CHAPTER ONE

INTRODUCTION

1.1 General

This modern era, life without electronics is unimaginable. With the progressive increase in the number of electronic gadgets, it becomes essential to design a remote control system that can control a number of them at the same time. A remote control system now finds a large number of crucial applications like controlling of artificial satellites, manufacture of products by machines or in the control of chemical reactions in dangerous plants from a distance. For the design of a remote control system that controls the switching of multiple electronic devices at the same time, DTMF tones have been used. The reason for the use of DTMF is that one can control a maximum of twelve devices simultaneously by means of a single remote system [1].

1.2 Problem Statement

Electrical appliances such as fans, air conditioners, motors, lighting systems, etc needs to turn on and turn off. From a few decades, controlling devices using remote control becomes common. Infrared and bluetooth technology are becomes common in remote control. But these technologies have their own limitations, an infrared signal to be detected must be a direct line of sight between the transmitter and the receiver, if there is a wall or large object between them the signal do not pass through it. IR does not penetrate walls and so does not interfere with other devices in adjoining rooms. bluetooth technology uses a short radio frequency, which allows transmission through walls and other objects but has lower distance range. Technologies infrared and bluetooth remote control are used for short distance applications. Hence need a system does not limitation of range it can be used from anywhere.

1.3 Objectives

The main aims of this thesis are:

- Design of a system that controls a four devices via the mobile phone.
- Simulation of proposed system.

- Implementation and testing of proposed system.

1.4 Methodology

- Study of previews related works.
- Global system for mobile communication is used as main media for the system.
- The DTMF decoder is used to convert the analogue signal to digital signal.
- The Atmega16 microcontroller is programmed using BASIC language.
- System simulation is done by using Proteus software.

1.5 Thesis Layout

This thesis consists of five chapters including chapter one. chapter two gives theoretical background and literature review including control system, global system for mobile communication and microcontroller. chapter three discusses system hardware and software considerations. chapter four describes system design, implementation and testing. Finally chapter five handles conclusion and recommendations.

CHAPTER TWO

THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 Control System

Control is used to modify the behavior of a system so it behaves in a specific desirable way over time. Control is used whenever quantities such as speed, altitude, temperature, or voltage must be made to behave in some desirable way over time. Automatic control has played a vital role in the advance of engineering and science. In addition to its extreme importance in 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 distinguishing feature of open-loop control is the open nature of its action, that is, the output variable does not have any influence on the input variable as shows in Figure 2.1.

Closed- loop control system is defined as a process where the control -led variable is continuously monitored and compared with the reference variable. Depending on the result of this comparison, the input variable for the system is influenced to adjust the output variable to the desired value despite any disturbing influences. This feedback results in a closed-loop action as shows in Figure 2.2. An advantages of the closed-loop control system is the fact that the used of feedback makes the system response relatively in sensitive to external disturbances and integral various in system parameters. It is thus to use relatively in accurate and inexpensive components to the obtain the accurate control of a given plant, whereas doing so is impossible in the open-loop case [2].

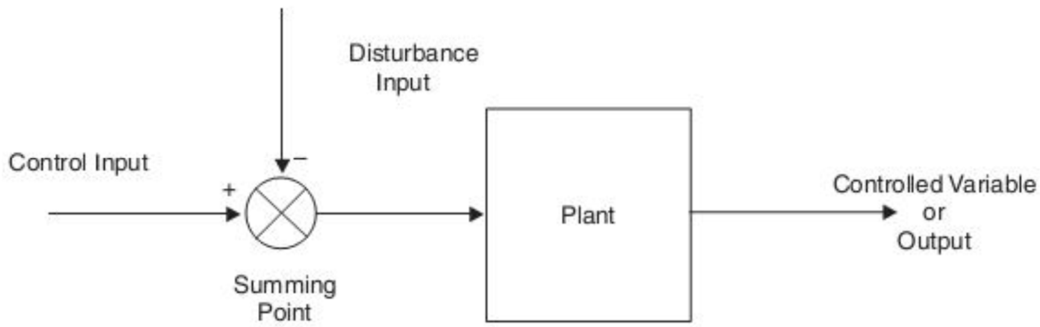


Figure 2.1: Open-loop control system

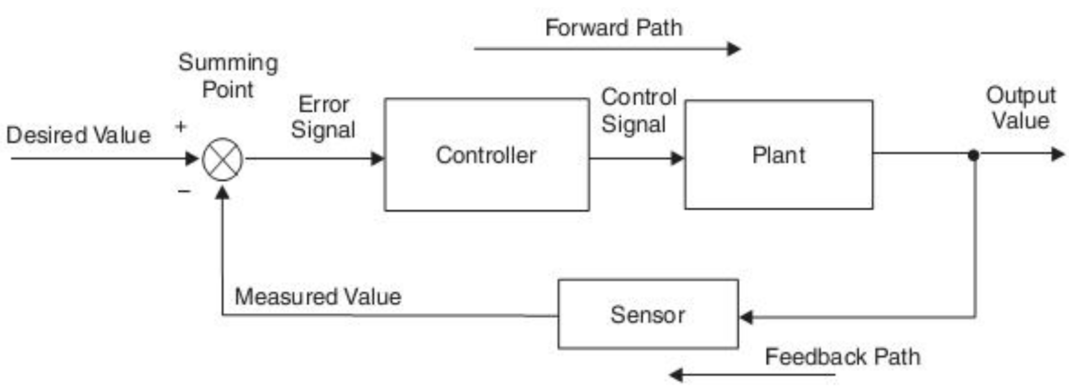


Figure 2.2: Close-loop control system

2.1.1 Remote control

The concept of remote control and monitoring becomes an essential feature in many systems nowadays. Remote control system is a control system that allows accessing and managing an electrical or electronic device remotely. Remote control systems are used in different fields like home management, factory automation, space exploration, robot operating, and other critical fields. There many advantages of using remote control systems. Remote control systems are great time and effort savers, also they provide flexibility, security, independence of location or geographical distance [3].

2.1.2 Infrared control

Infrared remote controls use invisible light pulses below the visible wavelength spectrum approx 950nm [4]. There must be a line of sight between the light source and the light detector. Any obstacles between transmitter and receiver will prevent from correct reception. Under good conditions scattered light or light reflected from walls may keep the system working. Having walls between the remote controller and the receiving device definitely disable the remote control. This obvious disadvantage and limitations of infrared remote controls simplifies the protocol at the same time. Infrared remote controls have proven being a cost efficient solution for controlling many kinds of electronic devices, home entertainment, air condition and home lighting [4].

2.2 Global System for Mobile

Global System for Mobile (GSM) communication is a globally accepted standard for digital cellular communication. GSM is the name of standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for pan –European mobile cellular radio system operating at 900 MHz. The GSM technical specifications define the different entities that form the GSM network by defining their functions and interface requirements.

2.2.1 GSM network architecture

The GSM network architecture shows in Figure 2.3 can be divided into four main parts:

i. Mobile station

A mobile station consists of two main elements mobile equipment or terminal and Subscriber Identity Module (SIM). The mobile equipment encompasses the Radio Frequency (RF) hardware to access the network. The mobile equipment unites take many functional elements in the transmission chain of the GSM system. With aid of the data stored in the SIM card, the speech is digitized, compressed, secured against loss of data through redundancy and interleaving, encrypted in prevent interception and modulated into the RF created by the mobile station. In the opposite direction, the process runs inversely, beginning with the reception of RF. The SIM shows in Figure 2.4 is a smart card that identifies the terminal.

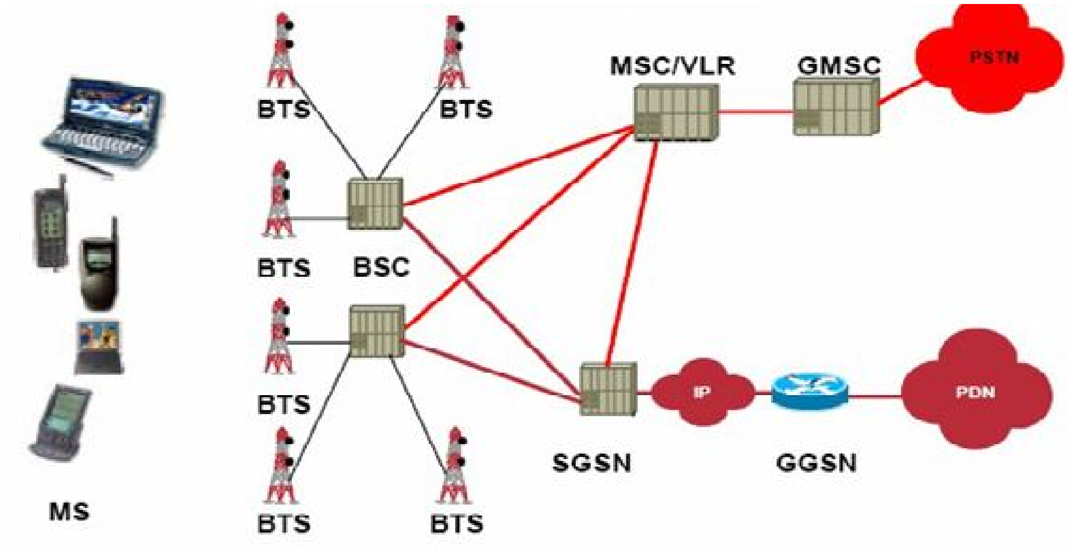


Figure 2.3: Architecture of the GSM network

By inserting the SIM card into the terminal, the user can have access to all the subscribed services. Without the SIM card, the terminal is not operational. The SIM card is protected by a four-digit Personal Identification Number (PIN). In order to identify the subscriber to the system, the SIM card contains some parameters of the user such as its International Mobile Subscriber Identity (IMSI). Another advantage of the SIM card is the mobility of the users. In fact, the only element that personalizes a terminal is the SIM card. Therefore, the user can have access to its subscribed services in any terminal using its SIM card.

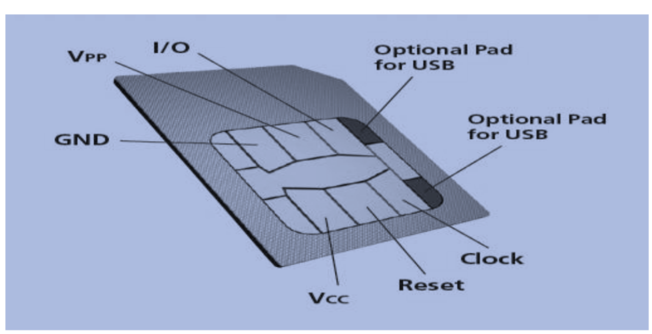


Figure 2.4: Subscriber identity module

ii. Base station subsystem

The Base Station Subsystem (BSS) connects the mobile station and the network switching subsystem. It is in charge of the transmission and reception. The BSS can be divided into two parts, the Base Transceiver Station (BTS) and Base Station Controller (BSC). The BTS corresponds to the transceivers and antennas used in each cell of the network. A BTS is usually placed in the center of a cell. Its transmitting power defines the size of a cell. Each BTS has (1-16) transceivers depending on the density of users in the cell. The BSC controls a group of BTS and manages their radio resources. A BSC is principally in charge of handovers, frequency hopping, exchange functions and control of the radio frequency power levels of the BTSs.

iii. Network and switching subsystem

The main role of the Network and Switching Subsystem (NSS) is a manage the communications between the mobile users and other users, such as mobile users, fixed telephony users, etc. It also includes data bases needed in order to store information about the subscribers and to manage their mobility.

iv**.** Operation and support subsystem

The Operation and Support Subsystem (OSS) is connected to the different components of the NSS and to the BSC, in order to control and monitor the GSM system. It is also in charge of controlling the traffic load of the BSS. However, the increasing number of base stations, due to the development of cellular radio networks, has provoked that some of the maintenance tasks are transferred to the BTS. This transfer decreases considerably the costs of the maintenance of the system.

To monitor the network components and, if necessary, control and adjust their performance, the GSM network needs the Operation and Maintenance Center (OMC). The OMC is responsible for:

- Error management.
- Configuration management.
- Performance management.
- Administration management.
- Remote access to different network components

Today's GSM stage is living, developing and advancing and as of now offers an extended and characteristic-rich "family" of voice and empowering administrations. The GSM system is cell telecommunication system with an adaptable structural planning following the European Telecommunications Standards Institute (ETSI) Gsm900/GSM 1800 standard. Seimen's usage is the advanced cell versatile correspondence framework D900/1800/1900 that uses the precise most recent innovation to meet each prerequisite of the standard [5].

2.2.2 Features of GSM

• Short message service which allows to send and receive 126 character text messages.

• Ability to use same phone in a number of network-related countries.

• Allows data transmission and reception across GSM networks at speeds up to 9,600 bps currently.

• Forwarding of calls to another number. More capacity, ensuring rapid call set-up.

• Handsets also smaller and more robust.

• Place a call on hold while you access another call.

• Encrypted conservations that cannot be tapped.

• Emergency calls - In the majority of countries, the global 112 emergency number can be dialed free.

• No-static connections [6].

2.2.3 Advantages of GSM

• Improved spectrum efficiency.

• International roaming.

• Low-cost mobile sets and base stations.

• High-quality speech.

• Compatibility with Integrated Services Digital Network (ISDN) and other telephone company services.

• Support for new services [6].

2.2.4 Disadvantages of GSM

• No end-to-end encryption of user data.

• Reduced concentration while driving.

• Electromagnetic radiation.

• Abuse of private data possible.

• Roaming profiles accessible.

• High complexity of the system.

• Several incompatibilities within the GSM standards.

2.3 Microcontroller

Microcontroller is a highly integrated chip that contains all the components comprising a controller. It includes Central Processing Unit (CPU), Random Access Memory/ Read Only Memory (RAM/ROM), Input /Output (I/O) ports, timers. Microcontrollers sometimes called embedded microcontrollers, which just means that they are part of a larger device or system unlike a general purpose computer, which also includes all of these components, a microcontroller is designed for a specific task to control a particular system. Microcontrollers used in a wide number of electronic systems such as control systems in industries, electronic measurement instruments, printers, mobile phones, security systems, garage door openers, etc [7].

2.3.1 AVR microcontroller architecture

Atmel's AVR microcontrollers introduced to the market only a few years ago. Atmel's AVR microcontrollers use a new Reduced Instruction Set Computer (RISC) architecture which has been developed to take advantage of the semiconductor integration and software capabilities. AVR microcontrollers have big register files and fast one-cycle instructions. The family of AVR microcontrollers includes differently equipped controllers [8].

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional Complex Instruction Set Computer (CISC) microcontrollers.

The ATmega16 provides the following features: 16 Kbytes of in-system programmable flash program memory with read-while-write capabilities, 512 bytes

Electrically Erasable Programmable Read Only Memory (EEPROM), 1 Kbyte Static Ram (RAM), 32 general purpose input/output lines, 32 general purpose working registers, a Joint Test Action Group (JTAG) interface for boundary scan, on-chip debugging support and programming, three flexible timer/counters with compare modes, internal and external interrupts, a serial programmable Universal Synchronous/Asynchronous Receiver/Transmitter (USART), a byte oriented two-wire serial interface, an 8-channel, 10-bit Analog-to-Digital Converter (ADC) with optional differential input stage with programmable gain (Thin Quad Flat Package (TQFP) only), a programmable watchdog timer with internal oscillator, an Serial Peripheral Interface (SPI) serial port, and six software selectable power saving modes. The idle mode stops the CPU while allowing the USART, two-wire interface, A/D converter, SRAM, timer/counters, SPI port, and interrupt system to continue functioning. The power-down mode saves the register contents but freezes the oscillator, disabling all other chip functions until the next external interrupt or hardware reset. In power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC noise reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In standby mode, the crystal/resonator oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption. In extended standby mode, both the main oscillator and the asynchronous timer continue to run.

The device is manufactured using Atmel’s high density nonvolatile memory technology. The on chip In-System Programming (ISP) flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an on-chip boot program running on the AVR core. The boot program can use any interface to download the application program in the application flash memory. Software in the Boot Flash section will continue to run while the application flash section is updated, providing true read-while-write operation. By combining an 8-bit RISC CPU with in-system self-programmable flash on a monolithic chip, the ATmega16 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The ATmega16 AVR is supported with a full suite of program and system development tools including: compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits [9]. The ATmega16 block diagram shown in Figure 2.5.

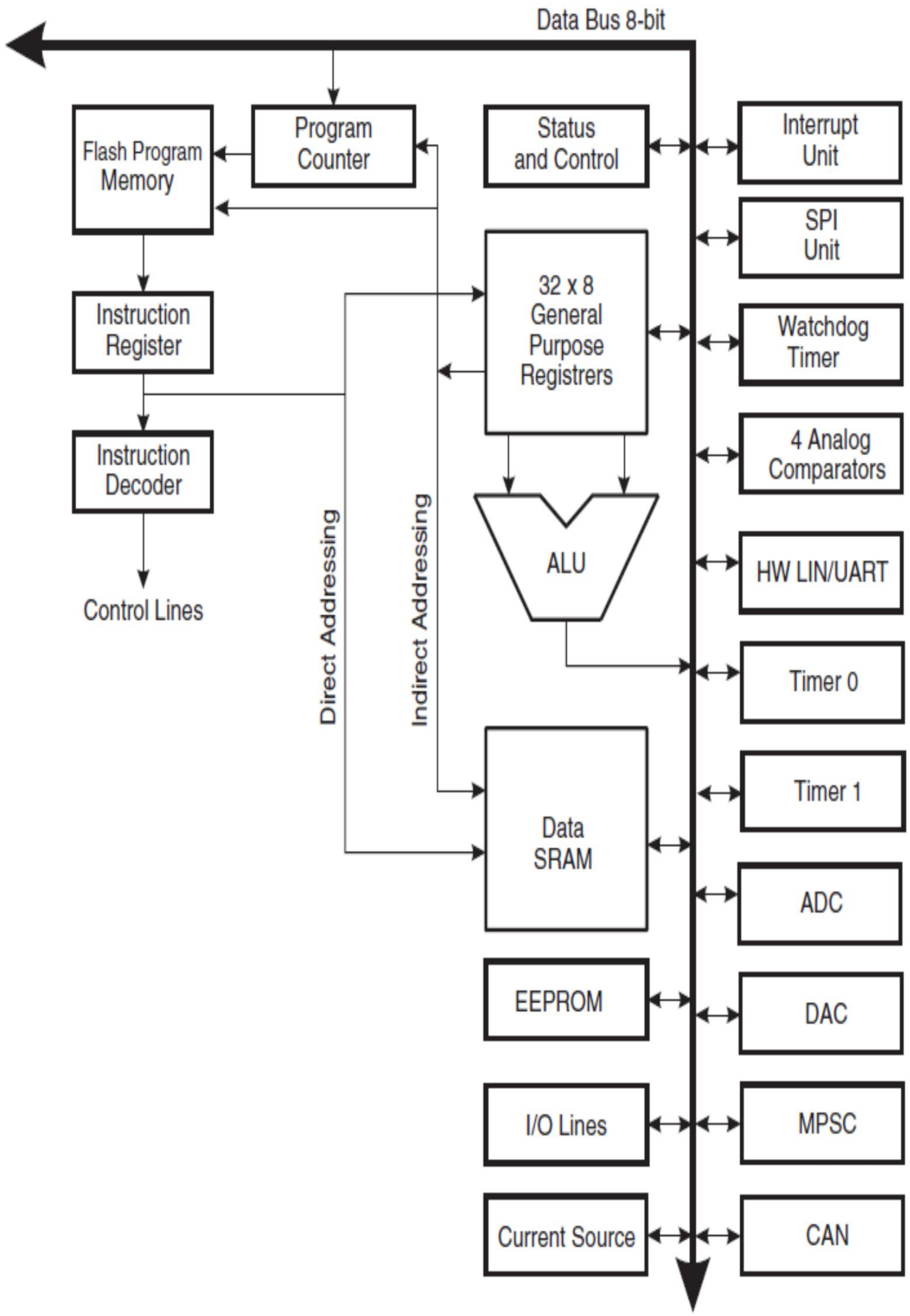


Figure 2.5:A Block diagram of the AVR architecture

2.3 .2 Atmega16 microcontroller Pin configuration

Figure 2.6 shows the pin configuration of Atmega16 microcontroller.

- **VCC**

Digital supply voltage.

- **GND**

Ground.

- **Port A (PA0..PA7)**

Port A serves as the analog inputs to the A/D converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D converter is not used. Port pins can provide internal pull-up resistors. The port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The port A pins are tri-state when a reset condition becomes active, even if the clock is not running.

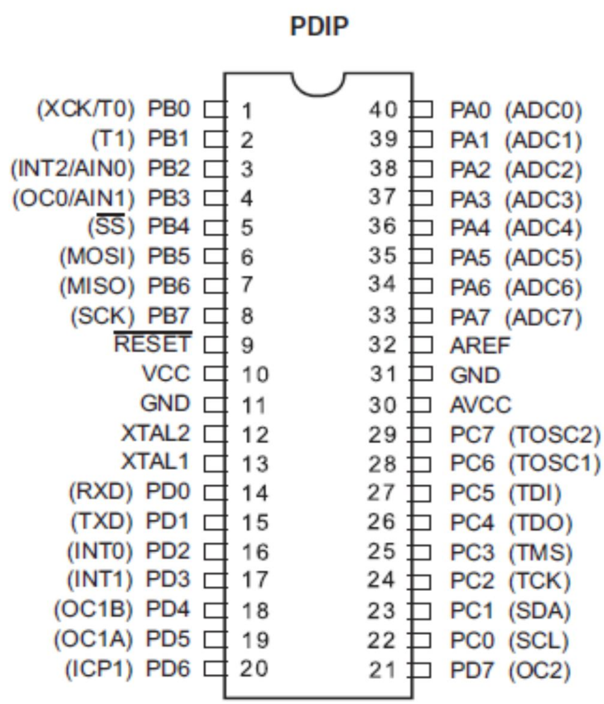


Figure 2.6: Pin configuration of Atmega16 microcontroller

• **Port B (PB0..PB7)**

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors. The port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port B pins that are externally pulled low will source current if the pull-up resistors are activated. The port B pins are tri-state when a reset condition becomes active, even if the clock is not running.

• **Port C (PC0..PC7)**

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors. The port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port C pins that are externally pulled low will source current if the pull-up resistors are activated. The port C pins are tri-state when a reset condition becomes active, even if the clock is not running.

• **Port D (PD0..PD7)**

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors. The port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port D pins that are externally pulled low will source current if the pull-up resistors are activated. The port D pins are tri-state when a reset condition becomes active, even if the clock is not running.

• **RESET**

Reset input: A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running.

• **XTAL1**

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

• **XTAL2**

Output from the inverting oscillator amplifier.

• **AVCC**

AVCC is the supply voltage pin for port A and the A/D converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

• **AREF**

AREF is the analog reference pin for the A/D converter [9].

2.4 Literature Review

The review was done based on studying proceeding papers and journal articles. Raqibull Hasan [10] design and implementation of a microcontroller based home security system with GSM technology. Two microcontrollers with other peripheral devices which include light emitting diode, liquid crystal display, buzzer and GSM module responsible for reliable operation of the proposed security system. In addition, a mobile phone is interfaced with microcontroller through a bluetooth device in order to control the system. Moreover, a manual keypad is another way to lock or unlock the system. A compiler code vision AVR is used to design a program that controls the system along with maintaining all security functions. The designed program is applied in Proteus software for simulation.

Adamu Murtala [11] design and implementation of a Short Message Service (SMS) based remote. Controller safeguarding home appliances has become an issue when dealing with an advancement and growth of an economy. The system is short message service based and uses wireless technology to revolutionize the standards of living. It provides ideal solution to certain problems faced by home owners in daily life. Due to its wireless nature, it is more adaptable and cost- effective. The research is divided into two sections; the hardware and the software sections. The hardware section consists of the global system for mobile.

Renuka P. Dhage [12] a review home automation system. Different systems or technologies are used to control electrical appliance like short message service, FPGA controller, AVR, GSM module, Zigbee, etc. This system provides an overview on home automation systems which are developed in the recent year and also provides system description and different methods used.

R. Chutia [13] design and development of a remote household appliance control system using mobile handset through GSM technology. Remotely, the system allows the homeowner to monitor and control his house appliances via his mobile phone set by sending commands in the form of SMS messages and receiving the appliances status as well. This system provides ideal solution to the problems caused in situations when a wired connection between a remote appliance and the control unit might not be feasible. The system is wireless and uses the user's mobile handset for control and therefore the system is more adaptable and cost-effective. The system uses GSM technology thus providing ubiquitous access to the system for appliance control.

Oyediran Mayowa [14] design and implementation of a GSM based electronic appliances monitoring and controlling system. This enables individuals to connect their home or office electronic appliances to the developed system which in turn enables them to remotely monitor and control these appliances though a short message service. In remotely controlling the connected electronic appliances, users can determine the status of the electronic appliances remotely and decide whether to either switch any of the connected electronic appliances on or off. The uniqueness of the approach introduced is further revealed in the way the GSM module of the developed system was integrated with the PIC16F877A microcontroller to give a single and more compact system. Also, the SMS format used in monitoring and controlling the connected electronic appliances allows users to control their electronic appliances from anywhere provided there is a GSM network.

Hussein Abdul Razzaq [15] implemented system is based on global system mobile network by using short message service. The design mainly contains a GSM modem and interfacing unit circuit with microcontrollers. This system could control up to eight different electrical devices such as light, Air conditioner, washing machine and many more applications which needed in daily life in different area. The control is done by sending a specific SMS messages from traditional or smart phone. The controlling devices are restricted to a pre-defined phone number and are set in the software of the receiver. Also feedback status of eight devices can be requested in designed system. The hardware of the receiver contains the two (PIC16F887) microcontrollers, GSM modem, and Interfacing unit circuit.

CHAPTER THREE

SYSTEM HARDWARE AND SOFTWARE CONSIDERATIONS

3.1 Circuit Description

Figure 3.1 shows the proposed system block diagram of electrical appliances control through mobile phone. The first mobile is used as remote. From first mobile call at the receiver phone through GSM network. The received signal is in DTMF format which is send to the DTMF decoder connected via headset of the receive phone. The DTMF decoder converts the analog signal into a digital signal and sends it to the microcontroller for process it. Then the microcontroller processes the code and carries out the specific operations.

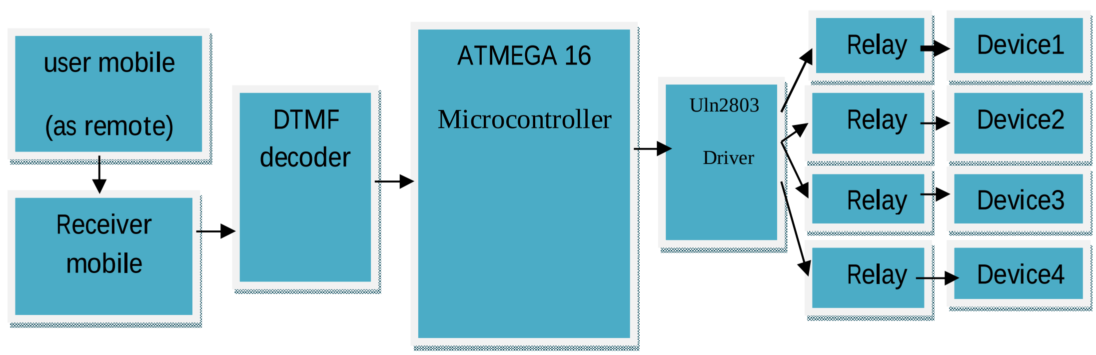


Figure 3.1 Block diagram of electrical appliances control through mobile phone

The ULN2803 is used to drive the signal. The devices may be motor, light, fan, etc. All these appliances can be controlled on/off using the mobile phone by assigning each number to certain device. The device controlling is achieved by relays [18].

3.2 System Hardware Components

The major components of this system are Atmega16 microcontroller, DTMF decoder, crystal oscillator, ULN2803 driver, relays, mobile phone and components power supply circuit.

3.2.1 Atmega16 microcontroller

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1MIPS per MHz allowing the system designed to optimize power consumption versus processing speed. The microcontroller controls the entire operation of the circuit, its receives the decoded signals from the DTMF decoder then processes it and activates or deactivates the corresponding device by sending a logic to enable or disable the relay connected to the load. A microcontroller is used because of its low power consumption and flexibility of its functions. The microcontroller receives the signal from the DTMF decoder in form of binary numbers then activates the corresponding device by sending a high logic to the transistor that controls the relay or if a deactivating data is received from the decoder, it sends a low logic to the transistor of the corresponding relay. The microcontroller operates on a 5V direct current supply. The data from the decoder is connected to port A [9].

3.2.2 Dual tone multi frequency

The MT8870 is a complete DTMF receiver offers small size, low power consumption and high performance. Architecture consists integrating both the band split filter and digital decoder functions. The filter section uses switched capacitor techniques for high and low group filters; the decoder uses digital counting techniques to detect and decode all 16 DTMF tone-pairs into a 4-bit code. The DTMF decoder is used in a wide number of electronic system such as receiver system for British telecom, paging systems, repeater systems mobile radio, credit card systems, remote control personal computers and telephone answering machine. The features of the DTMF decoder are complete DTMF receiver, low power consumption, internal gain setting amplifier, adjustable guard time, central office quality power-down mode, inhibit mode. Figure 3.2 shows the block diagram of the DTMF decoder. The main principle of the DTMF is that it takes a number code from the number pad converts it to DTMF signal and a DTMF decoder converts the DTMF signal to a digital code that can be fed to a microcontroller. A DTMF generator generates two frequencies corresponding to a number or code in the number pad which is transmitted through the communication networks, constituting the transmitter section which is simply equivalent to a mobile set [16].

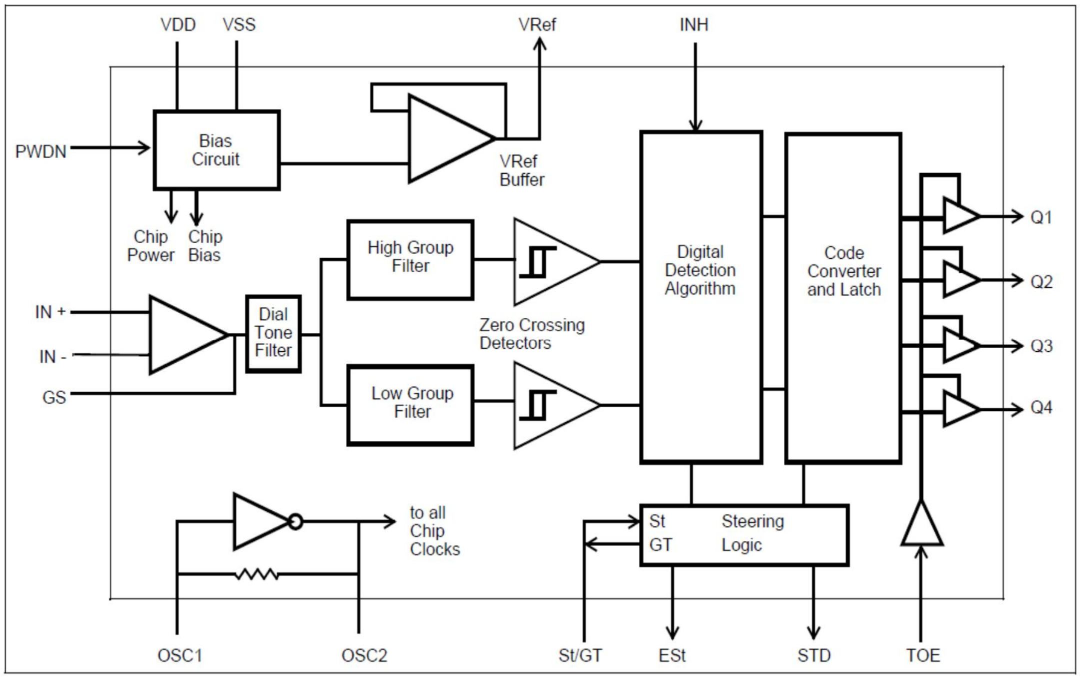


Figure 3.2**:** Block diagram of the DTMF decoder

In the receiver part, the DTMF detector Integrated Circuit (IC), for example MT8870 detects the number code represented by DTMF back, through the inspection of the two transmitted frequencies. The DTMF frequencies representing the number codes is shown in Table 3.1. DTMF generation is a composition of two audio signals or two tones between the frequency 697Hz and 1633Hz. In a DTMF each row has its own unique tone frequency and also each column will have its own unique tone. The tone frequencies are selected such that harmonics and inter modulation products will not cause any unreliable signal. Each and every tone falls within a proper band pass before valid decoding takes place. If one tone falls outside the band pass spectrum, the decoder will become unreliable. A DTMF decoders main purpose is to detect the sinusoidal signals in the presence of noise [16]. The MT8870 is an 18-pin IC. The pins are all connected as per the diagram shown in Figure 3.3. The input is given at the pin IN+, IN- and the digital output is taken the from the pins Q1, Q2, Q3, Q4.

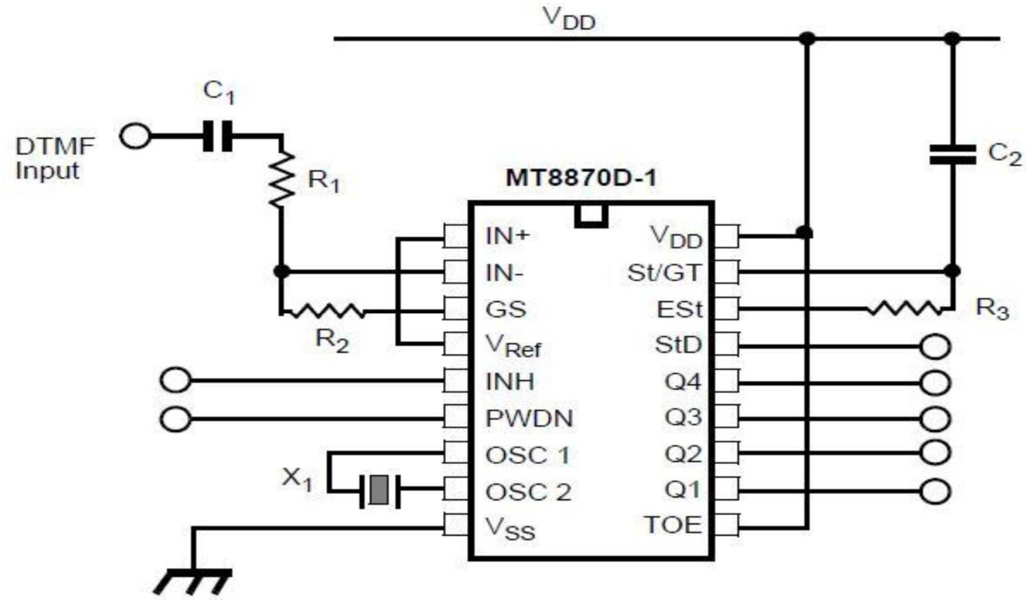


Figure 3.3: Circuit diagram of the DTMF decoder

Table 3.1: Tone frequency associated with a particular key resulting

Key	Low Band (HZ)	Upper Band (HZ)	Key Frequency	Q1	Q2	Q3	Q4	Comment
1	697	1209	1906	1	0	0	0	Used
2	697	1336	2033	0	1	0	0	Used
3	697	1477	2174	1	1	0	0	Used
4	770	1209	1979	0	0	1	0	Used
5	770	1336	2106	1	0	1	0	Used
6	770	1477	2247	0	1	1	0	Used
7	852	1209	2061	1	1	1	0	Used
8	852	1336	2188	0	0	0	1	Used
9	852	1477	2329	1	0	0	1	Unused
0	941	1209	2150	0	1	0	1	Unused
*	941	1366	2307	1	1	0	1	Unused
#	941	1477	2418	0	0	1	1	Unused

3.2.3 Crystal oscillator

The internal clock circuit is completed with the addition of an external 3.579545 MHz crystal shown in Figure3.4 [19].

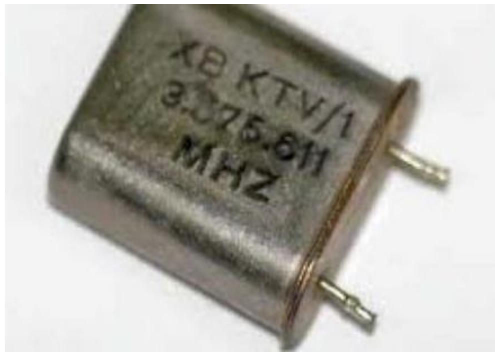


Figure 3.4: Crystal oscillator

3.2.4 ULN2803A driver

Figure 3.5 shows the ULN2803A device is a high-voltage, high-current darlington transistor array. The device consists of eight NPN darlington pairs that feature high voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each darlington pair is 500mA. The darlington pairs may be connected in parallel for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers, line drivers, and logic buffers. The ULN2803A device has a 2.7kΩ series base resistor for each darlington pair for operation directly with TTL or 5V CMOS devices [17].

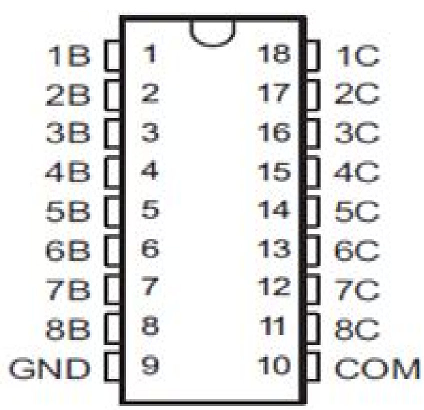


Figure 3.5: ULN2803 driver pin function

3.2.5 Mobile phone

A Nokia 206 mobile phone is used as the modem because of its affordability and availability. A mobile phone is used to send controlling signal.

3.2.6 Headset

Figure 3.6 shows image headset is a Tip Ring Sleeve (TRS) connector. The audio output of the mobile phone was connected to the DTMF decoder through headset.

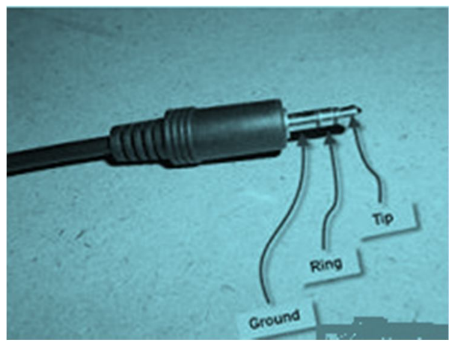


Figure 3.6: Headset

3.2.7 Relays

Figure 3.7 shows the relay circuit connection. A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. In the home, relays used in refrigerators, washing machines and dishwashers, and heating and air conditioning controls. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic [18].

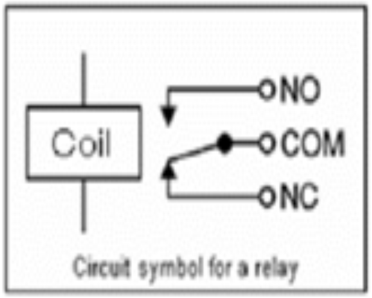


Figure3.7: Relay circuit connection

Where:

NC: Normally Close

NO: Normally Open

Com: Common

3.2.8 Transformer

Figure 3.8 shows step down transformer 220/9V output to supply all the electronics circuit. It consists of primary and secondary coils. The output from the secondary coil is alternating current voltage output. The operation of a transformer is based on two principles of the laws of electromagnetic induction: An electric current through a conductor, produces a magnetic field surrounding the conductor, and a changing magnetic field in the vicinity of a conductor induces a voltage across the ends of that conductor. The magnetic field excited in the primary coil gives rise to self-induction as well as mutual induction between coils. This self-induction counters the excited field to such a degree that the resulting current through the primary winding is very small when the secondary winding is not connected to a load [19].

Figure 3.8: Transformer

3.2.9 Bridge rectifier

A bridge rectifier basically has four diodes connected as shows in Figure 3.9 to provide rectification.

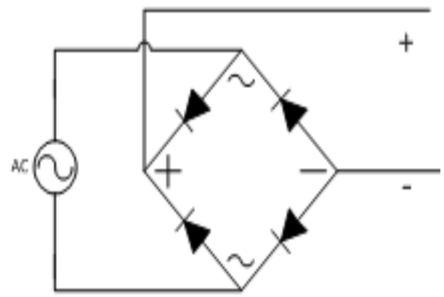


Figure 3.9: Bridge rectifier

3.2.10 Filter circuit

The filter circuit is simply a capacitor of 2200µf associated in parallel to the power circuit. Capacitor acts as filter. The principle of the capacitor is charging and discharging. It charges in the positive half cycle of the Alternating Current (AC) voltage and it will discharge in the negative half cycle.

3.2.11 Voltage regulator

Figure 3.10 shows voltage regulating IC LM7805. A voltage controller is intended to naturally keep up a consistent voltage level [19].

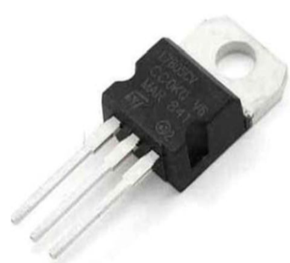


Figure 3.10: Voltage regulating IC LM7805

3.2.12 Resistances

A resistor is a passive two terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits [19].

3.2.13 Capacitors

A capacitor is a passive two terminal electrical component used to store energy electrostatically in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric. The conductors can be thin films of metal, aluminum foil or disks a dielectric, etc. The 'non-conducting' dielectric acts to increase the capacitor's charge capacity. A dielectric can be glass, ceramic, plastic film, air, paper, mica, etc. Capacitors widely used as parts of electrical circuits in many common electrical devices [19].

3.2.14 The devices to be controlled

The devices final stage in this system (fan, motor and two lamps). Figure 3.11 shows the Circuit diagram of the system. Table 3.2 shows equipments uses in the circuit.

Table3.2: Equipment uses the circuit

No.	Equipment	Quantity
1	Atmega16 Microcontroller	1
2	MT8870 DTMF Decoder	1
3	Cristal Oscillator 3.57954MHz	1
4	ULN2803A Darlington Transistor	1
5	Mobile Phone	1
6	Headset	1
7	Resistance	6
8	Capacitor	5
9	Relays	4
10	Transformer	1
11	Diode	4
12	Voltage Regulating IC 7805	1
13	Light Emitted Diode (LED)	3
14	Fan 5V Direct Current (DC)	1
15	Motor 5V DC	1

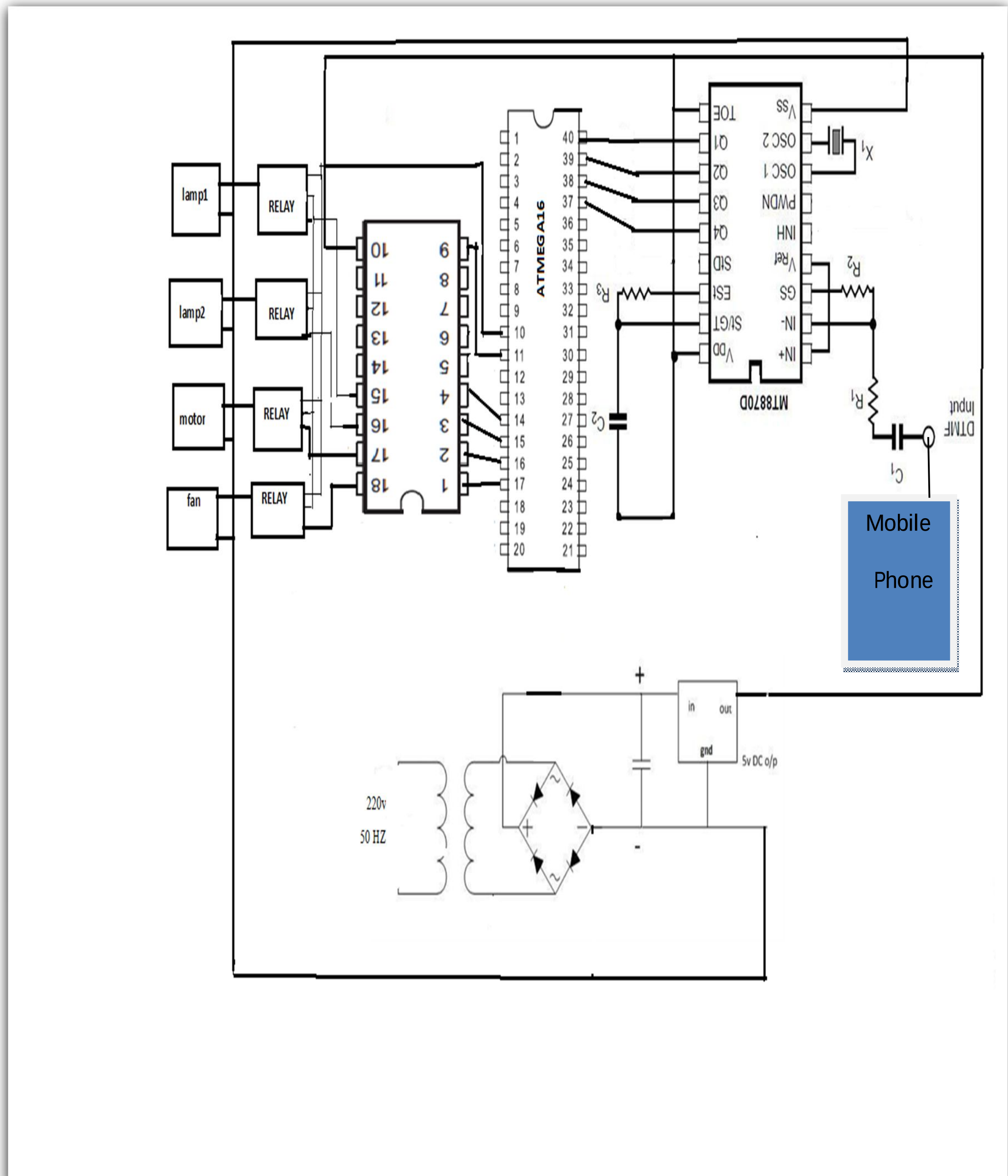


Figure 3.11: Circuit diagram of the system

3.3 System Software

System software of this study includes flowchart, program code and simulation.

3.3.1 System flowchart

A flowchart is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem. Flowcharts used in analyzing, designing, documenting or managing a process or program in various fields, in this thesis the flowchart illustrates the principle of system code as shown in Figure 3.13.

3.3.2 System code

The code has been written in BASIC language and compiled using code vision BASCOM compiler, after program is completed it has been converted to hex file to install it in Atmega16. Where was the use of primary instructions in writing program such as Do-loop instruction to implement the control conditions. The illustrative code in Appendix.

3.3.3 System simulation

Computer simulations have become a useful part of mathematical modeling of many natural systems to observe their behavior. It allows the engineer to test the design before it is built in the real situation. The simulations for this thesis performed in Proteus program shown in Figure 3.12. The DTMF decoder MT8870 is not present in the IC given in the simulation.

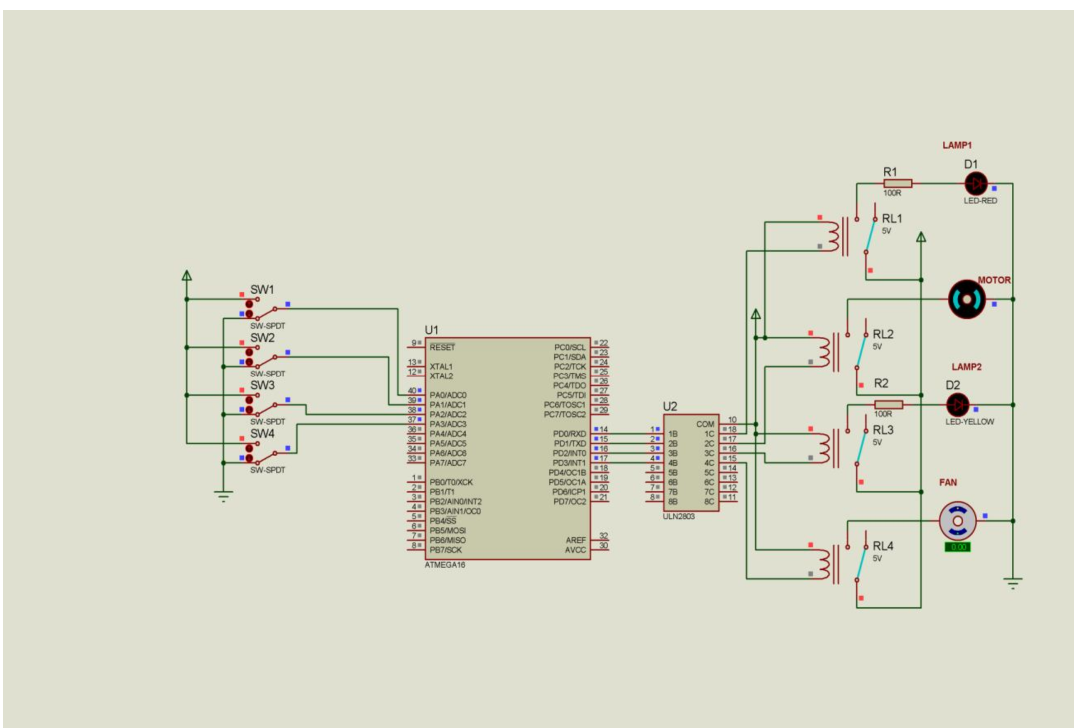
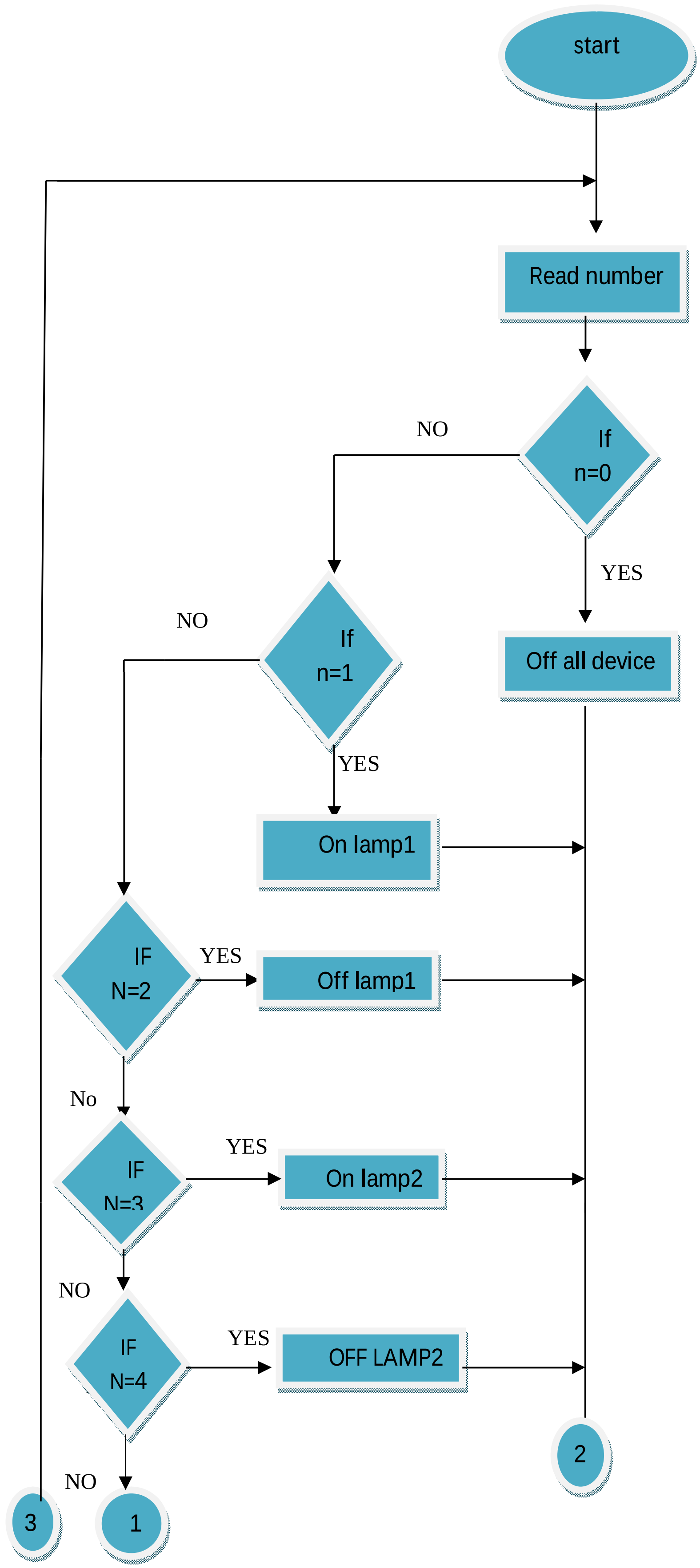


Figure 3.12: The main circuit design


start
Read number
If
n=0
NO
YES
Off all device
If
n=1
NO
YES
On lamp1
IF
N=2
YES
Off lamp1
No
IF
N=3
YES
On lamp2
NO
IF
N=4
YES
OFF LAMP2
NO
2
3
1

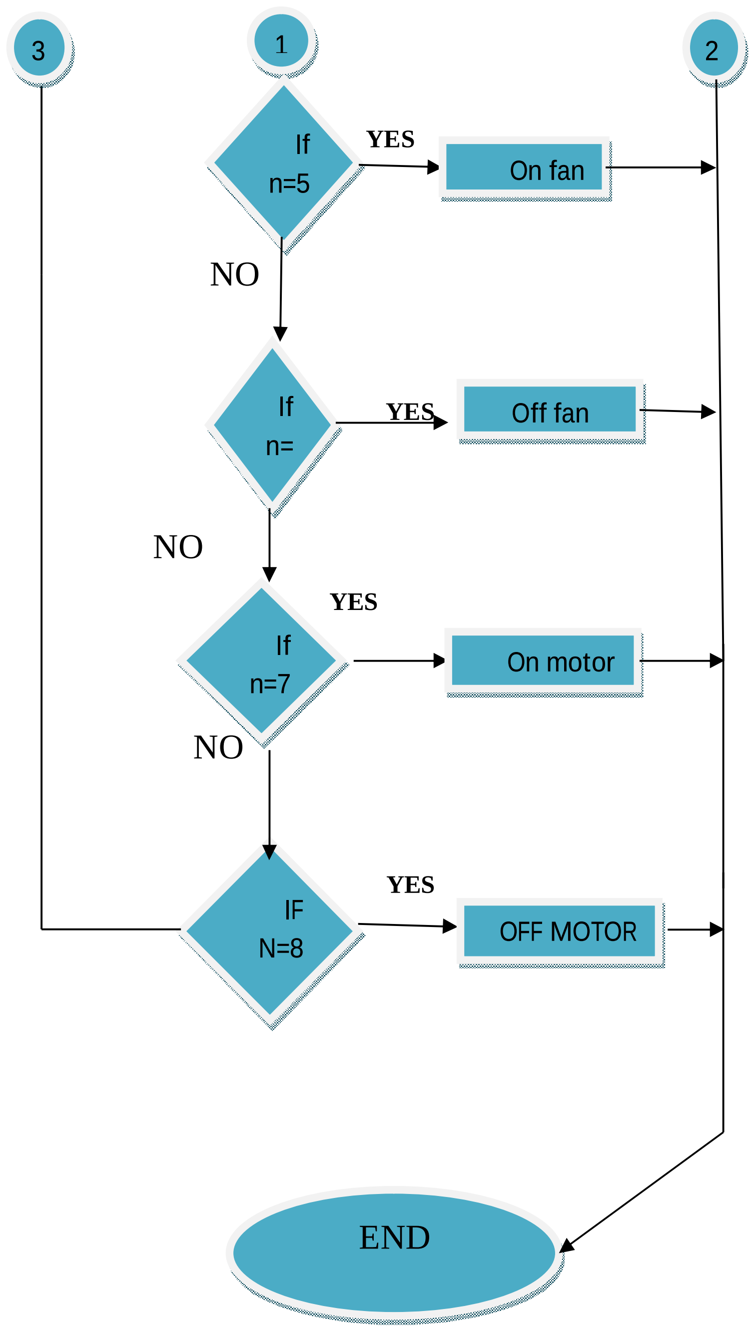


Figure 3.13: System flowchart

3.3.4 Working principle of the circuit

The control circuit contains, the Atmega16 microcontroller which receives the signal from the DTMF decoder through port PA and it processing the signal and then it sends the signal through PD to the driver ULN2803 through pin1, pin2, pin3, pin4 to enlarge. The ULN2803 driver send the signal to the relays through pin15, pin16, pin17, pin18. The relay connected to the appliances which to be turned ON or turned off. The system has a mobile phone installed in control circuit, when a user dials the number of the phone, the system automatically answers the call then waits for the user to press the command button. If key1 is pressed the lamp1 is turn ON as shown in Figure 3.14. If key2 is pressed, the lamp1 is turn off. If key3 is pressed it goes turn ON lamp2 as shown in Figure 3.15. If key4 is pressed, the lamp2 turn off. If key5 is pressed fan its turn ON. If key6 is pressed fan its turn off. If key7 is pressed turn ON motor. If key8 is pressed motor turn off. If is pressed keys1, 3, 5 and 7 all devices turn ON as shown in Figure 3.16. The system is designed for four pieces of equipment but more equipment can be used by adding more relays and changing the coding sequence of the equipment control.

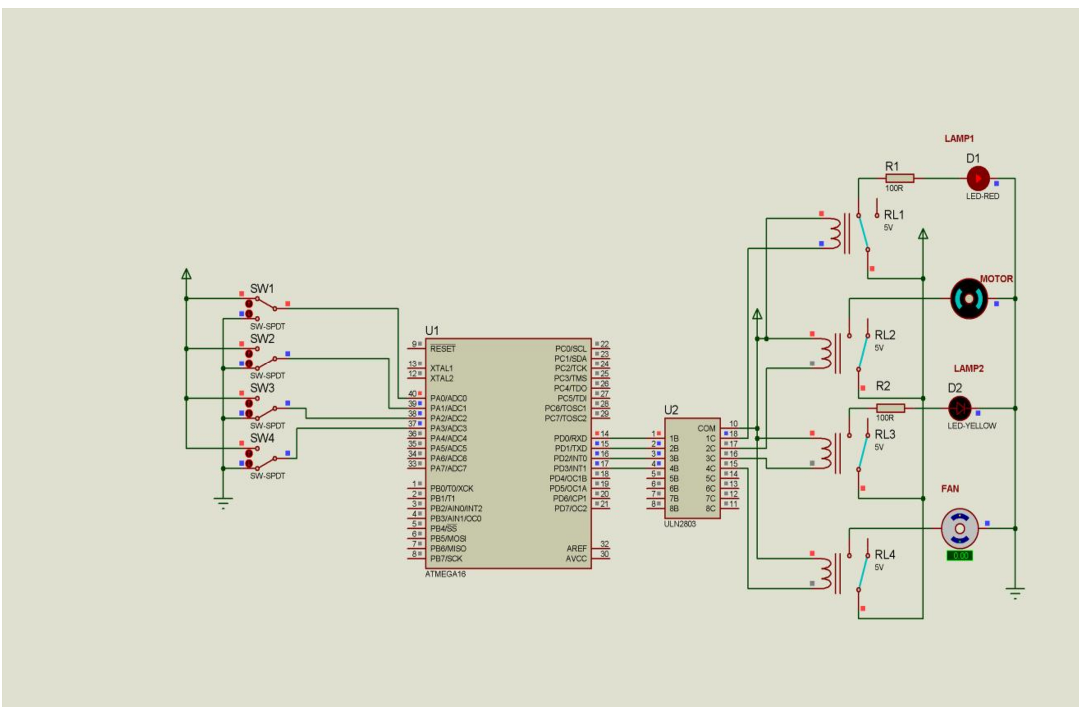


Figure 3.14: The main circuit design after running (ON lamp1)

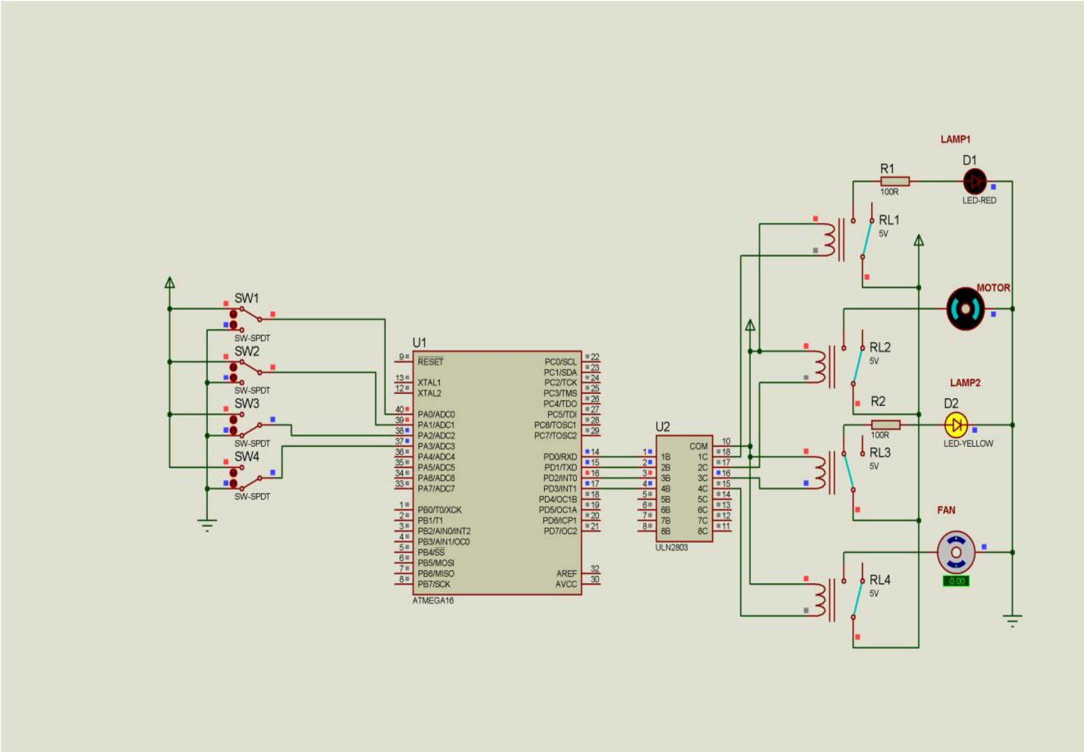


Figure 3.15: The main circuit design after running (ON lamp2)

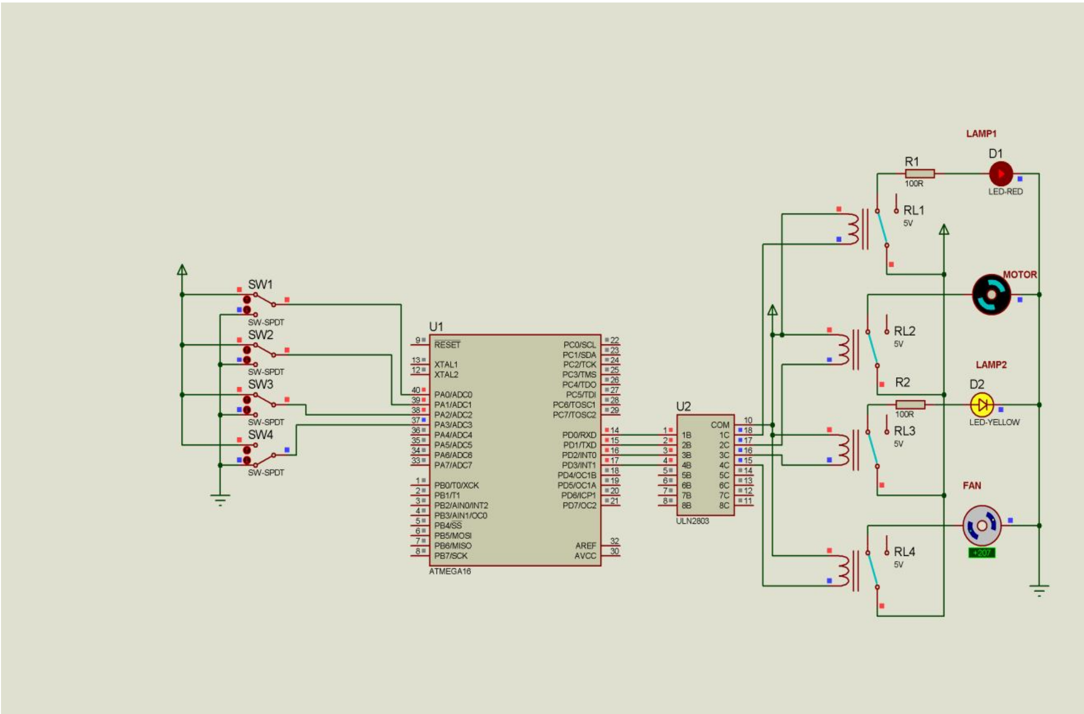


Figure 3.16: The main circuit after ON all device

Table 3.3 shows output of controlling appliances.

Table 3.3: Output of controlling appliances

Command From User Mobile Phone	Output of The DTMF Decoder	Input Microcontroller	Output Microcontroller	Actions Carried Out by the Microcontroller
Pres key1	0001	0001	0001	ON lamp1
Pres key2	0010	0010	0000	Off lamp1
Pres key3	0011	0011	0100	ON lamp2
Pres key4	0100	0100	0000	Off lamp2
Pres key5	0101	0101	1000	ON fan
Pres key6	0110	0110	0000	Off fan
Pres key7	0111	0111	0010	ON motor
Pres key8	1000	1000	0000	Off motor

CHAPTER FOUR

SYSTEM IMPLEMENTATION AND TESTING

4.1 System Implementation

The control circuit consists of different devices represented in power supply, DTMF decoder, crystal oscillator, resistors, capacitors, ATmega16 microcontroller, ULN2803driver, relays, the electrical devices to be controlled and a mobile phone. For the implementation of the control circuit correctly follow the following steps:

4.1.1 Power supply installation

Figure 4.1 shows installation power supply circuit. All electronic circuit used 5V DC. The power supply is a linear power supply type and contain a step down transformer, bridge rectifier, filtering capacitor and a voltage regulator to give the voltage levels. The 220V supply power is stepped down to 9V AC by transformer (T1) then the output from the transformer is connected to a bridge rectifier to make it DC by (D1), the voltage is filtered by (C3) and regulated to 5V by (U3).

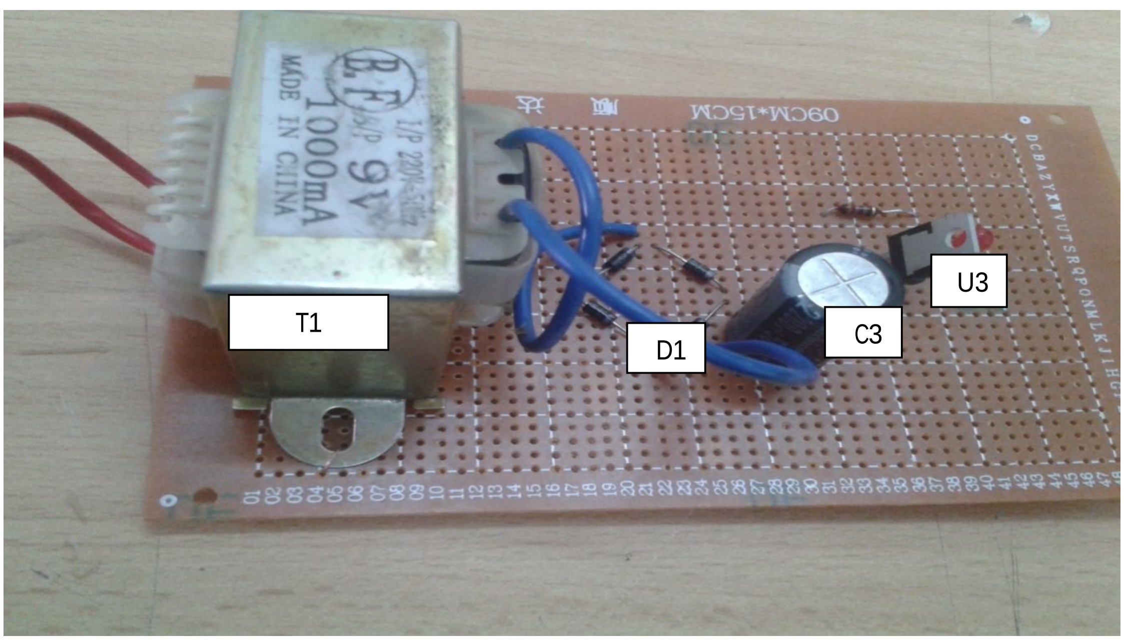


Figure 4.1: Installation power supply circuit

4.1.2 DTMF decoder module installation

Installation of DTMF decoder module, consists DTMF decoder, crystal oscillator, resistors and capacitors shown in Figure 4.2. From datasheet value of parameter for this circuit, R1=100 KΩ, R2=68 KΩ, R3=300 KΩ,C1, C2=100nf, X1=3.57954MHz, VDD =5 VDC. The pin connection of DTMF decoder shown in Table 4.1.

Table 4.1: DTMF decoder pin connection

Pin Number	Pin Name	Function	Connected to
1	IN+	Input	Headset
2	IN-	Input	Headset
3	GS		
4	Vref		
5	INH		
6	PWDN		
7	OSC1	Input	Oscillator
8	OSC2	Input	Oscillator
9	Vss	0V	GND
10	TOE	+5V	VCC
11	Q1	Output	Atmega16 (PA0)
12	Q2	Output	Atmega16 (PA1)
13	Q3	Output	Atmega16 (PA2)
14	Q4	Output	Atmega16 (PA3)
15	StD		
16			
17			
18	VDD	+5V	VCC

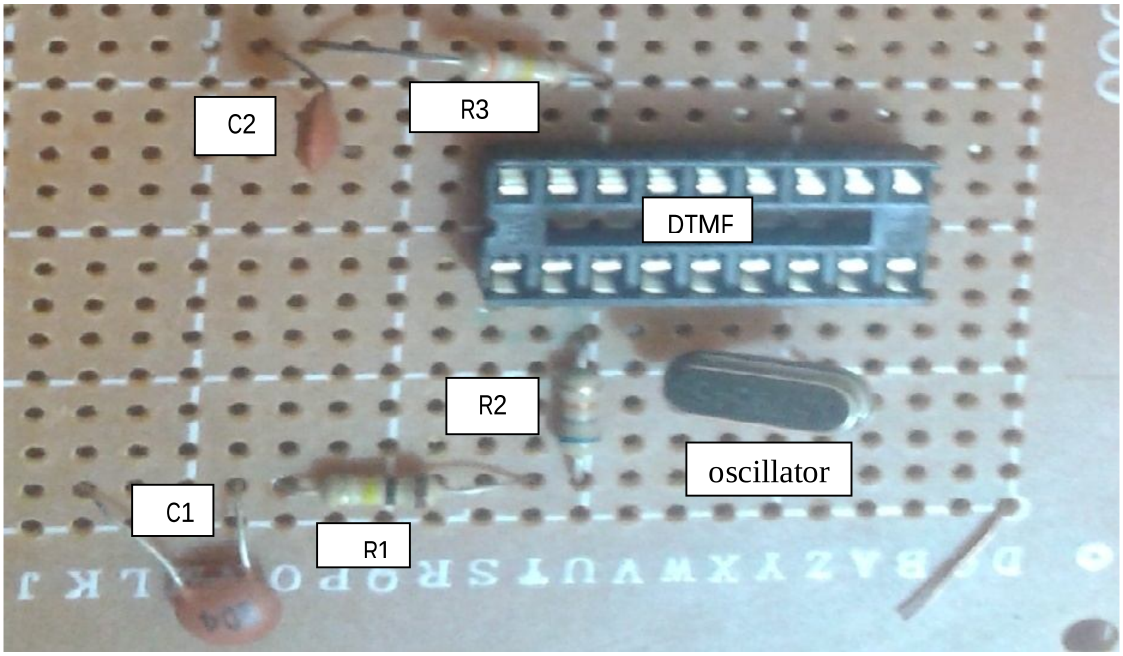


Figure 4.2: Installation DTMF decoder module

4.1.3 Atmega16 microcontroller plug in

plug in of ATmega16 microcontroller in the port as shown in Figure 4.3. The pins connection of ATmega16 microcontroller shows in Table 4.2.

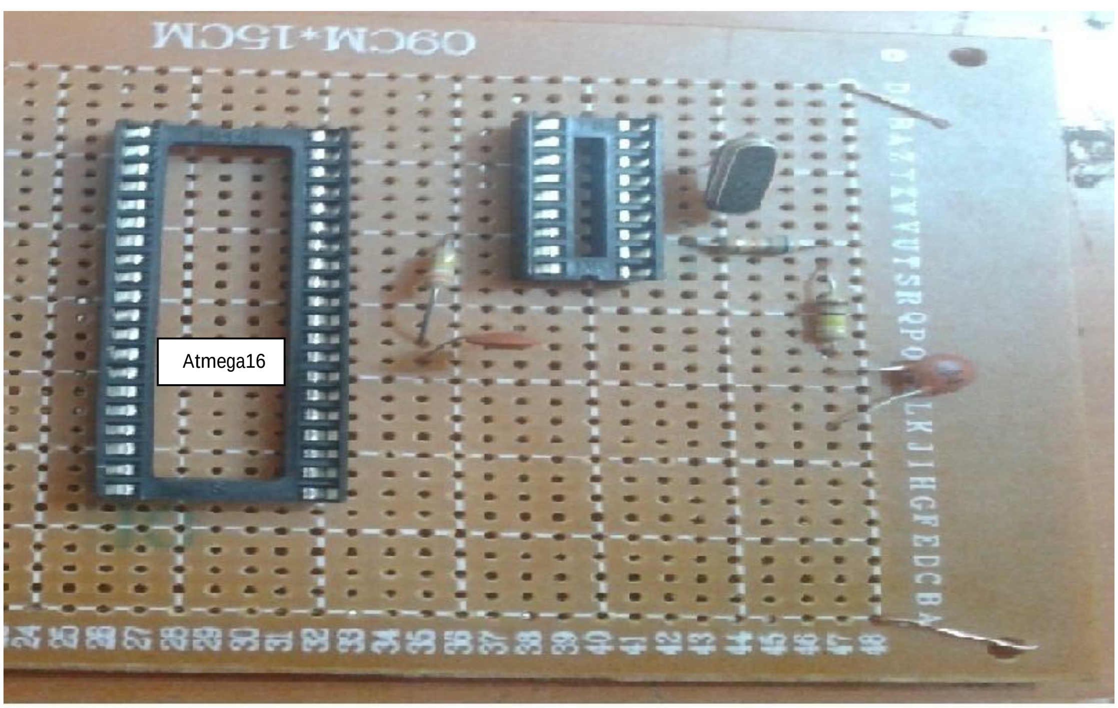


Figure 4.3: Atmega16 microcontroller plug in

Table 4.2: Microcontroller pin connection

Pin Number	Pin Name	Function	Connected to
1	PB0		
2	PB1		
3	PB2		
4	PB3		
5	PB4		
6	PB5		
7	PB6		
8	PB7		
9	RESET		
10	VCC	VCC	+5V
11	GND	GND	0 V
12	XTAL2		
13	XTAL1		
14	PD0	Output	ULN2803(1B)
15	PD1	Output	ULN2803(2B)
16	PD2	Output	ULN2803(3B)
17	PD3	Output	ULN2803(4B)
18	PD4		
19	PD5		
20	PD6		
21	PD7		
22	PC0		
23	PC1		
24	PC2		
25	PC3		
26	PC4		
27	PC5		
28	PC6		
29	PC7		
30	AVCC	VCC	+5V
31	GND	GND	0 V
32	AREF		
33	PA7		
34	PA6		
35	PA5		
36	PA4		
37	PA3	Input	DTMF(Q4)
38	PA2	Input	DTMF(Q3)
39	PA1	Input	DTMF(Q2)
40	PA0	Input	DTMF(Q1)

4.1.4 ULN2803 driver plug in

Figure 4.4 shows ULN2803 driver plug in. The pin connection of ULN2803 driver shown in Table 4.3.

Table 4.3: ULN2803 driver pin connection

Pin Number	**Pin Name**	**Function**	**Connected to**
1	1B	Input	Atmega16 (PD3)
2	2B	Input	Atmega16 (PD2)
3	3B	Input	Atmega16 (PD1)
4	4B	Input	Atmega16 (PD0)
5	5B		
6	6B		
7	7B		
8	8B		
9	GND	GND	0V
10	COM	VCC	5V
11	8C		
12	7C		
13	6C		
14	5C		
15	4C	Output	Relay1
16	3C	Output	Relay2
17	2C	Output	Relay3
18	1C	Output	Relay4

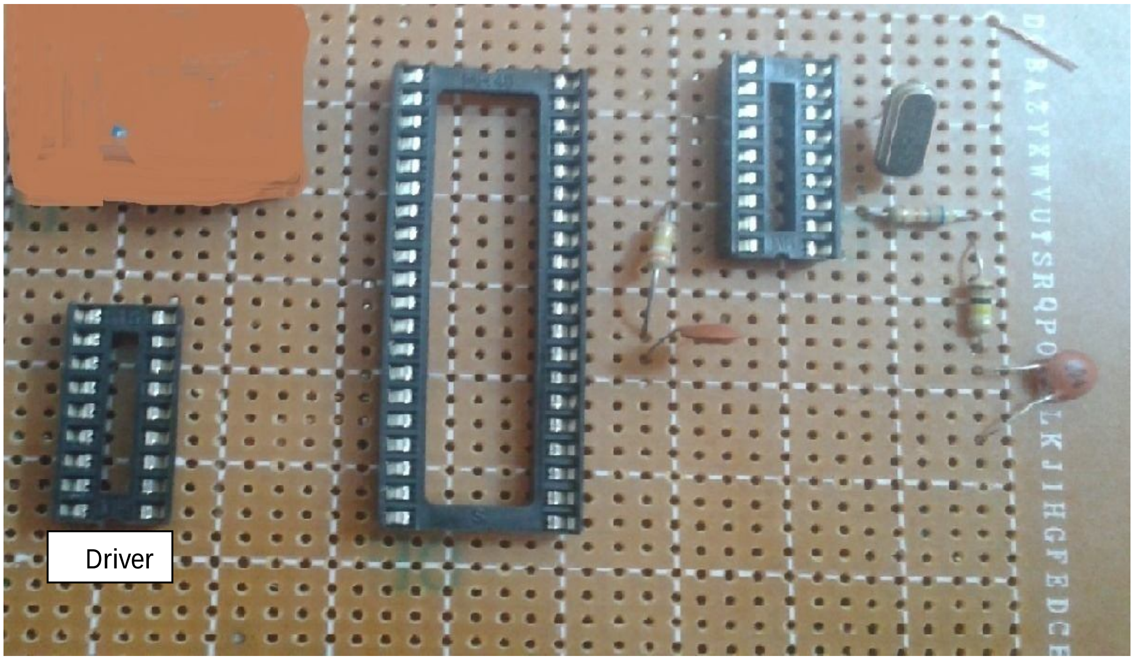


Figure 4.4: ULN2803 driver plug in

4.1.5 Connecting relays

Figure 4.5 shows connecting the relays.

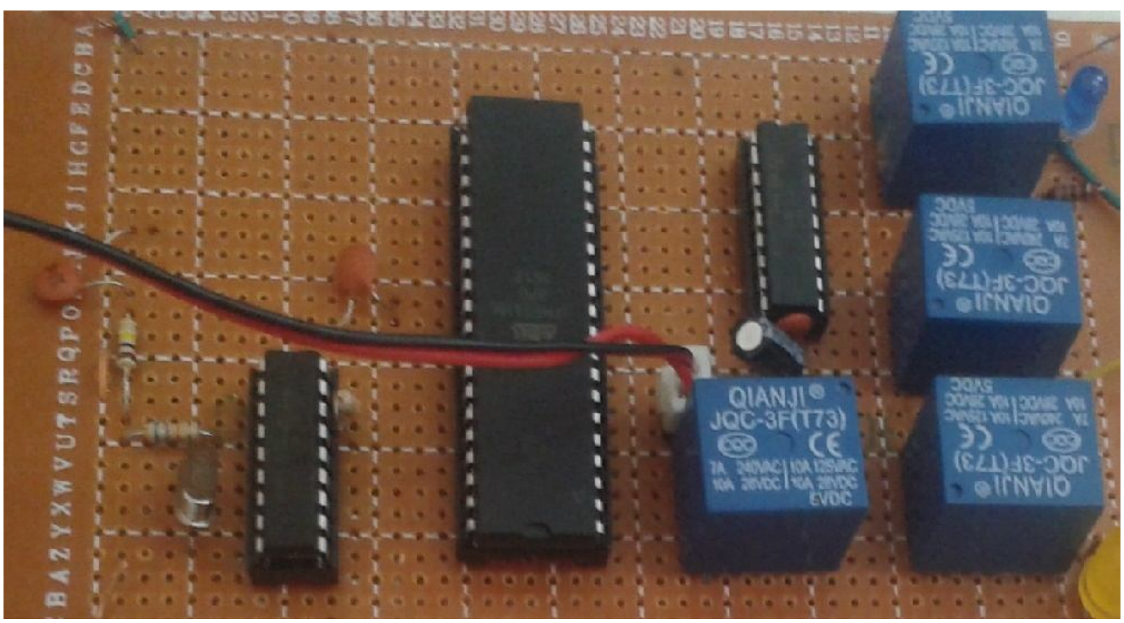


Figure 4.5: Connecting the relays

4.1.6 Connecting the electrical devices

Figure 4.4 shows connecting the electrical devices fan, motor and two lamps.

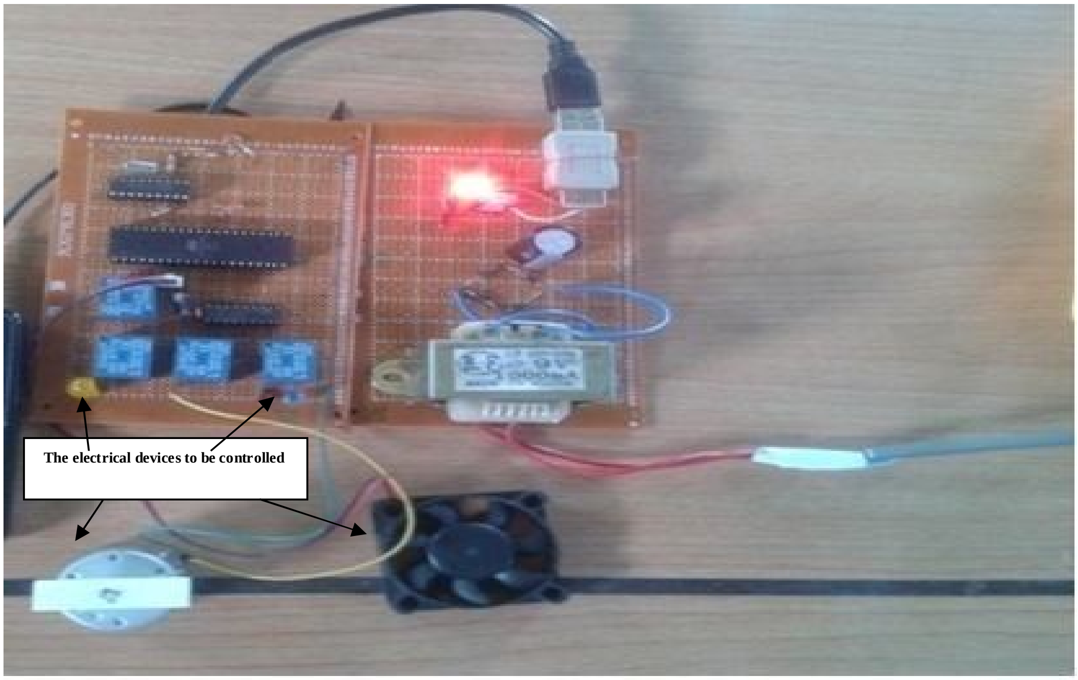


Figure 4.6: Connecting the electrical devices

4.1.7 Mobile phone installation

Finally, mobile phone installation as shown in Figure 4.7. The audio output of the mobile phone connected to the DTMF decoder through headset.

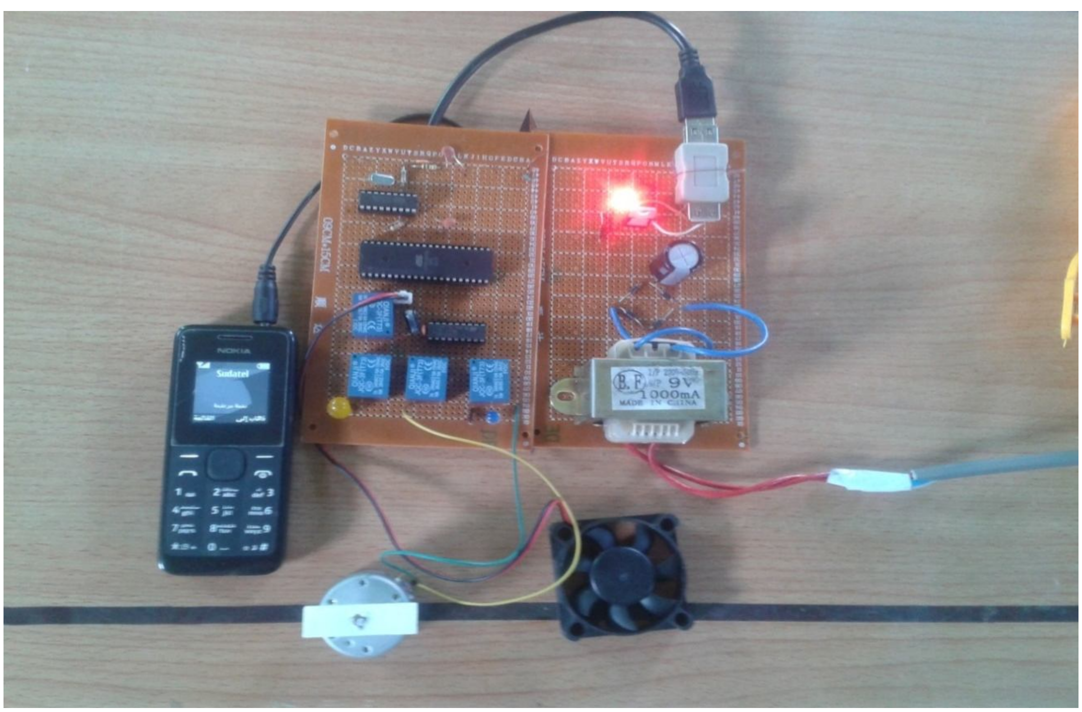


Figure 4.7: Mobile phone installation

4.2 System Testing

After the electrical circuit is completed the system was able operation the following electrical appliances such as lamp, fan and motor.

4.2.1 Operation of device 1

If pressed key1 the lamp1 turn ON as shown in Figure 4.8. The lamp1will turn off by pressed key2.

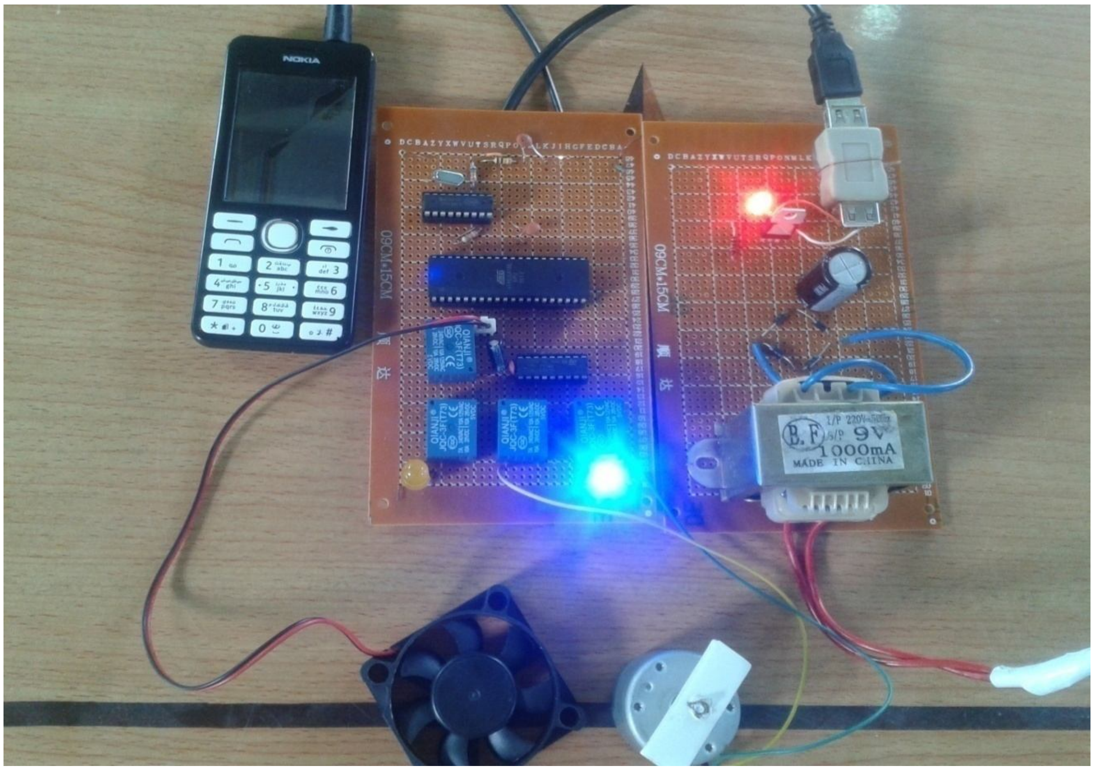


Figure 4.8: The overall system with connection and lamp1 ON

4.2.2 Operation of device 2

If pressed key3 the lamp2 turn ON as shown in Figure 4.9. It will turn off by pressed key4.

4.2.3 Operation of all devices

If pressed keys 1, 3, 5 and 7 all devices turn ON as shown in Figure 4.10.

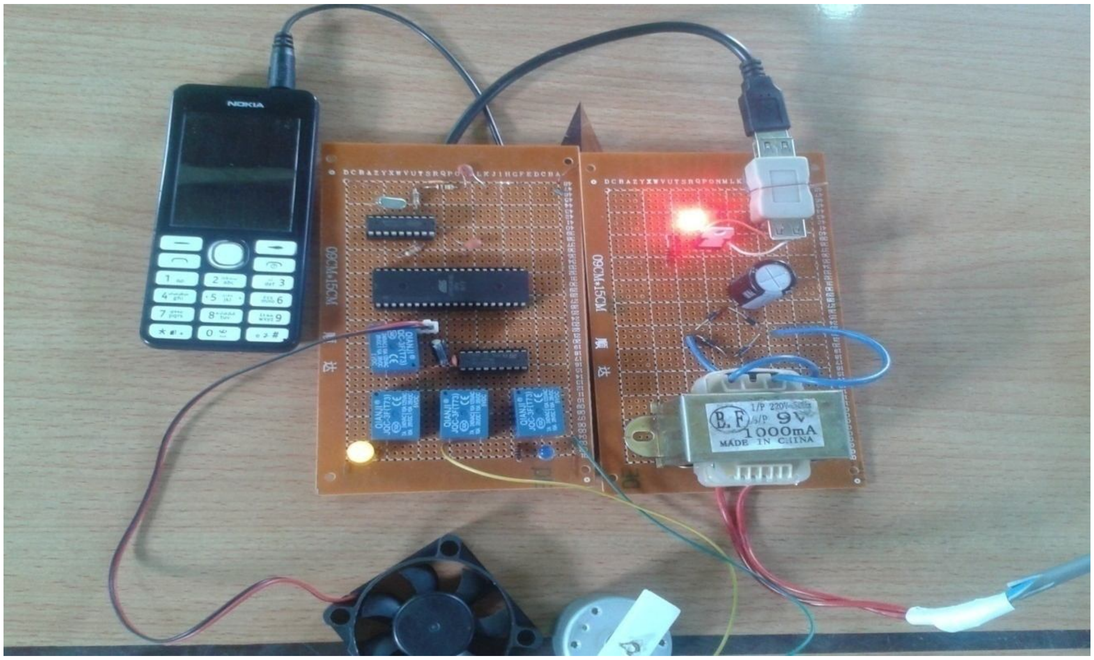


Figure 4.9: The overall system with connection and lamp2 ON

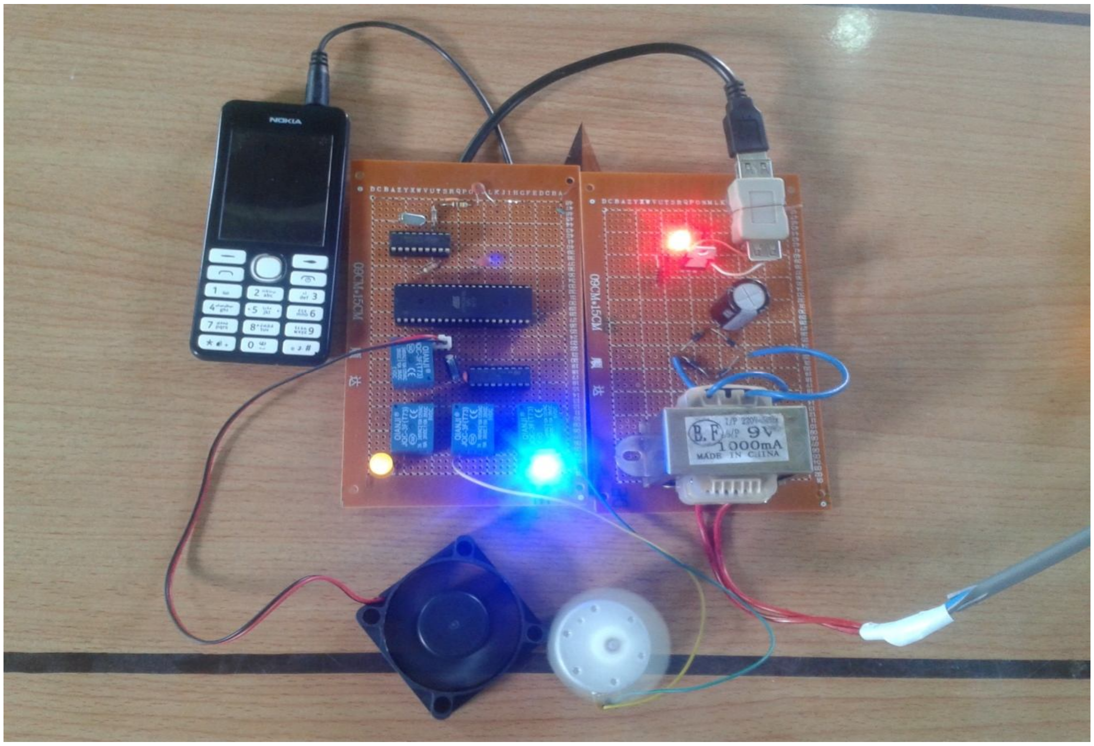


Figure 4.10: Circuit diagram with connection and all device ON

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study was aimed to design and implementation of electrical appliances control mobile phone based. It was done using the wireless system and it is extremely fast and efficient. The DTMF tone can be transmitted over the GSM network and hence, the basis for the control of multiple devices from a distance was successfully achieved. This will help people to regulate the controlling of a device situated at a hazardous place like a chemical plant where the presence of a human is harmful.

5.2 Recommendations

- Modify of system power supply to be suitable to operation with 220V Ac.
- Provide the monitor system with camera mentoring purpose.
- Adding more electrical appliances to the system.
- To replace relays with push button switch.
- Adding Liquid Crystal Display (LCD) to illustrate status of the device.

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APPENDIX

CODE

```
regfile  =          "m16def.dat"                              ' specify the used micro$
crystal  =          8000000$
Config PINA.0 = Input                                       'dtmf1
Config PINA.1 = Input                                       'dtmf2
Config PINA.2 = Input                                       'dtmf3
Config PINA .3 = Input                                      'dtmf4

Config PORTD.0 = Output                                     'lamp1
Config PORTD. 1 = Output                                    'motor
Config PORTD.2 = Output                                     'lamp2
Config PORTD.3 = Output                                     'fan
Do
Waitms 5000
If PINA.0 = 0 And PINA.1 = 0 And PINA.2 = 0 And PINA 3 = 0 Then        '0
PORTD.0 = 0
PORTD.1 = 0
PORTD.2 = 0
PORTD.3 = 0
End If
If PINA.0 = 1 And PINA.1 = 0 And PINA.2 = 0 And PINA.3 = 0 Then        '1
PORTD.0 = 1                                                 'on lamp1
End If
If PINA.0 = 0 And PINA.1 = 1 And PINA.2 = 0 And PINA.3 = 0 Then        '2
PORTD.0  = 0                                                'off lamp1
```

```
End If
If PINA.0 = 1 And PINA.1 = 1 And PINA.2 = 0 And PINA.3 = 0 Then        '3
PORTD.2 = 1                                         'on lamp2
End If
If PINA.0 = 0 And PINA.1 = 0 And PINA.2 = 1 And PINA.3 = 0 Then        '4
PORTD.2 = 0                                        'off lamp2
End If
If PINA.0 = 1 And PINA.1 = 0 And PINA.2 = 1 And PINA.3 = 0 Then        '5
PORTD.3 = 1                                         'on fan
End If
If PINA.0 = 0 And PINA.1 = 1 And PINA.2 = 1 And PINA.3 = 0 Then        '6
PORTD.3 = 0                                         'off fan
End If
If PINA.0 = 1 And PINA.1 = 1 And PINA.2 = 1 And PINA.3 = 0 Then        '7
PORTD.1 = 1                                         'on motor
End If
If PINA.0 = 0 And PINA.1 = 0 And PINA.2 = 0 And PINA.3 = 1 Then        '8
PORTD.1 = 0                                         'off motor
End If
Loop
```