetic field moves across a wire, a voltage is induced into the wire, if the wire forms a complete circuit, current will flow in the wire. If a second coil of wire is placed in a moving magnetic field, then a voltage will be induced in this second coil, this phenomenon is called mutual induction. Alternating current in one winding produces a moving magnetic field that induces a voltagein a second winding. Electrical energy is converted into' magnetic field and then converted back into electrical energy in a second winding.

The transformer primary is connected to the power A.C. source thru cable and the secondary windings are connected to the bridge rectifier.

The transformer in Figure 3.10 used to step down the 220 voltage A.C. To a 12 voltage A.C. and transfer it the rectifier bridge.

Figure 3.10: Novel Developer Kit(NDK) control transformer

3.9 Relay Module

A relay is electrically operated switchesare used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal Relays control power circuits with no moving parts, instead using a semiconductor device to perform switching protect electrical circuits from overload or faults in modern electrical power systems. The Relay input voltage is 5v, so the relay output 10 amps / 250v A.C and the signal input 5v D.C from microcontroller.

An iron core is surrounded by a control coil. As shown, the power source is given to the electromagnet through a control switch and through contacts to the load. When current starts flowing through the control coil, the electromagnet starts energizing and thus intensifies the magnetic field. Thus the upper contact arm starts to be attracted to the lower fixed arm and thus closes the contacts causing a short circuit for the power to the load.

There are two Relay types used in project:

A relay connected to the breadboard through (VCC) & (GRD),and signal transmitted to it via AVR,Four relays excited from the breadboard (+) &(-) to positive(VCC) and negative (GRD)relay pins respectively, and the operating signal is transmitted from Arduino Uno digital I/P pins (8,9,10,11) and the relay output in directly connected to the Loads.

The relay connected to AVR used to protect the control circuit in respond to AVR signal from over-under voltage. The other relays used to control the load in response to Arduino signal.

Figure 3.11: Relay Module

3.10 Bridge Rectifier

A diode bridge is an arrangement of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. Bridge Rectifier used for conversion of an alternating current (AC) input into a direct current (DC) output. And it used in this project to rectifies the AC current of the control Transformer to DC current.

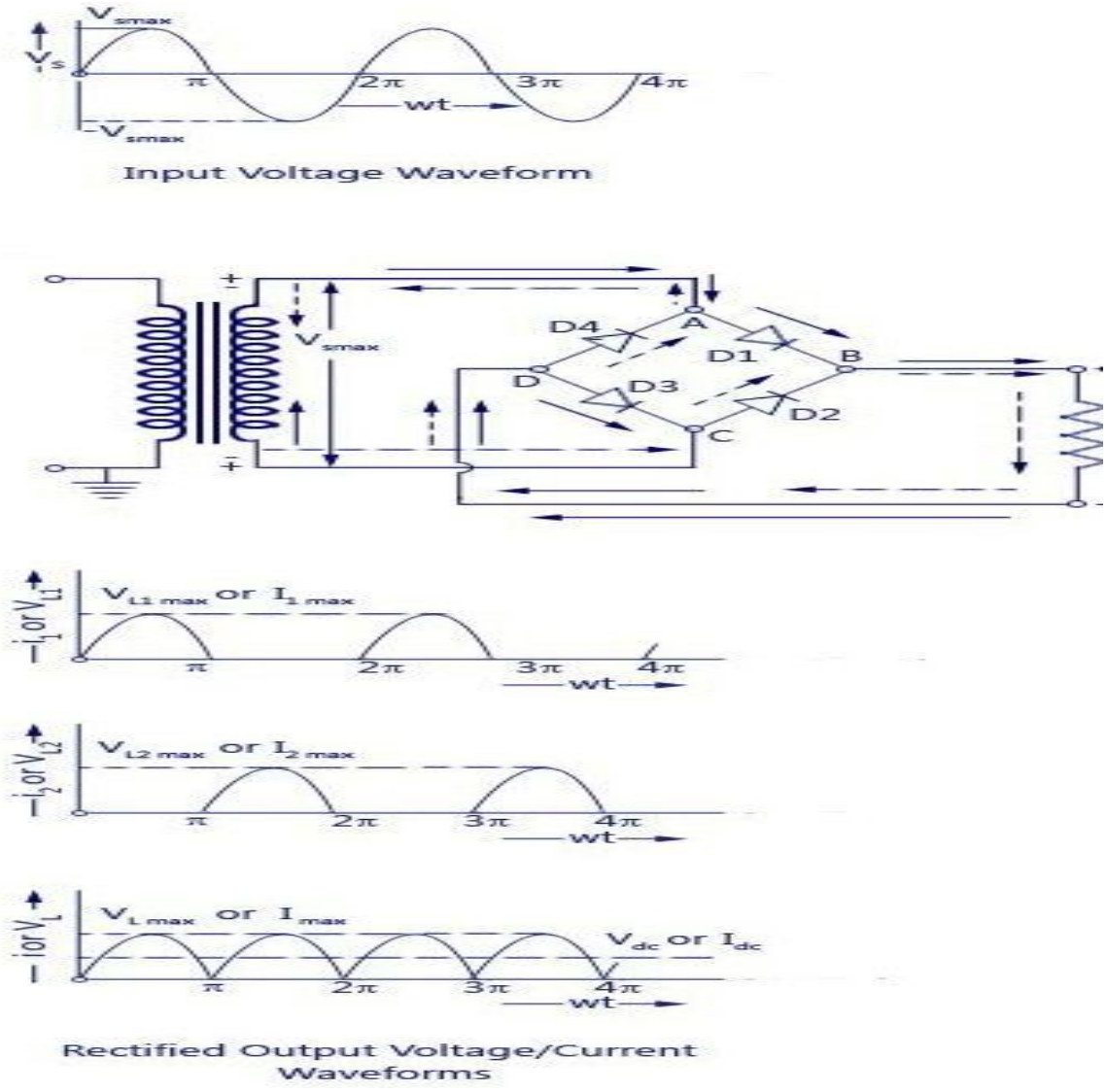

Figure3.12: Full wave bridge rectifier

3.11 Smoothing Circuit

Rectifiers are normally used in circuits that require a steady voltage to be supplied. To provide a steady DC output. The raw rectified DC requires a smoothing capacitor circuit to enable the rectified DC to be smoothed so that it can be used to power electronics circuits without large levels of voltagevariation. The DC supplied by a rectifier on its own would consist of a series of half sine waves with the voltage varying between zero and √2 times the RMS voltage (ignoring any diode and other losses). A supply of this nature would not be of any use for powering circuits because any analogue circuits would have the huge level of ripple superimposed on the output, and any digital circuits would not function because the power would be removed every half cycle.

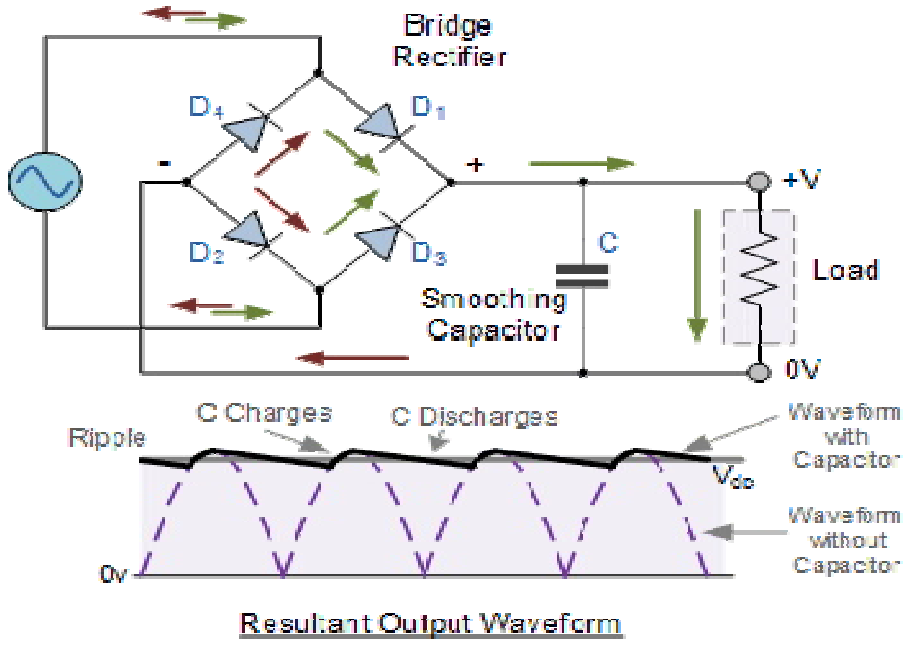

Figure 3.13: Smoothing circuit

3.12 Jumper Wires

A jump wire is an electrical wire or group of them in a cable with a connector or pin at each end which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without solderingas shown in Figure3.14. .

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

There are different types of jumper wires. Some have the same type of electrical connector at both ends, while others have different connectors. Some common connectors are:

- ✓ Solid tips – are used to connect on/with a breadboard or female header connector. The arrangement of the elements and ease of insertion on a breadboard allows increasing the mounting density of both components and jump wires without fear of short-circuits. The jump wires vary in size and colour to distinguish the different working signals.
- ✓ Crocodile clips – are used, among other applications, to temporarily bridge sensors, buttons and other elements of prototypes with components or equipment that have arbitrary connectors, wires, screw terminals, etc.
- ✓ Banana connectors – are commonly used on test equipment for DC and low-frequency AC signals.
- ✓ Registered jack (RJnn) – are commonly used in telephone (RJ11) and computer networking (RJ45).
- ✓ RCA connectors – are often used for audio, low-resolution composite video signals, or other low-frequency applications requiring a shielded cable.
- ✓ RF connectors – are used to carry radio frequency signals between circuits, test equipment, and antennas.

.

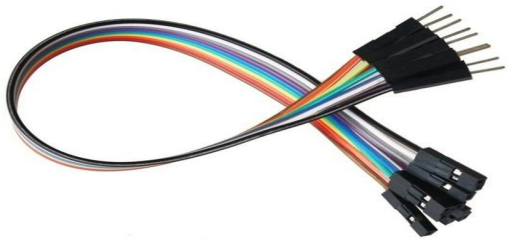

Figure3.14: Jumper wires

CHAPTER FOUR

SYSTEM IMPLEMENTATION AND TESTING

4.1 Introduction:

This chapter will be containing a brief and specific explanation of how the circuit in chapter three is working and maintain the desired goals or jobs with help of a simulation diagram,starting from the power supply to the controlled loads through both power and control circuit, first we will showing the role of power circuit and its task in the module, each of its element function and how the desired power reach the control circuit , then we will come to the control part explaining how the signal flow through the circuit over each element to the relays ,Reminding all the above will be with aid of simulation diagram

4.2 Implementation System

The Control of four relays using Bluetooth module and Arduino-Uno through android phone signal with addition for AVR power circuit for protection. This part describes the implementation of the whole system, from Arduino-Uno board to the appliances. This system is integrated using Arduino-Uno board, Bluetooth module, relays modules, protection regulator, an android device, an android app to control the Arduino board, and other electronics components.

4.3 Simulation and Software

The program used in this simulation is called Proteus, The Proteus Design Suite is a proprietary software tool suite used primarily for automation. The software is used mainly by electronic design engineers and electronic

technicians to create electronic schematics and electronic prints for manufacturing printed circuit boards.

It is a software suite containing schematic, simulationsas well as PCB designing. it's contain:

- ISIS is the software used to draw schematics and simulate the circuits in real time.The simulation allows human access during run time, thus providing real time simulation.
- ARES is used for PCB designing. It has the feature of viewing output in 3D view of the designed PCB along with components.
- The designer can also develop 2D drawings for the product.

ISIS has wide range of components in its library. It has sources, signal generators, measurement and analysis tools like oscilloscope, voltmeter, ammeter etc., probes for real time monitoring of the parameters of the circuit, switches, displays, loads like motors and lamps, discrete components like resistors, capacitors, inductors, transformers, digital and analoge Integrated circuits, semi-conductor switches, relays, microcontrollers, processors, sensors etc.

ARES offers PCB designing up to 14 inner layers, with surface mount and through whole packages. It is embedded with the foot prints of different category of components like ICs, transistors, headers, connectors and other discrete components. It offers Auto routing and manual routing options to the PCB Designer. The schematic drawn in the ISIS can be directly transferred ARES. The circuit has been discussed in previous chapter will be discussed here with aid of simulation diagrams and symbols, screen shots

has been taken to the simulation diagram of each element and its function discussed.

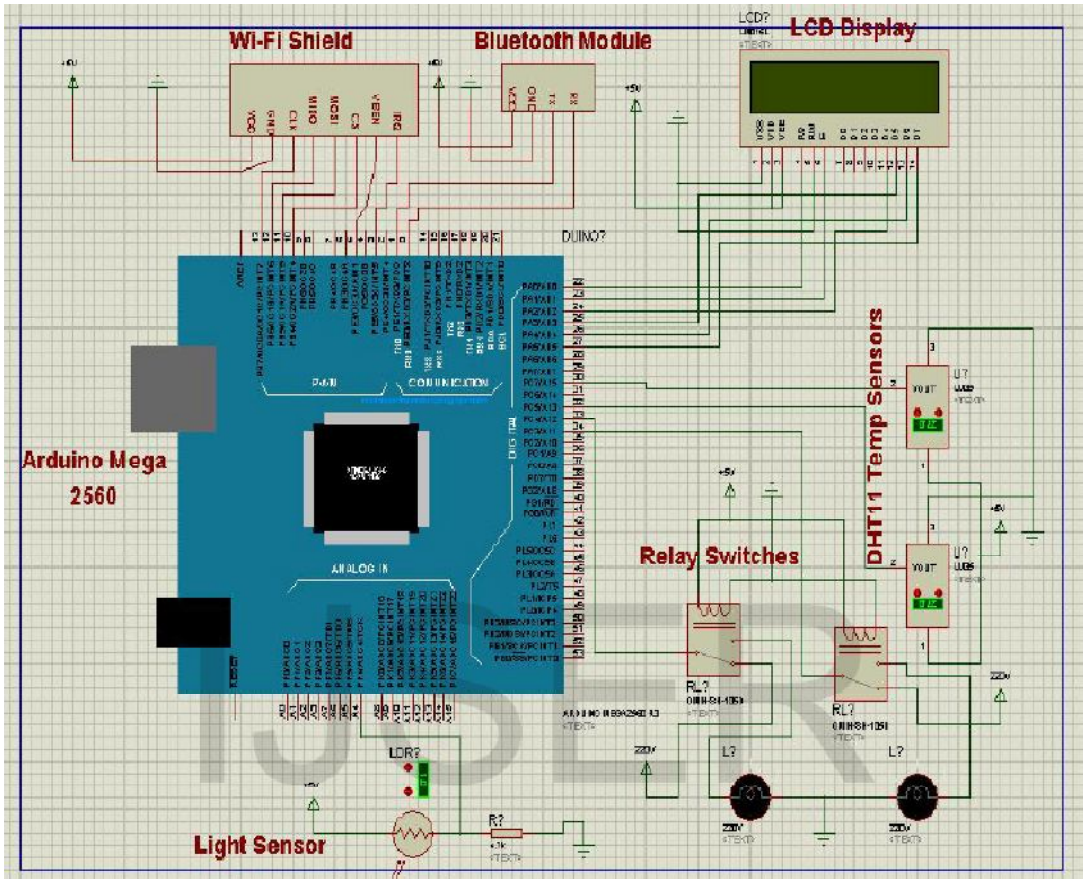

Figure 4.1: Circuit design using proteus simulator

4.3.1 Android application

The android application was designed using the Google App-Inventor Integrated Development Environment (IDE) and Java programming language. The application contains both a Bluetooth module and a Wi-Fi module which interfaces with the micro-controller and allows the android smart phone to communicate with the micro-controller effectively and efficiently.

The android application allows the user to control devices and monitor conditions in the home using the Bluetooth connection. The android application is efficient, flexible and has a user friendly Graphic User Interface (GUI). The application has a user authentication page to verify that the authorized user is logged in and has full control of the home-appliances. The authentication page and the bedroom page after login are shown in figure

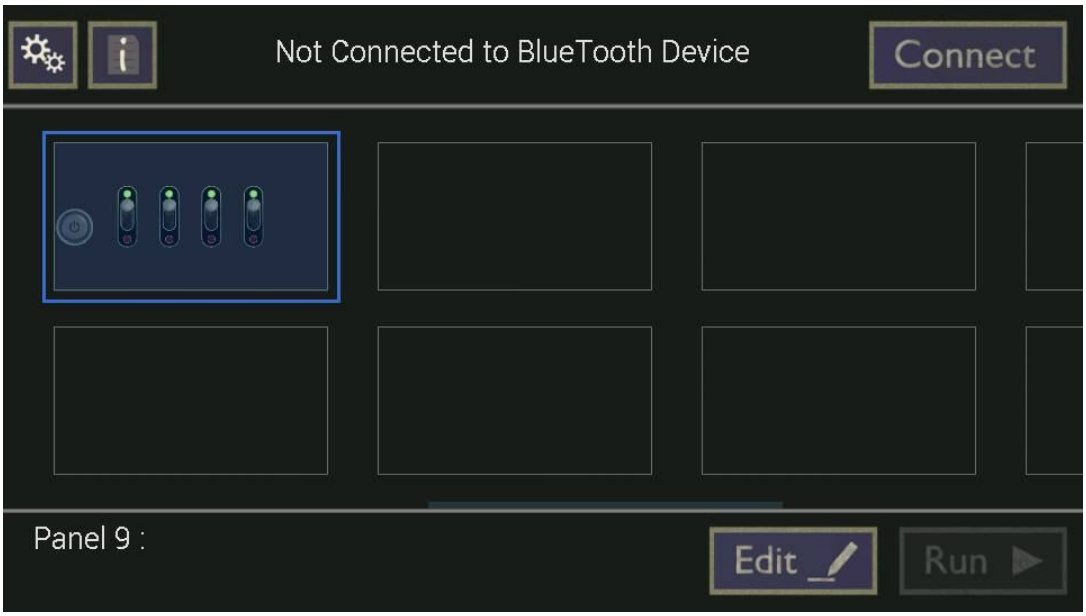

Figure 4.2: The android phone application interface

4.3.2 Operation

The input from power supply 230V AC power is converted into RMS value of 12V AC by the mean a step down transformer as mentioned. Peak value of 12V (approx.). The 12V AC is converted into DC using a Full-wave bridge rectifier that consists of four diodes, which are called as uncontrolled rectifiers. Diode will conduct only in forward bias and will not conduct during the reverse bias. If anode voltage of diode is greater than cathode, then the diode is said to be in forward bias. Diodes D2 and D4 conducts

during positive half cycle and diodes D1 and D3 conduct during negative half cycleThe output signal from the full-wave bridge rectifier then flow through smoothing capacitor , which reduce the ripples of the output signals of the rectifier and make it near as possible to a dc power supply , as shown in Figure 4.2.

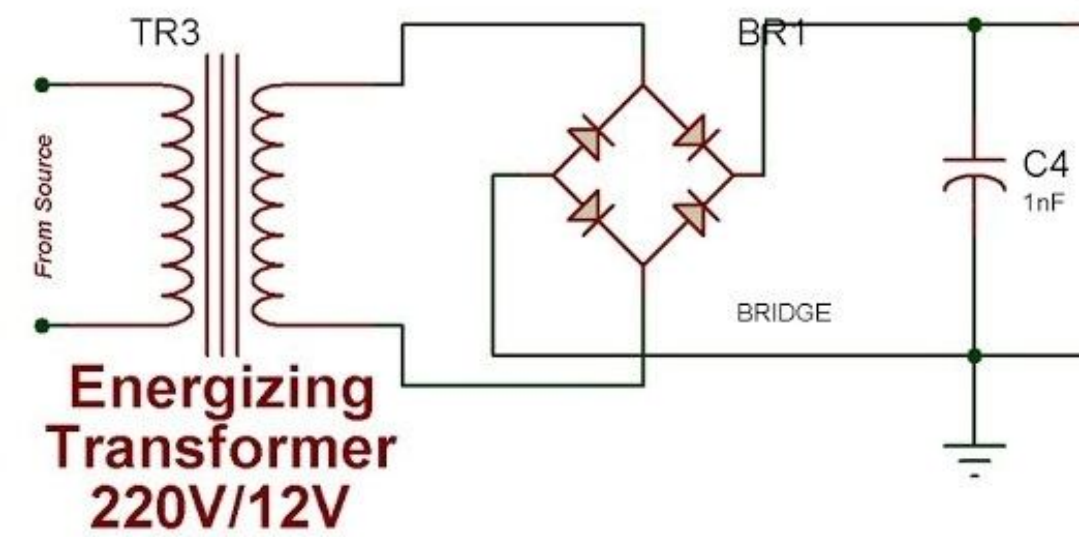

Figure 4.3: The power supply circuit

Then the output from the power supply circuit flow through AVR circuit, thiscircuit protects the overall system as well as other electrical appliances from over and under voltage.If the input voltage is more or less than the required voltage then the electrical appliance is turned off and disconnected from its respective power supply. This circuit uses an operational amplifier IC LM324 which is used as a comparator. Generally, the IC LM324 consists of four operational amplifiers, of which only two operational amplifiers are used. In this IC, we have an inverting terminal and a non-inverting terminal. The voltages at the inverting terminal and the non-inverting terminal are

6.0v and 6.8v respectively. When the input AC voltage exceeds 240v, the voltage at the non-inverting terminal increases. So now if the voltage at the non-inverting terminal increases more than 6.8v then the output of the operational amplifier is pulled high. So the electrical appliance is turned off by means of a relay connected to the output pin of the op-amp. Thus the electrical appliance is now protected against over voltage. Now let us consider under voltage condition. When the line voltage is below 180v, the voltage at the inverting terminal is less than the voltage at the non-inverting terminal. Thus the output of the operational amplifier now goes high and the AC supply gets disconnected and the electrical appliance also turns off. Thus, the appliance is now protected against under voltage, as shown in Figure 4.3

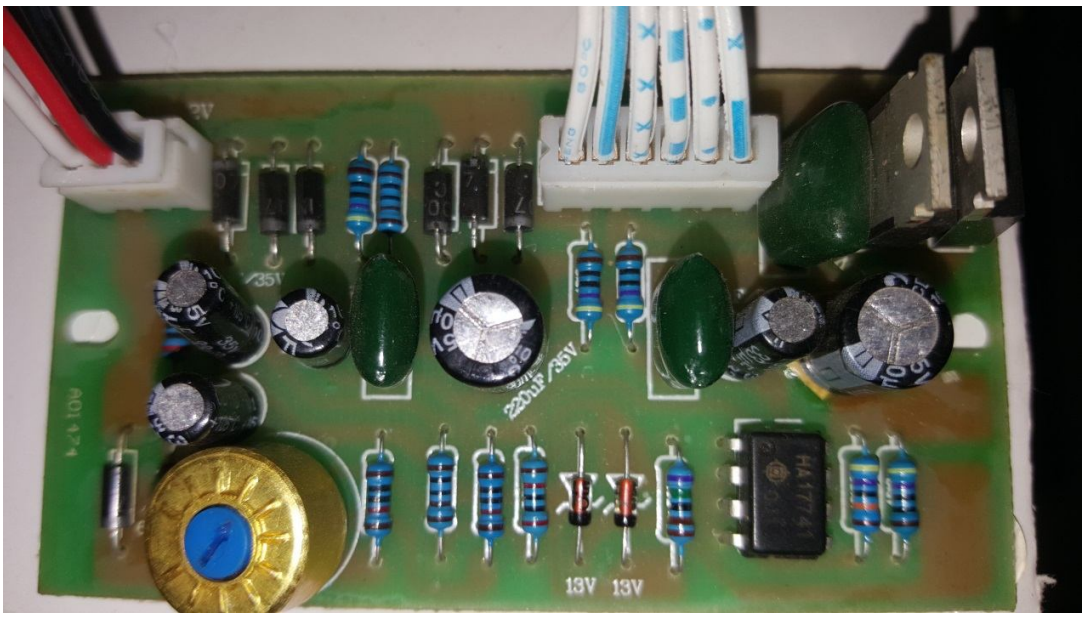

Figure 4.4: Automatic voltage regulator circuit

The output signal from AVR control relay which control the input signal 12V DC to Arduino-Unoand protect the overall system from over and under voltage .then the 5V voltage signal from theArduino-Uno output pins operates the Bluetooth module. The projected system works using the smart phone Android application, which is the main source for giving the instruction to the Bluetooth module. In this proposed system, from user side, user can select the option, which switch he/ she wants to ON/OFF from their Android smart phone App. This command goes to the Bluetooth module. Bluetooth modules transmitter convert it into signals and send that command to the receiver of the Arduino-Uno microcontroller which is protected by regulator for over and under voltage protection. After that controller activates that particular I/O pin on the board and send input to the Relay. In that Relay, which has already 230V power supply, after receiving current it generates electromagnetic field in coil and passes the 5V current to switch ON the light. User can select the option from anywhere in remote access area network, which is near about 20m from Bluetooth module. It generates HIGH frequency i.e. 0 for switch ON and LOW frequency i.e.1 for switch OFF the electrical supply, as shown in Figure 4.7 below.

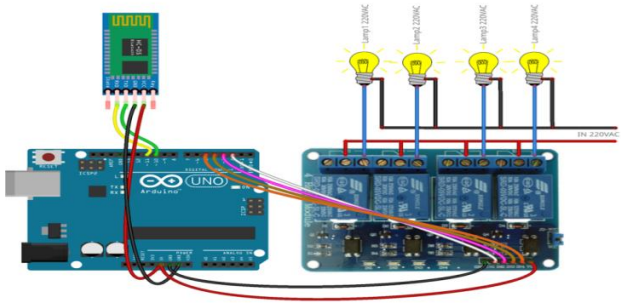

Figure 4.5: Arduino-Uno connected to Bluetooth and relays

Figure 4.6: design prototype

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

a Smart Home Automation System will achieved. It is Bluetooth based, hence wireless and can be flexible in terms of cost. The home automation system has been experimentally proven to work satisfactorily by connecting sample appliances to it and the appliances were successfully controlled from a wireless mobile device. The Bluetooth client was successfully tested on a multitude of different mobile phones from different manufacturers, thus proving its portability and wide compatibility. It requires authentication details as a medium of security.This project will not only provide convenience to the common man but will be a boon for the elderly and disabled.

5.2Recommendations

The project has a space for recommend to further improvementsare:

- Detection of fire, gas leaks and water leaks by using sensors.
- The system can call the home owner on their mobile phone to alert them, or call the fire department or alarm monitoring company as securitysystem.

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APPENDIX

The Arduino-uno IDE programming code

```
#include<SoftwareSerial.h>

SoftwareSerialhc06(0, 1);
intsignl = 0;
intcurrentState = 0;

voidsetup() {
pinMode(8, OUTPUT);
digitalWrite(8, LOW);
pinMode(9, OUTPUT);
digitalWrite(9, LOW);
pinMode(10, OUTPUT);
digitalWrite(10, LOW);
pinMode(11, OUTPUT);
digitalWrite(11, LOW);
hc06.begin(9600);
}

voidloop() {
if (hc06.available()) {
signl = hc06.read();
  }
if (signl == 'A' && !currentState) {
digitalWrite(2, HIGH);
currentState = 1;
  }
if (signl == 'a' &&currentState) {
digitalWrite(2, LOW);
currentState = 0;
  }
if (signl == 'B' &&currentState) {
digitalWrite(3, HIGH);
currentState = 1;
```

```
  }
if (signl == 'b' &&currentState) {
digitalWrite(3, LOW);
currentState = 0;
  }
if (signl == 'C' &&currentState) {
digitalWrite(4, HIGH);
currentState = 1;
  }
if (signl == 'c' &&currentState) {
digitalWrite(4, LOW);
currentState = 0;
  }
if (signl == 'D' &&currentState) {
digitalWrite(5, HIGH);
currentState = 1;
    }
if (signl == 'd' &&currentState) {
digitalWrite(5, LOW);
currentState = 0;
     }
delay(100);
}
```