VOICE-ACTIVATED REMOTE CONTROL FOR FAN/HEATER

By

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CERTIFICATION OF APPROVAL

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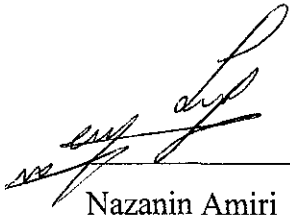

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TRONOH, PERAK

JUNE 2007

CERTIFICATION OF ORGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein has not been undertaken or done by unspecified sources or persons, anywhere else.

Nazanin Amiri

ABSTRACT

The objective of this project is to activate the old version of remote control, used for home electrical appliances by human voice instead of operating manually. This is intended with a view to provide more comfort for the human community. A variety of remote controls available in market today are made to function by pushing the buttons manually in order to have required changes in the electrical device such as increasing or decreasing temperature. Technological advancements in the society have made people to look for the easiest and novel ways to respond to their needs. In addition to this, some old and/or disabled people have difficulties in doing their work with out others help. Successful implementation of this project in the practical device will provide opportunity to people who are tired enough to look for the remote control ,old and/or disabled people who can not walk or have problems working with their hands, to interact with the remote control through their voice commands. This type of remote control triggered by human voice will be realized through the use of a microcontroller and a multipurpose voice recognizing IC (HM2007) to get the user command and compare it with the prerecorded voices on the IC HM2007. Upon voice comparison, the microcontroller will choose appropriate button to be pushed according to the requirement of the user, and the user command will be executed. The successful out come of this project will be a useful voice activated remote control which can be exploited with regard to the electrical appliances.

ACKNOWLEDGEMENTS

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF ABBREVIATIONS

1. LCD   Liquid Crystal Display

2. D-Bus   Data Bus

3. SRAM   Static Ram

CHAPTER 1

INTRODUCTION

1.1   Background of Study

Voice communication is the fundamental way which people use to express their needs, feelings, and transferring knowledge among them. Other methods of communication like drawing on rocks and body language were used by people many years ago, but the most practical way of communication is known as voice communication. Today's world technology is growing tremendously fast. Everyday new innovations are being introduced to the market for people's usage. One way or other they all keep in trade one thing, which is human comfort.

"Voice recognition is the field of computer science which deals with designing computer systems that can recognize spoken words"[1] .Voice recognition process is one of the effective techniques used in today's world projects in order to provide instruments controllable by human voice and changes the old method of manual controlling of instruments in to vocal controlling form. It is the process of converting the input signal which is usually human voices or any other analogue signal in to a sequence of words, by means of an algorithm implemented as a computer program.

1

The voice activating remote control will help those who want to enjoy the comfort and technical advancements, or old and disabled people who can not do their daily jobs without others help to change the weather conditions of their place through their voice commands rather than looking for the remote control to push its buttons manually.

1.2 Problem Statement

This project is an implemented version of existing fan/heater remote controls which is used by human voices rather than manually. Improvement of technology accompanied by exhausting daily occupations makes people become lazier and tend to make them very comfortable. As people get used to automated industry, life becomes sophisticated and they become impatient, seeking the easiest and fastest way of doing their jobs. There are old people living alone having difficulty to walk. Also disabled people who can not walk easily .They are all looking for a way to do their daily jobs independently with out requesting help from others.

The remote control in the present project is designed to accept limited number of commands from the user. Nevertheless it can be improved further to accept hundreds of commands by increasing the memory capacity. Also there are provisions readily available for making suitable modifications to control all home electrical appliances.

In order to use the voice activated remote control the user should first train the remote. After training whenever user says a command, his/her command will be compared with the prerecorded voices which were stored in HM2007 memory during the training section. The result of comparison will activate the proper button to be pushed on the remote control. In this way user will be able to control the device just through his/her voice commands rather than doing it manually.

1.3 Objectives and Scope of Study

1.3.1 Objectives

This project's aim is to implement a voice activating remote control which changes the temperature of the place by human voice (user's commands). Objectives of implement this project is:

- Ability of recognizing the correct users commands
- Time taken for processing should be fast enough
- Different voices being recognized by the chip
- Expected command being performed by the remote control

1.3.2 Scope Of Study

This project is the implemented version of the existing remote controls in the market. This remote control will be activated with human's voice by using a voice recognition IC (HM 2007).The remote can be further improved to accept hundreds of user's commands also it can be further implemented to become a universal voice activated remote control for all electrical appliances.

CHAPTER 2

LITERATURE REVIEW AND THEORY

2.1 History of Voice Recognition

"The history of speech recognition is littered by smart people who underestimated how difficult the task really is. The tradition dates back to the 1870s, when Alexander Bell came up with the idea of a machine that would make speech visible to help people with hearing difficulties. He is more famous for the invention of the telephone. Bell claimed his first success in the field in 1936, when researchers developed a machine capable of synthesizing speech"[2].

History of implementing the voice recognition software is summarized as follows:

1936   AT&T's Bell Labs produced the first electronic speech synthesizer called the Voder, which used a keyboard and foot pedals to emit speech.

1969   John Pierce of Bell Labs found out that automatic speech requires artificial intelligence.

1970   Lenny Baum of Princeton University invented the Hidden Markov Modeling (HMM) approach to speech recognition and shared it with several ARPA (Advanced Research Projects Agency) contractors including IBM.

1978 The popular toy "Speak and Spell" by Texas Instruments was introduced. Speak and Spell used a speech chip which led to the development of human digital synthesis sound.

1997 Dragon introduced "Naturally Speaking", which was the first device using continuous dictation speech. By invention of this software, pausing needed previously between words for computer to understand the user's speech was eliminated.

2000 Net Bytel launched the world's first voice enabler, including an on-line ordering application with real-time Internet integration for Office Depot [3].

2.2   Voice Recognition

Voice recognition is "the technology by which sounds, words or phrases spoken by humans are converted into electrical signals and these signals are transformed into coding patterns to which meaning has been assigned" [4].It can also be defined as "The ability of a machine or program to receive and interpret dictation, or to understand and carry out spoken commands" [5].

In this project we use the concept named "voice recognition", because we are focusing on human voice to communicate with remote control through voice recognition IC, HM2007. Difficulty in using voice as an input to a computer simulation lies in the fundamental differences between human voice and the traditional forms of computer input. Each human voice is different, and identical words can have different meanings if spoken in different contexts. Several approaches have been tried to overcome these difficulties.

In voice recognition projects we are dealing with two ways of using words: isolated-words and continuous-words. An isolated-word voice recognition system requires the speaker pause between words, whereas a continuous voice recognition system does not. Recognizing and dealing with continuous speech contains miss fluencies and it is much more difficult than recognizing isolated voice recognition. Recognition is more difficult when vocabularies are large or having similar-sounding words. When speech is produced in a sequence of words, language models or artificial grammars are used to restrict the combination of words [6].

2.2.1 Types of Voice Recognition

Voice recognition is done by computers; this does not mean that computers are able to understand the meaning of user's command. Recognition process is of two types.

They are:

(a) Speaker dependent

Speaker-dependent recognition is desirable where user-specific or language-specific vocabularies are required. In this method user should train the system before he/she wants to use the voice activating device. This method has the ability of 95% accuracy in recognizing the words. The only disadvantage of this method is, it only responds to the user who trained the system during the training section [7].In this method the voice activating circuit is dependent on several factors such as: tone and accent of the trainer and also position of the microphone .Any changes in these factors will led to inaccuracy of detecting the command, which finally results in not performing the action required by the user.

(b)   Speaker independent

In this method the recognition does not depend only on the user who trained the system. Therefore the system must respond to a large variety of speech patterns of the target word. The command word count is usually lower than the speaker dependent. This method still has good accuracy and more often used in today's industry [7].In this method several user can train the voice recognition device in order to make the circuit ready for multiple users' usage.

2.3   Recognition Style

Speech recognition systems have another constraint concerning the style of speech being recognized. They are three styles of speech: isolated, connected and continuous. In this project we are dealing mostly with isolated or connected commands.

- **Isolated:** This method is capable of handling words that are spoken separately, means that accurate recognition happen only when speaker pause between the words. This is the most common speech recognition systems available today and suitable when user is required to give only one word responses or commands [7].

- **Continues:** This method is like daily conversational speech, where adjacent words run together without pauses or division between words. A speech recognition system that handles continuous speech is the most difficult to implement. This technique is on the market and still under development [7].

- **Connected:** In this method user is allowed to speak in multiple word phrases, but he or she must be careful to articulate each word and not connect the end of one word into the beginning of the next word. This method also allow user to speak multiple words [7].

2.4   What Is HM2007?

In order for this project to be able to use the voice recognition process, the HM2007 IC is required to process the input signal (human voice), and send the correct information to microcontroller.

"HM2007 is a single chip CMOS voice recognition LSI circuit with the on chip analog front end, voice analysis, recognition process and system control functions. The chip provides the options of recognizing either forty words each take 0.96 second or twenty words each take 1.92 seconds. This circuit allows the user to choose either the .96 second word length (40 word vocabulary) or the 1.92 second word length (20 word vocabulary)"[3,7].

This IC can be used in two different modes; Manual mode and CPU control mode, depending on the type of project ,the suitable mode will be chosen .In this project we are dealing with manual mode of HM2007.

2.4.1   Manual Mode: This method is the one we are applying in our project in order to perform the voice recognition process. This mode doesn't require a host computer which makes it suitable to be applied on a small remote control as needed in this project [8].

2.4.2   CPU control mode: The CPU mode is designed to allow the chip to work under a host computer. In this method the speech recognition chip operates as a co-processor to the main CPU. When the HM2007 recognizes a command it will interrupt the host CPU and relay the command code [8].

8

2.5   What is SR-07 Circuit?

The SR-07 kit is composed of 48 pin PDIP, SRAM, tri-state octal latch, analogue AGC front end, A/ D converter, BCD to seven segment decoders and a masked CPU running at 3.58MHZ.It also composed of some additional hardware including, microphone, HM2007 IC key pad and Seven segments[3].

The minimum audio signal input necessary in order to avoid shouting in the microphone is about 20mv but still depends on the type of microphone we are using .The output of the latch goes to the parallel shift register of the RF transmitter module. The transmitter will convert these parallel signals into serial signals and send them over the receiver module which will then being send to HC11.This output which is a binary digit is the SR-07 kit's output. The SR-07 kit is shown in **Figure 2.1.**
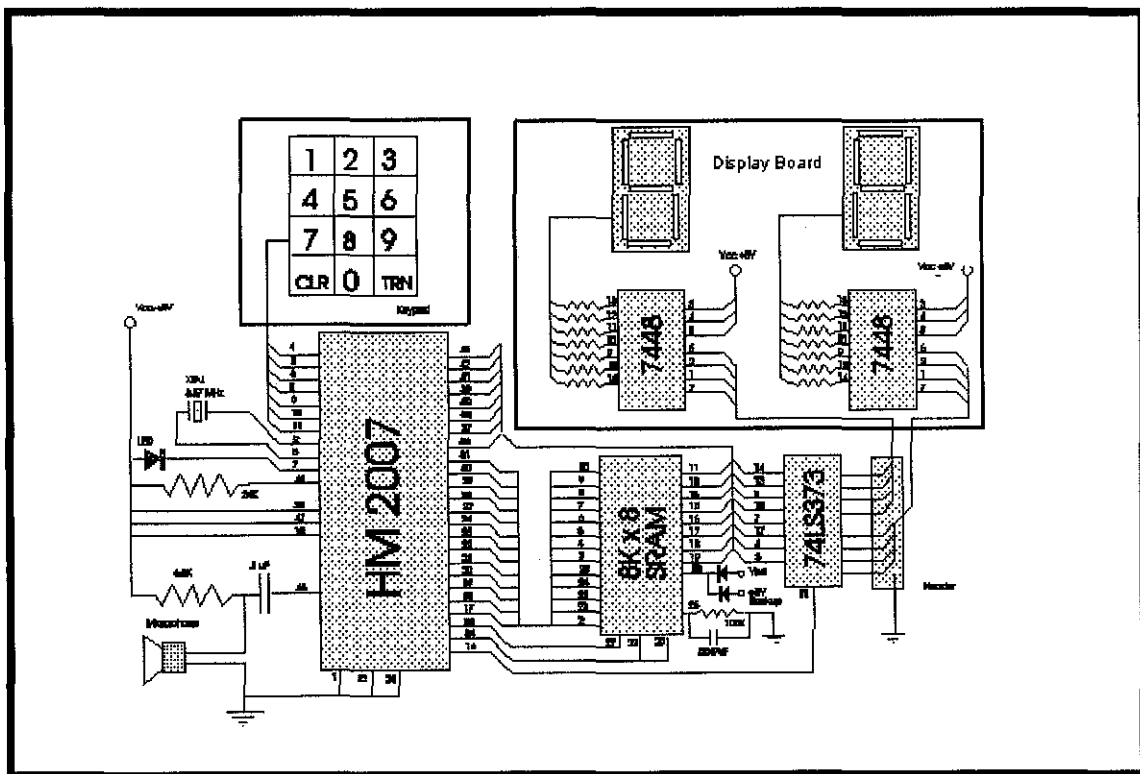
Figure 2.1: SR-07 kit composed of: PDIP, CPU, SRAM, A/D converter, BCD to seven segment decoders.

9

2.6   MICROCONTROLLER AT89C52

"A highly integrated chip that contains all the components comprising a controller. Typically this includes a CPU, RAM, some form of ROM, I/O ports, and timers. Unlike a general-purpose computer, which also includes all of these components, a microcontroller is designed for a very specific task is to control a particular system."[9]. "The AT89C52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology .

The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer which provides a highly-flexible and cost-effective solution to many embedded control."[10]

This microcontroller is composed of 4 input /output ports: Port 0,Port 1,Port 2,Port 3 which allows four different devices to be controlled and working together via its ports. This microcontroller uses either a quartz crystal or ceramic resonator clock in order to synchronize its operation and make the program to be executed in a sequential manner. This microcontroller should be connected to the 5volt supply via its pin 40 and 20, also in order to make the microcontroller to get activated and start its operation the enable pin which is pin number 31, should be always connected to Vcc. Also there are situations, where the microcontroller needs to get restarted. The Reset pin (pin9) should always be connected to Vcc from one side and to the ground from its other side via a push button key in order to give this opportunity to the user to restart the microcontroller whenever it declines executing its program. In this project the user command will be recognized by the HM2007 kit and the digital output of this voice recognition kit will be sent to the microcontroller via one of its ports. The suitable relay which has to push the remote button will be activated according to the microcontroller decision and the suitable user command will be executed on the fan/Heater. The microcontroller AT89C52 pin layout is shown in **Figure 2.2.**
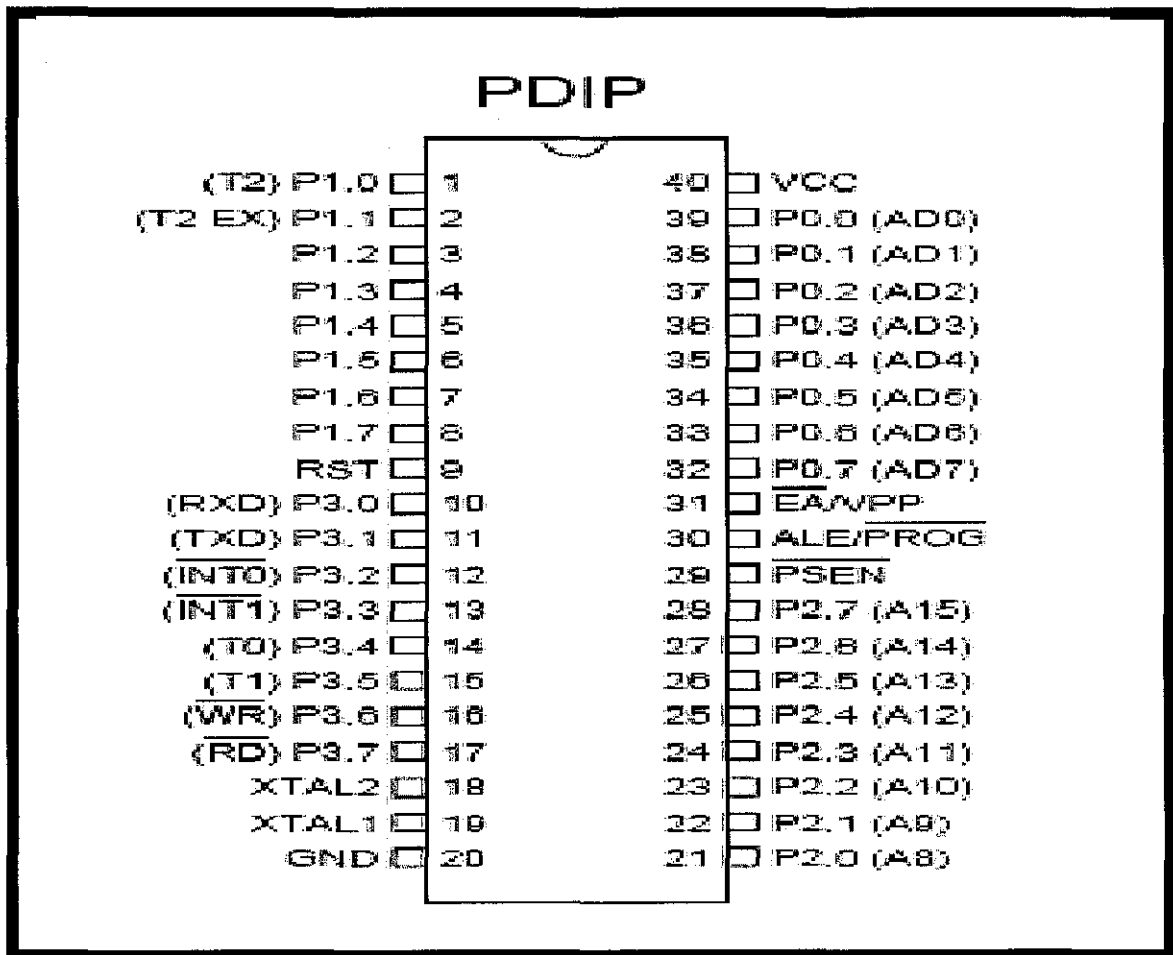
Figure 2.2: PIC Microcontroller AT89C52 (pin layout)

2.7 RELAYS

Relay is an electromagnetic switch. It is composed of a coil of wire which acts as an electromagnet. Since electric currents are magnetic, this coil of wire develops north and south magnetic poles whenever current passes through it. A metal core is placed inside the coil of wire to enhance its magnetism. Adjacent to the coil is a moveable piece of iron. While iron normally appears nonmagnetic when it's by itself, it becomes highly magnetic whenever it's exposed to a nearby magnetic pole. The iron piece becomes magnetic as current flows through the coil and the two are attracted toward one another. As the iron piece shifts toward the coil, it moves various electric contacts that are attached to it. These contacts close some circuits while opening others. The coil remains magnetic and continues to hold the iron piece near it until current stops flowing through the coil. When the current does stop, the coil loses its magnetism and so does the iron piece. The spring which is located in the relay then pulls the two apart and the electric contacts return to their original positions [11, 12].
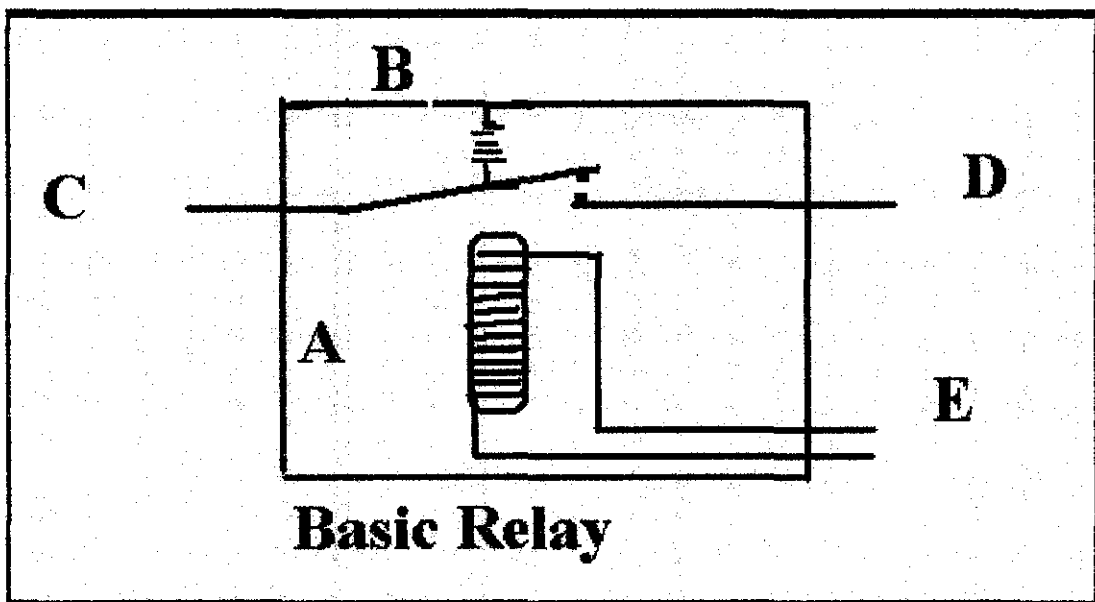
Figure 2.3: By applying power to pin E, the produced magnetic field in part A results in attraction of the small coil which leads to connection between C and D.

As shown in **Figure 2.3** by applying a dc power to the E contacts, a magnetic field will be created at contact A, this magnetic field is strong enough to overcome the strength of the spring B, and pulls down the flexible armature connected to C towards the electromagnet and thereby closing the contact which connects the circuit between C and D. When power is removed from E (supplying power to the electromagnet), it collapses the magnetic field on the electromagnet A, and the spring B will pull the armature back disconnecting the contacts and breaking the circuit between C & D [12].
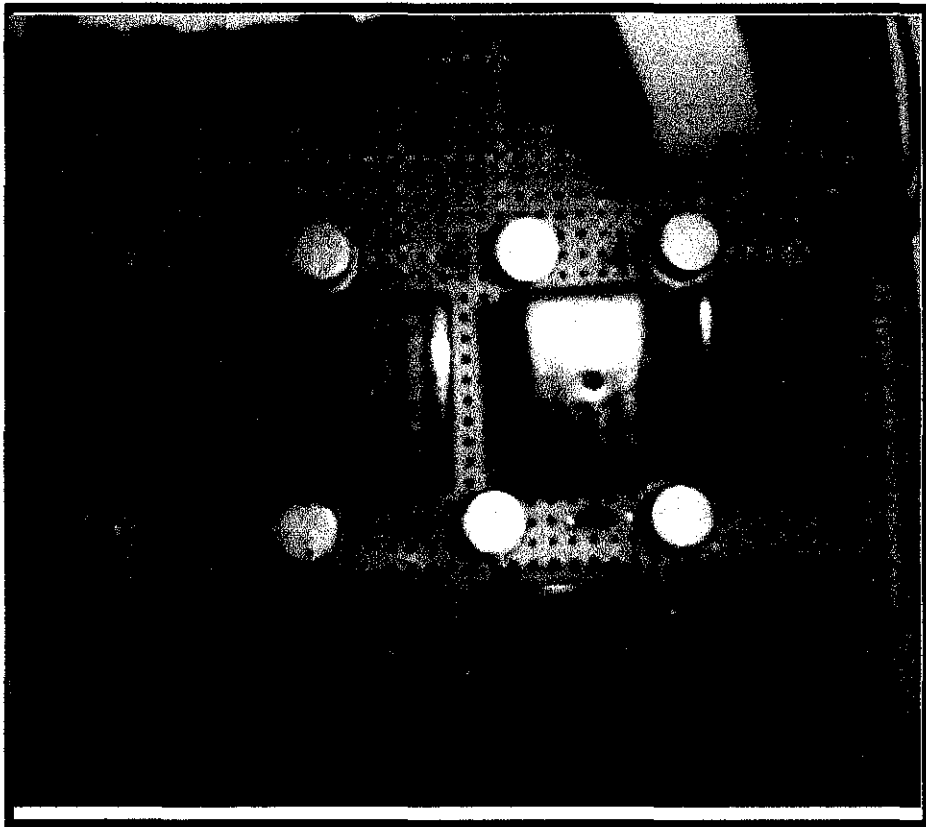
Figure 2.4: Relay's board: Eight relays are connected in order to respond to eight users command; these relays are connected to the microprocessor board from one port and form the other port to the remote control.

CHAPTER 3

METHODOLOGY

Good literature review and adequate references always play an important role in meeting the objectives of a project. Prior to materializing the objectives in the real device and testing, much time was spent reading up on microcontroller programming and voice recognition methods. Books and online references are the preferred choice of information. In order to use the voice activating remote control, the person should save his/her voice on HM2007 memory via the training session. Whenever user says a command, this command will be compared to the prerecorded one and the digital output from the HM2007 will be sent to the microcontroller. According to the burned program on the microcontroller, the suitable line of the program will be executed which results in activating one of the relays. The total project's schematic is shown in **Figure3.2**. The activated relay will then push the button on the remote control. The process diagram is shown in **Figure 3.1**.

This chapter has been divided into five parts:

- Voice recognition circuit (HM2007)
- Microcontroller and Buffer
- Relays
- Remote control
- Assembly programming
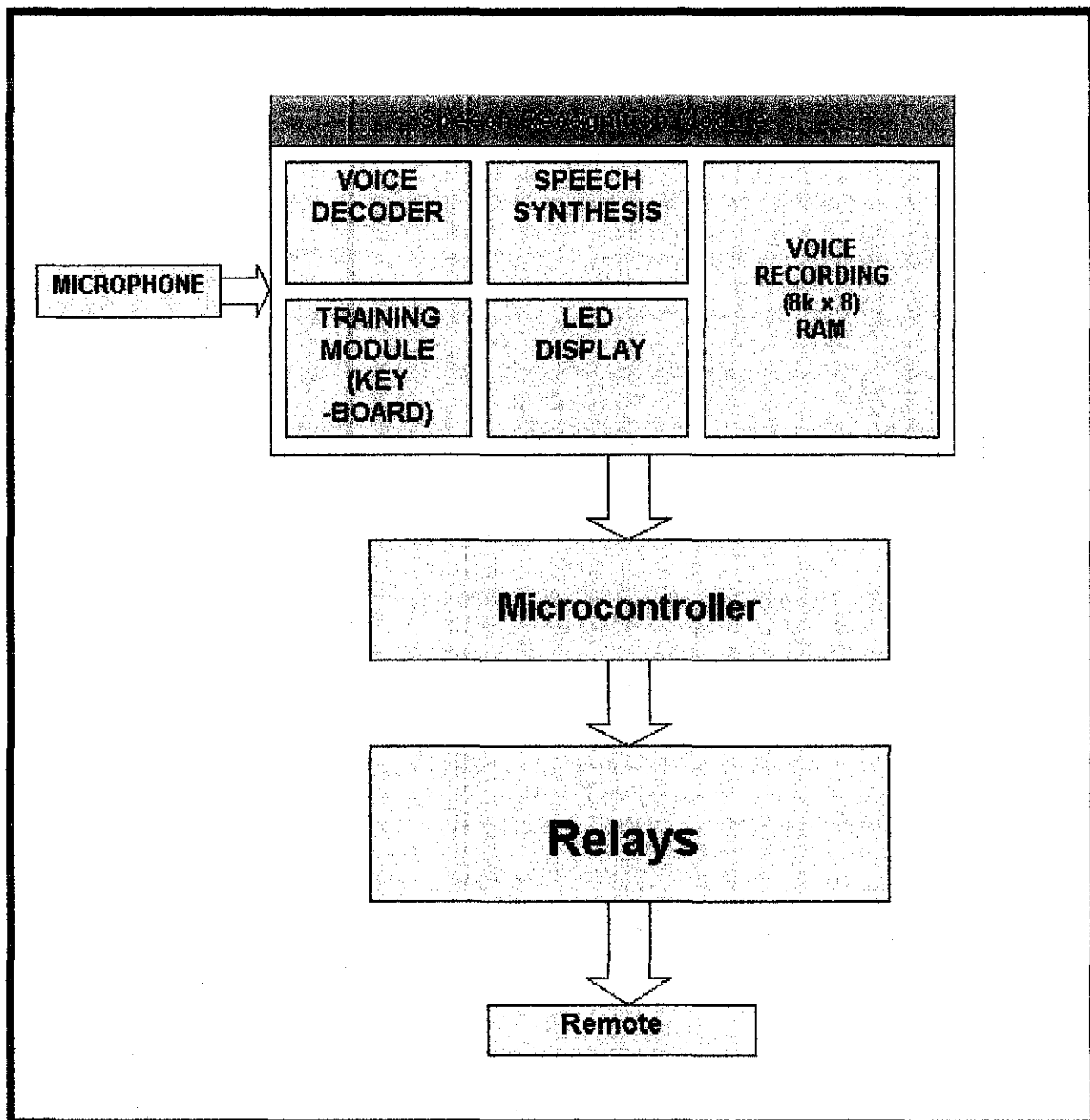
Figure 3.1: Process diagram of the voice activated remote control
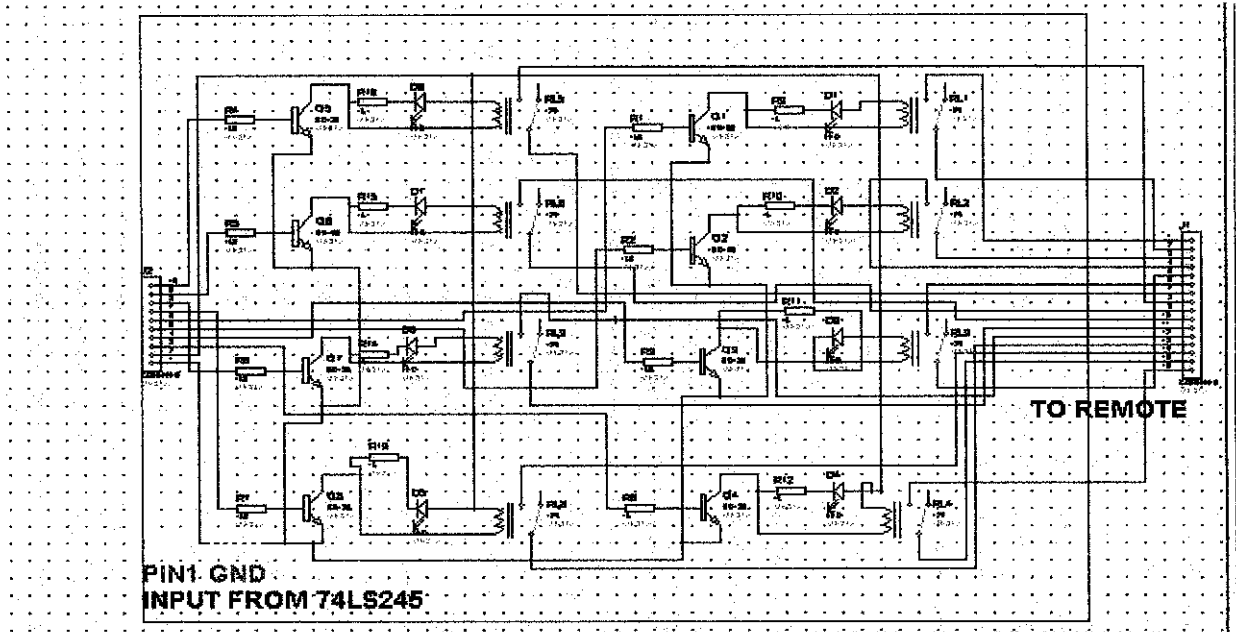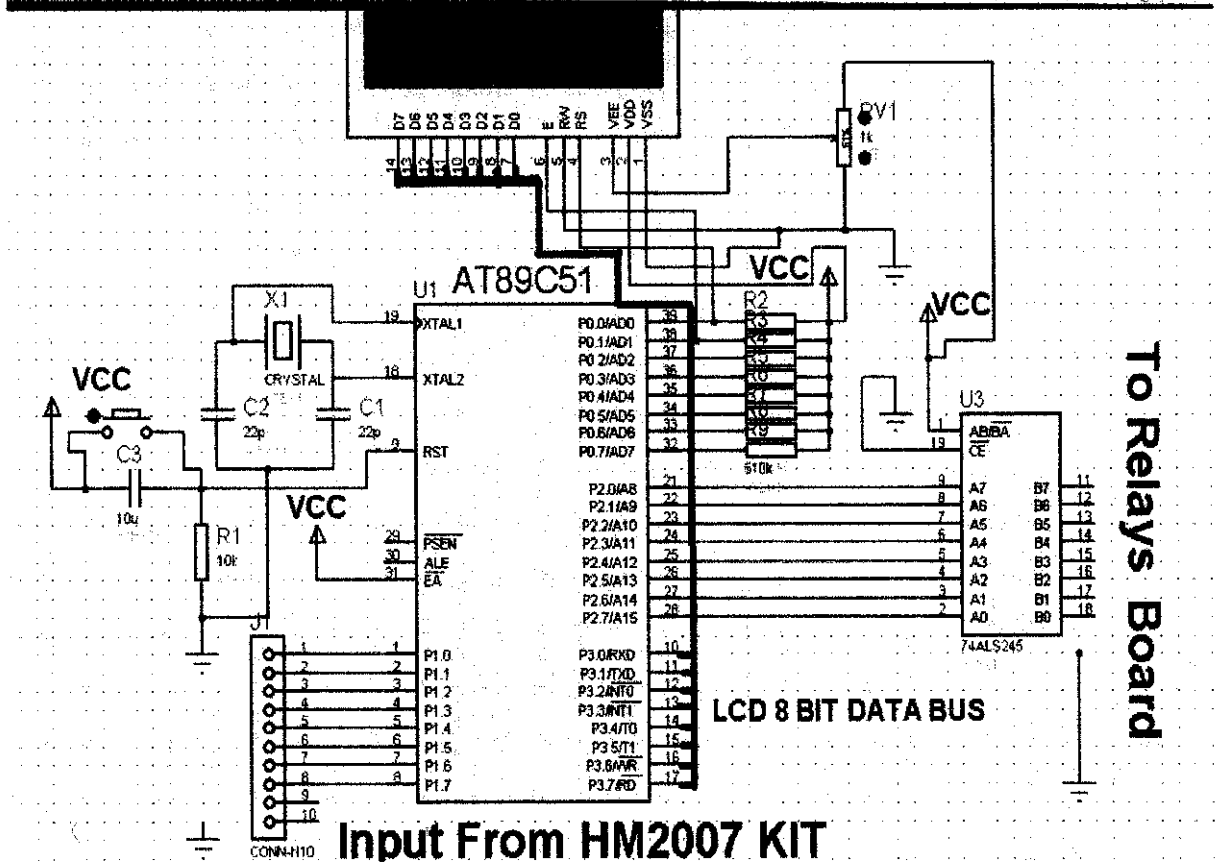
Figure 3.2: Total circuit schematic.

3.1   Voice Recognition Circuit (SR-07)

In this project we are using a voice recognition circuit which is composed of the HM2007 IC, SRAM, keypad and seven segments .The main purpose of using SR-07 circuit is the voice recognition which will be used via its manual mode in this project in order to analyze the user's commands. The SR-07 circuit is shown in **Figure 3.3.**
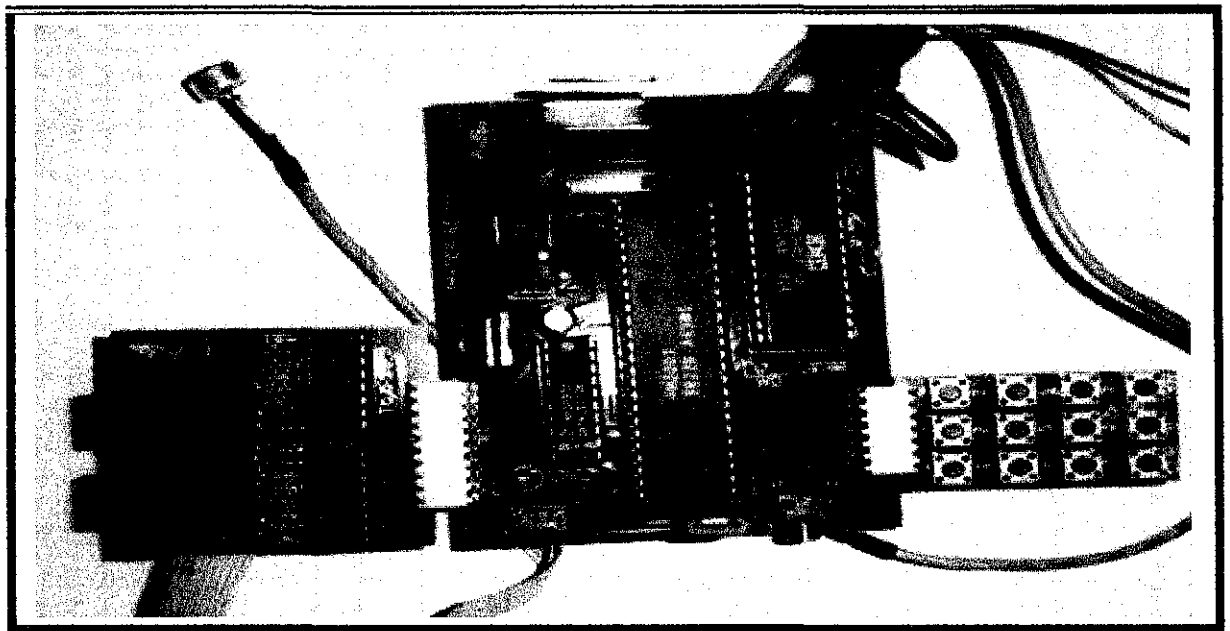
Figure 3.3: Voice recognition circuit

3.1.1 Manual mode

In this mode HM 2007 is equipped with key pad and a SRAM. After turning the IC on, in it will start recognition process and by comparing the input command to the pre recorded voice commands which were saved during training section, the correct data will be sent on the D- bus. The output of the voice recognition part is a decimal code in binary format. According to the binary values given to pins shown in Table1, the LCD will show the suitable message [3].

Table 1: Content of D-bus output of manual mode

D7	D6	D5	D4	D3	D2	D1	D0	Description
0	0	0	0	0	0	0	0	Power on
		A				B		Word AB
0	1	0	1	0	1	0	1	Voice too long
0	1	1	0	0	1	1	0	Voice too short
0	1	1	1	0	1	1	1	Not Match

In order for the user to work with this type of voice recognition IC, he/she should start the training section.

3.1.2 How to train the SR-07 circuit?

Training will be started by pressing the word number the user wants to train on the keypad. Before doing the training process its better to press the digit 99 and then clr button on the keypad in order to clear any prestored data on the memory of the kit. In order to train the kit, user should just key in the number on the keypad and say the word

18

through the microphone. For example by pressing number "1" word number 1 is ready to be trained. By pressing the number(s) on the keypad followed by pressing the "#" key the chip will be signaled to listen for the training word .If the word has been accepted by the circuit, the red LED will turn on and off .Blinking of this red LED is an indicator whether the word has been accepted by the SR-07 kit or not, if the LED didn't blink user should again key in the word number and repeat the word till the blinking happened. By saying the word in the microphone, the circuit will recognize this command and save it in its memory. The training for other words can be continued by pressing the key pad numbers and doing the same procedure.

In order to train the system in voice independent mode recognition style, we will use four word spaces for each target word. The words can be recognized just according to the least significant digit allocated to that word .For example we will use numbers 02,12,22,32 in the training session for word "power". We are able to use four different people to train the kit for word "power" with these four digits (02, 12, 22, and 23). By only decoding the least significant digit (2), the kit will match the command to the pre recorded voice and the command will be executed accordingly. This ability of the kit makes it to be more in use by several people such as family members. Also it gives the opportunity to the only user doing the training session to repeat the same word several times so the circuit will be less dependent on his/her accent when using the remote.

 Even if we use HM2007 in its voice dependent style it still does not depend on the user's voice tone, the IC is just sensitive to the user's accent and the way the user pronounced the word during the training session. This ability of the kit makes it to be more in use by several people such as family members with just one of the members trains the remote control.

The voice input to the chip is an analog signal (human voice) which enters through the microphone. In recognition mode, the chip compares the user command from the microphone with those stored in the SRAM and if it recognizes the command, an output

of the command identifier will be sent to the microprocessor through the D0 to D7 ports of the chip. Whenever recording and recognition process is successful, the ready pin on the chip will be set to low and then back to high [3].

3.1.3 How does SR-07 circuit do voice recognition process?

SR-07 circuit consists of HM2007 IC, a keypad and LEDS.
The recognition process of the circuit is as follows:

Voice decoder: It samples the speech signal and converts it into block of digital data.

Voice Recording: It is a RAM used to store the converted block of data.

Speech synthesis: In this part the input data is compared with the data stored in RAM and the result will be given to the next module.

3.2 Microcontroller

In order to use the microcontroller in this project, it should first be programmed according to the project needs. Universal Burner is used for burning the assembly programming on the microcontroller. Three ports of the microcontroller are being used in this project port 1 as the input port which is connected to HM2007 output, port 2 which is the output port connected to the relays and port 3 which is connected to LCD.
In order to be able to use the microcontroller, some pin connections should be made to make the microcontroller be ready for the project. The microcontroller's Vcc pin (pin 40) should be connected to 5 volt dc supply while connecting its ground pin (pin 20) to the negative port of the power supply. Also in order to make the microcontroller being

in its active mode and start its operation, its enable pin (pin 31) should be always high (connected to Vcc).There are situations happened sometimes that microcontroller can not continue its operation or it will enter to hang mode, in order to solve this problem there is a reset pin considered for the microcontroller which is to be connected to the Vcc and ground via a push button to be pressed whenever microcontroller stops responding to the program. In order for microcontroller to synchronize all its operation it needs a clock to give the microcontroller a constant sequence, so it will be able to synchronize all its process with the reference clock pulses. Two pins are located on the microcontroller IC which are XTAL1 1 and XTAL 2 pin number (18 and 19), these two pins will be connected to the clock in order to generate clock pulses for the microcontroller. Basic connections of the microcontroller are shown in **Figure 3.4**.

The input user's command will be recognized by SR-07 kit and a binary digit will be available at the kit output, which is connected to microcontroller's input port. Microcontroller will start executing its program and comparing the digit available on its input port with the digits being programmed on it, the result of the comparison will be sent through its output port which is the relays board.
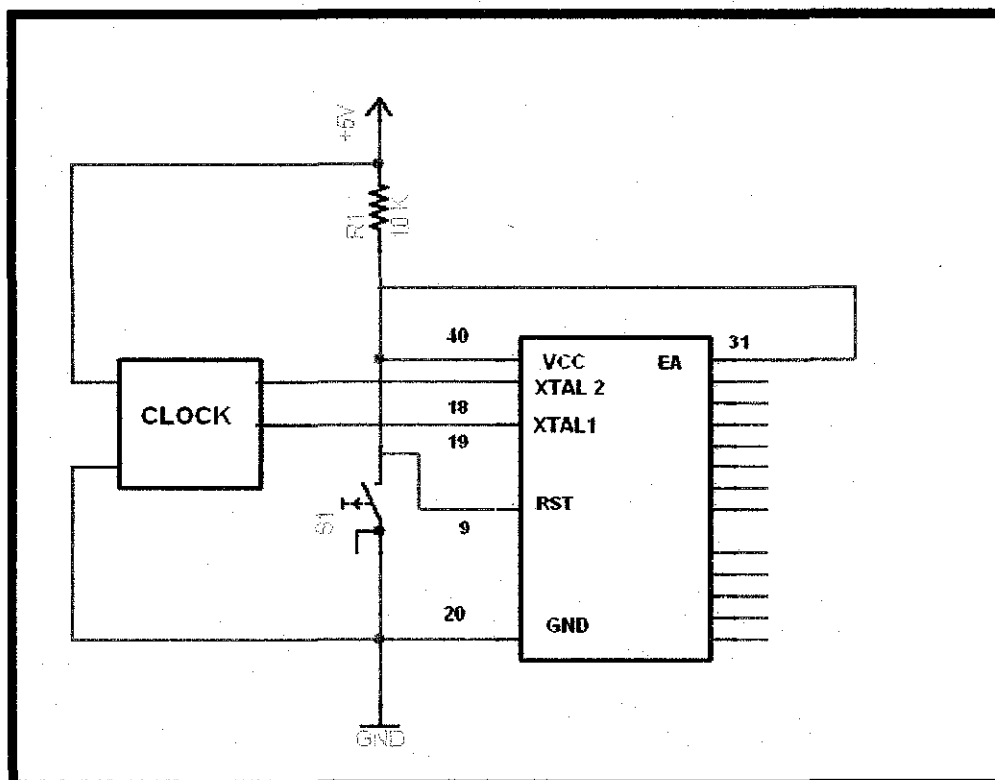
Figure 3.4: Preset up for microcontroller

3.2.1 Input port connections

In this project port 1 of the microcontroller is used as the input port which is the port coming from the HM2007.When user say a command to the microphone, HM2007 will start the process of voice recognition and the result of the process which is a binary digit output will be appeared at the output of SR-07 kit buffer which is the port connected to seven segments display of the SR-07 kit. The output of the HM2007 will enter to the microcontroller via its port 1. According to the digit, the suitable line of the program which has been burned on the microcontroller previously will be executed and ready to be sent out of the microcontroller. **Figure 3.5** shows the connection required for port1.
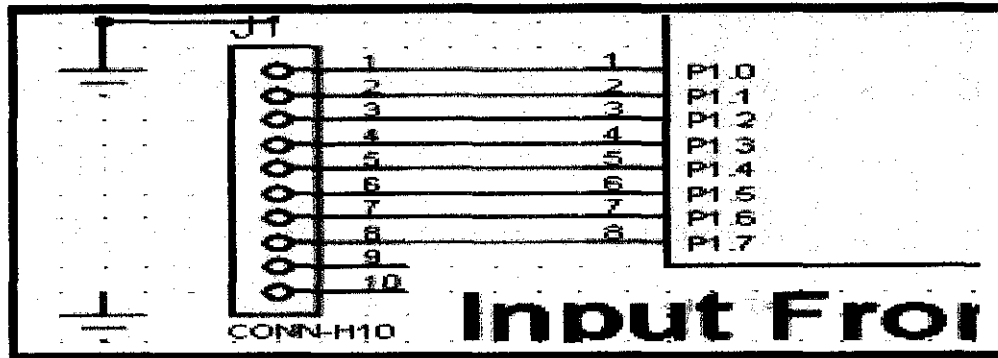
Figure 3.5: Microcontroller's input port connections

3.2.2 Output port connections

Port 2 of the microcontroller is the output port which is connected to 74LS245 IC which acts as a buffer. This buffer will then be connected to the relay's input .The result of the program execution will make a signal which lead in to the 74LS245 buffer in order to be able to activate the relay. After the buffer the current will activate the corresponding relay to be latched which results in pushing the remote button.

There are eight commands being recognized by this project: Up, Down, Power, Fan, High power, Mode, Swing, Filter .The number of commands being recognized by the remote can be further implemented by making changes in the software programming of the microcontroller and adding decoders in order to respond to more than eight user commands. . **Figure 3.6** shows the connection required for port2.
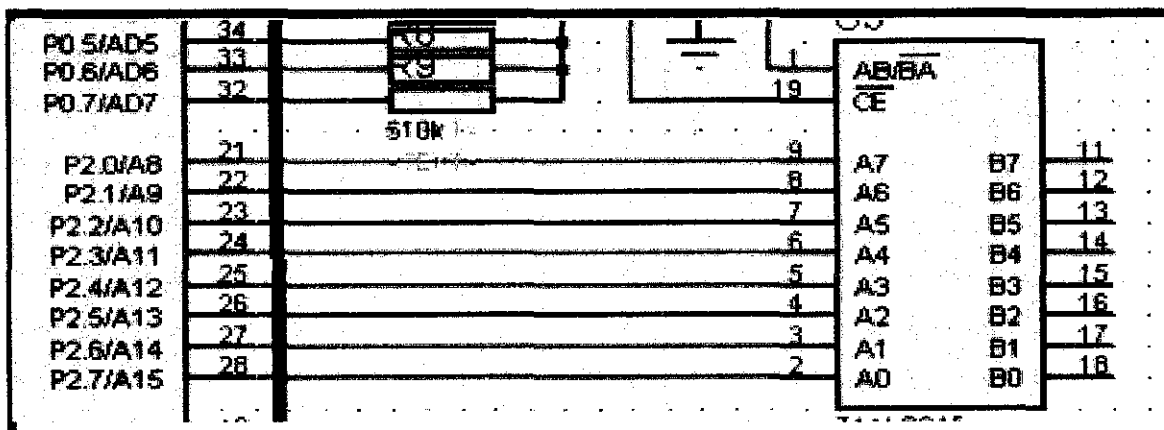
Figure 3.6: Microcontroller's output port connections

3.2.2.1   74LS245 IC

"The SN74LS245 is an Octal Bus Transmitter/Receiver designed for 8-line asynchronous 2-way data communication between data buses. Direction Input (DR) controls transmission of Data from bus A to bus B or bus B to bus A depending upon its logic level"[13].By making the pin 1 to be set or reset we will be able to select the direction of the data transmission.

On the way of microcontroller's output port and the relay's input connection, there is a 74LS245 IC which acts as a buffer. In order to active relays there are BJT s located prior to the relays' input on the relay board. To activate these BJTs' base terminal, we need high currents while the microcontroller's output can not provide .To solve this problem, the 74LS245 buffer is located on the way to the relays input in order to empower the microcontroller's output current, so it will be able to activate the base terminal of the relay which needs to get activated.

24

3.2.3   LCD port connections

Port 3 of the microcontroller has been connected to the LCD in order to display the title of the user's commands after it has been recognized by SR-07 .This port of microcontroller is counted as an output port because its sending the information from the microcontroller process to the LCD in order to be displayed. We used this LCD in the process in replace of using the SR-07 kit's seven segments. Instead of just showing the number of user's command in this way LCD is capable of showing the exact message being recognized by HM2007 instead of showing only digits.

LCD is working with two types of messages, whether the message is a data or it's a command. If the message is command like moving the cursor it doesn't need to be displayed on the LCD, but if the message is data, means it should be displayed on the LCD which needs the data first to be loaded on the data bus of the LCD and then being displayed on the screen. In order for the LCD to discover whether the message is a command or data there is a pin allocated for this purpose called RS pin, which by being 0 or 1 it informs the LCD about the type of message. The enable pin of the LCD should be in active low mode for at least 450 ns in order to let the data to be written on the LCD from data bus. **Figure 3.7** shows the connection required for port3.
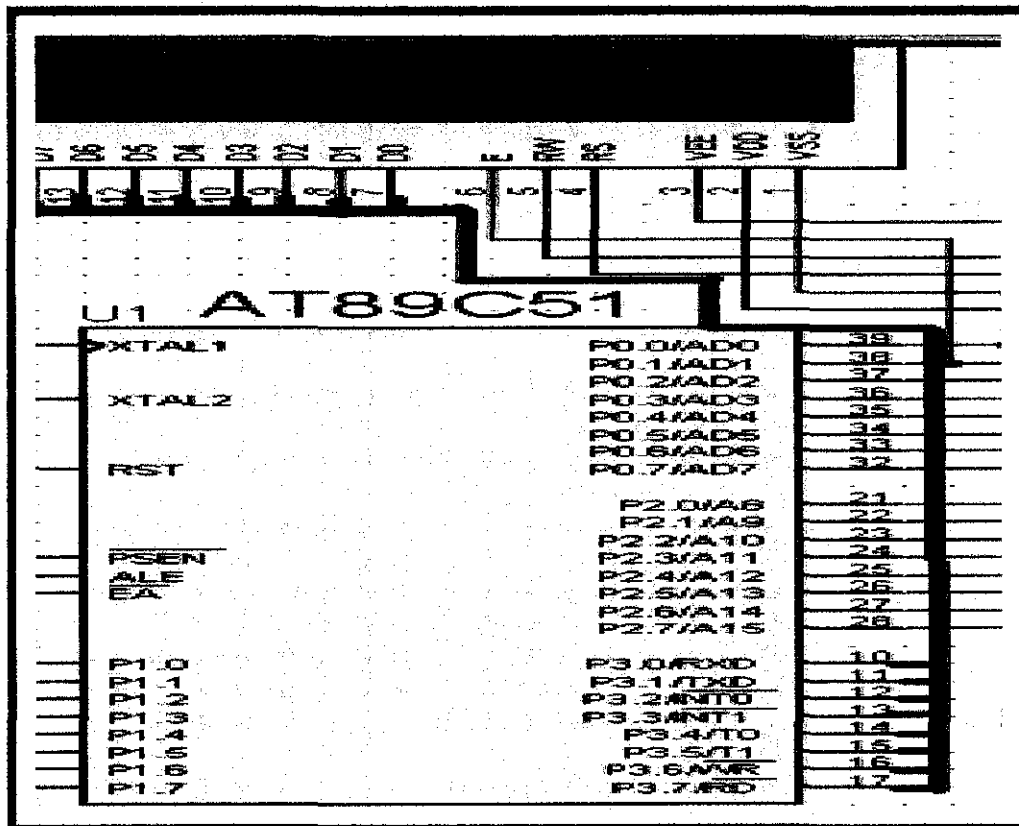
Figure 3.7: Microcontroller's output port connected to LCD

3.3 Relays

In this part of the project eight relays are being used and connected by a cable to the buffer and from buffer directly to the microcontroller via its port2.The output of the microcontroller will be sent to the 74LS buffer and from buffer to the relays. The output of the buffer will be connected through the cable to one of the relays that is matched to the user's command .The 5 volt signal makes the relay to turn on and makes a click sound. By building a connection from relays to the remote button, the two connectors

26

on the remote's keypad will be connected to each other which mean the button has been pressed. **Figure 3.8** shows the connection required for relays.
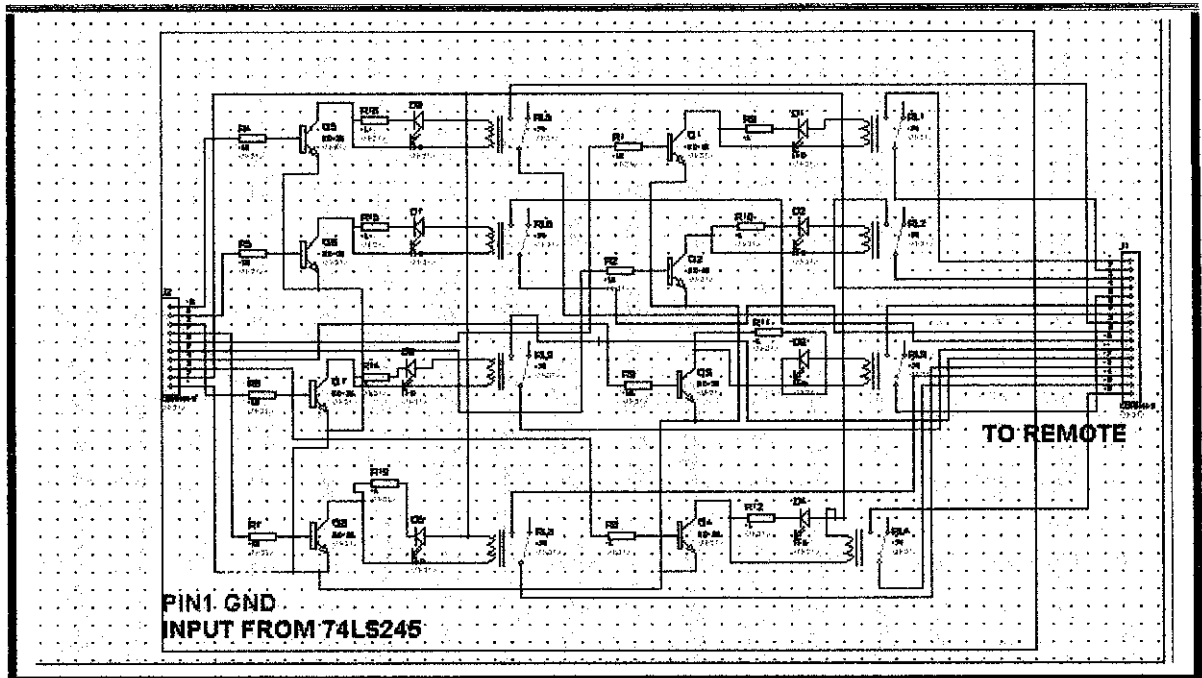
Figure 3.8: Relay connections

3.4 Remote Control

The remote control being used in this project is TOSHIBA brand. This remote control is counted as universal TOSHIBA remote because it is applicable on all models of Toshiba's fan/heater available in the market. In order to make connection between the remote control and the relays, several holes have been made by using CNC machines. These holes are made under the plastic buttons on the remote's keypad which will then

27

be attached to a cable entering the relays' board. The printed motherboard of the remote can be seen by removing its plastic hard cover .There are set of contact points under the button's plastic cover, located on the remote's mother board. Whenever user press a button, the black conductor will touch the contacts on the motherboard, which results in producing a signal. The signal will be sent to transistors for amplification and then translated in to infrared light which can be recognized by the Fan/heater device.

The remote is shown in **Figure 3.9.**

(a)
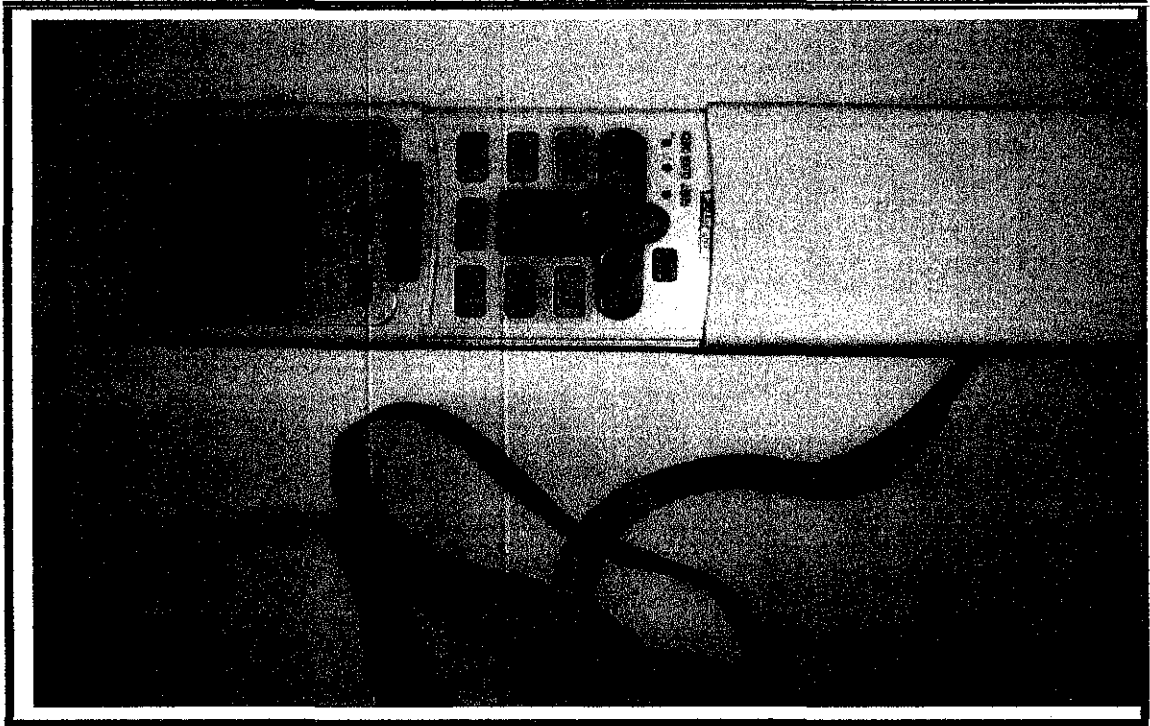
(b)
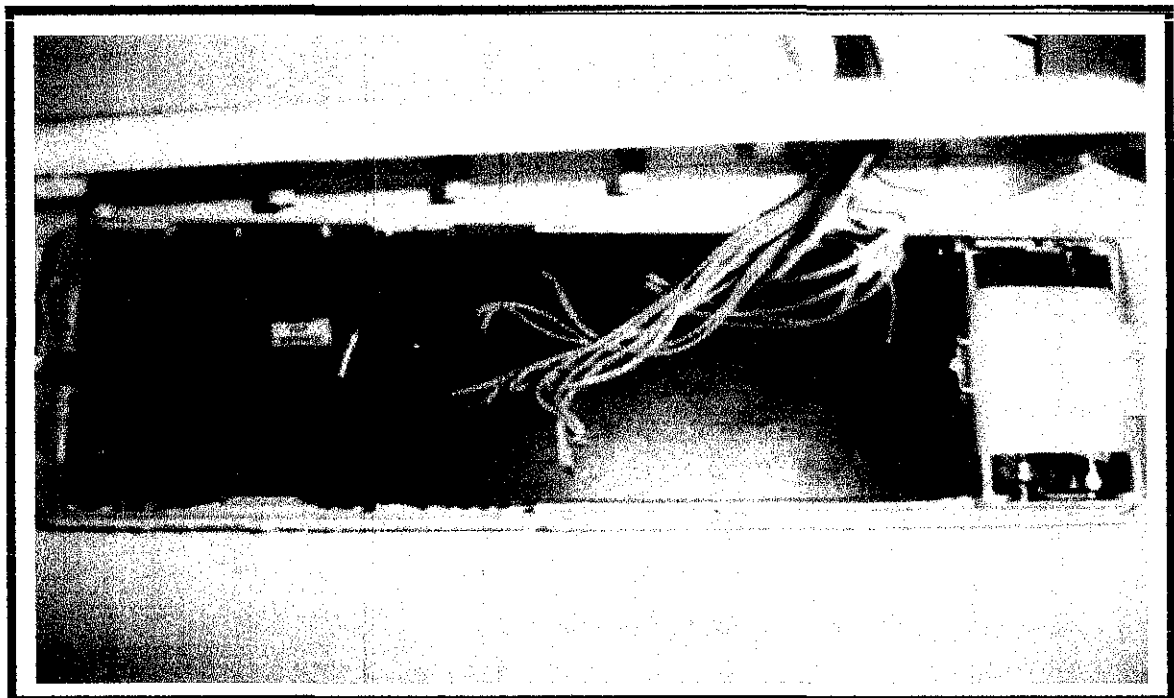
Figure 3.9: Remote control: a) Forward view. b) Holes made on remote board

29

3.5 Assembly programming

For the assembly programming of the microcontroller, it has been designed in order to show a text message at the beginning of the project when the remote turns on. This start up text message is "Nazanin Amiri Final project" as shown in **Figure 3.10**. This message will be gone after few seconds and the project will be ready for accepting commands and showing them on LCD while pressing the remote button. After showing the message there are some settings required for the LCD and the curser in order to know where to start writing the messages prior to executing the main program. The input of the SR-07 will be saved in memory location 35 hex decimal .So when ever an input enters the hm2007, it will compare it to the data stored in memory location 35h,if it was the same means no new data has been entered and if it was not the same it will copy the data in 35h and it understand a new input has been entered and it start searching through the subroutine written in the program to find the match with user's input and executing the functions allocated to that subroutine. The whole assembly programming is available in the **APPENDIX C**.
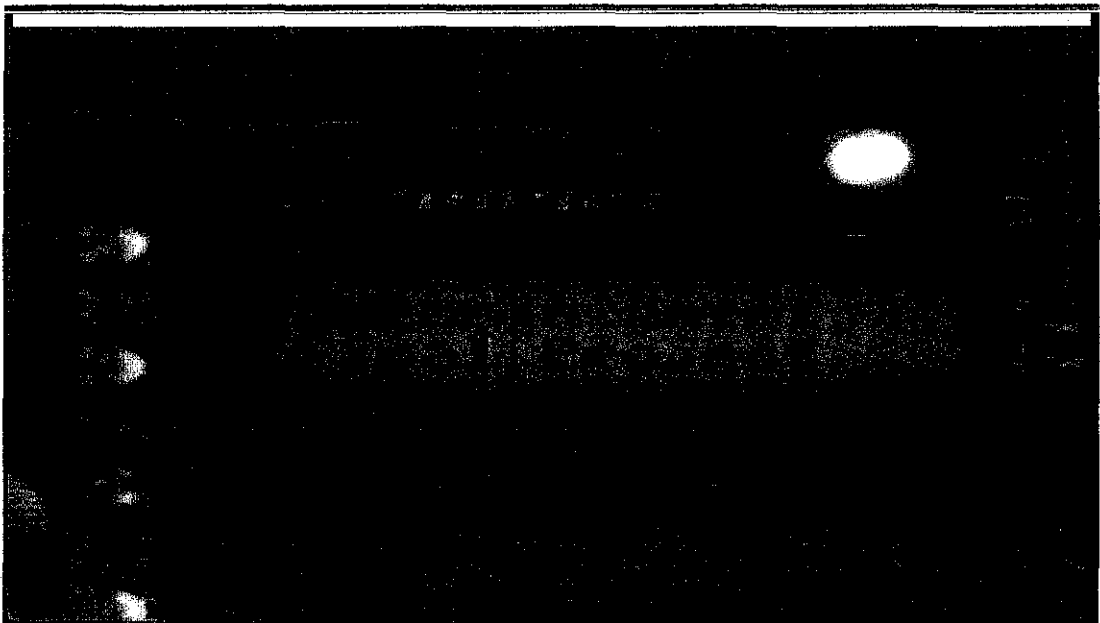
Figure 3.10: The start up message when the remote turns on.

CHAPTER 4

RESULTS AND DISCUSSION

This section of the report deals with the results obtained from the designed project and all associated discussions.

The hardware design of the project has been completed and tested several times. Remote control has performed properly and responds to the users commands accurately. In this project, user trained the SR-07 kit through a training section. After storing the user's commands the remote will be ready to be used by user who did the training section. This remote control should be always in its active mode in order to be available whenever user wants to say a command to be performed on the fan/heater.

User's command will be the input to the SR-07 kit and it will be compared with the pre recorded commands if it matches the trained voice the result of comparison which is a binary digit will enter the microcontroller via its input port. According to the assembly programming burned on the microcontroller through the universal burner, it will start finding the suitable command of the program that matches the binary code entered to the microcontroller via its input port. The suitable relay number will be known after microcontroller does the comparison process of its software programming. The current flows to the appropriate relay which has to be activated through microcontroller's output port and by activating the BJT connected to the relay, the relay will be latched and the voltage will push the connector of the desired remote control's button.

4.1 TEMPERATURE UP

In this remote control the first word of the SR-07 kit is allocated to the increasing the temperature command number 1.After the user train the kit, remote will be ready to be used. Whenever user feels cold and needs to increase the temperature of the place, she/he will just say the word "Up" and the user's voice will be recognized by HM2007, and the digit 1 will be displayed on its seven segments. After comparison with the prerecorded voices, the result which is a binary digit will enter to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will be displayed on the LCD and at the same time activate the relay which is connected to the increasing button of the remote controller. The button will be pressed continuously till the user says the command "break". The remote control's LCD shows the number being increased as shown in **Figure 4.1**, till user says the break command.
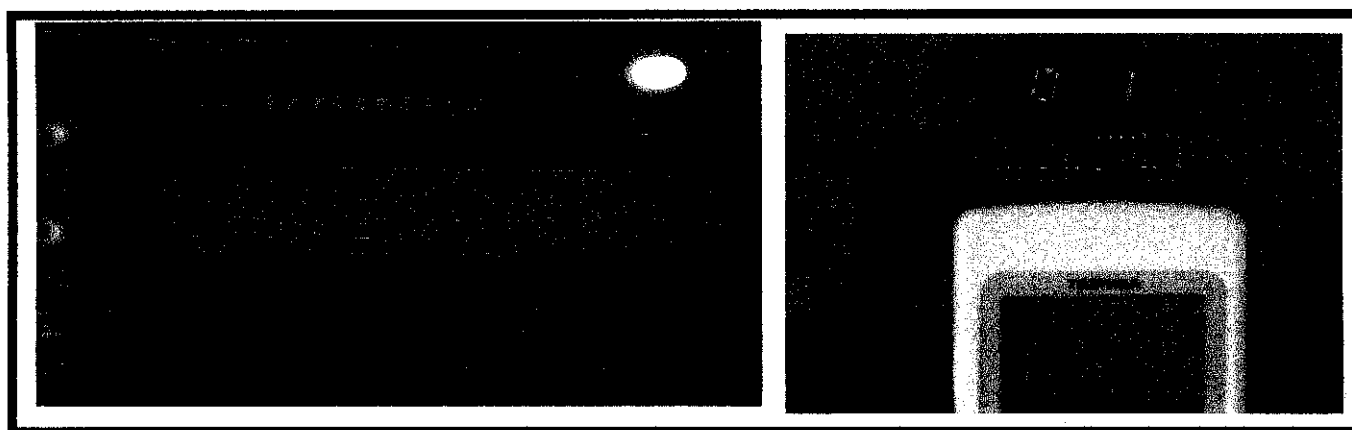
Figure 4.1: Remote starts increasing the fan/heater temperature according to the user command, it continuously increases the temperature till user says the Break command.

4.2 TEMPERATURE DOWN

The second word in this voice activated remote control is allocated to decreasing the temperature (command number 2) .After the user train the kit, remote will be ready to be used. Whenever user feels hot and needs to decrease the temperature of the place, she/he will just say the word "Down" and the user's voice will be recognized by HM2007 and the command code number will be displayed on its seven segments. After comparison with the prerecorded voices, the result which is a binary digit will enter to the microcontroller board through its input port and microcontroller starts executing its program to compare the input binary with the codes and the result of the comparison will be displayed on the LCD and at the same time activates the relay which is connected to the decreasing button of the remote controller. The button will be pressed continuously till the user says the command "Break". The remote control's LCD shows the number being decreased as shown in **Figure 4.2**, till user says the break command.
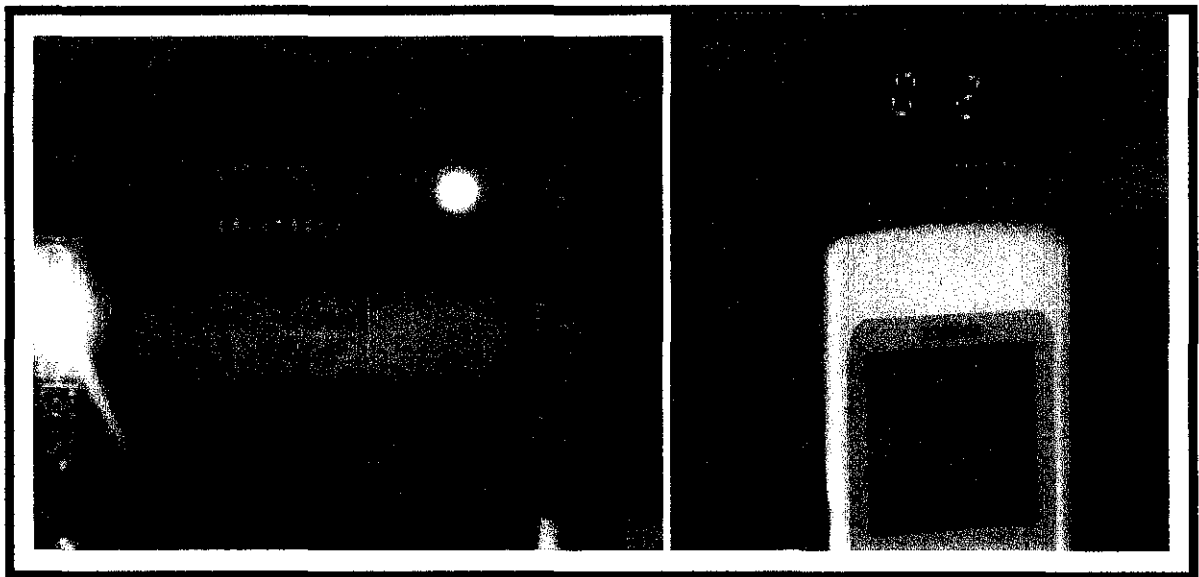
Figure 4.2: Remote starts decreasing the fan/heater temperature according to the user command, it continuously decreases the temperature till user says the Break command.

4.3 POWER

The third word of the SR-07 kit is allocated to power command which turns the remote on and off (command number 3). After training the kit, remote will be ready to be used. Whenever user wants to start using the remote control, he/she should says the word "Power" in order to turn on the remote and whenever user doesn't want to use the remote for long time, he/she should repeat the word "Power" again to turn off the remote control. Whenever user say the word "Power" the voice will be recognized by HM2007 and the digit 3 will be displayed on its seven segments. The result which is a binary digit will enter to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will be displayed on the LCD and at the same time activates the relay which is connected to the power button of the remote controller as shown in **Figure 4.3**.
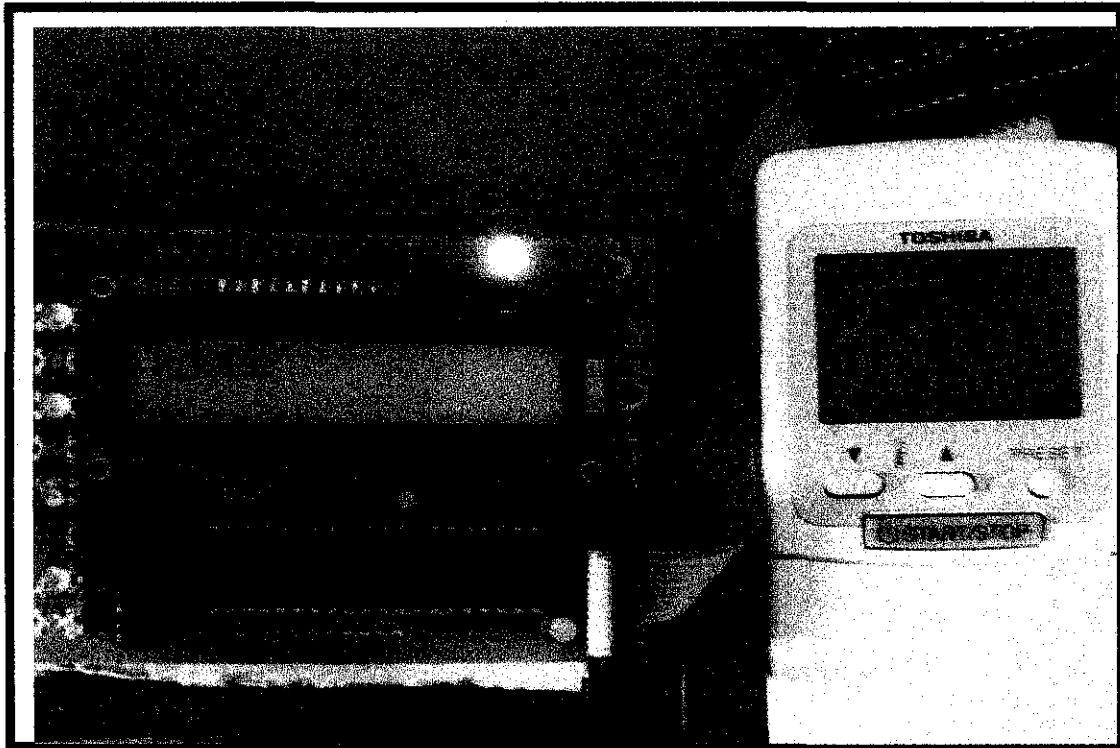
Figure 4.3: Remote turns on after user says the word "Power".

4.4 FAN

The fourth word of the SR-07 kit is allocated to fan command (command number 4). After training the kit, remote will be ready to be used. When ever user wants to use the fan mode rather than the AC mode of the fan/heater device he/she should say the word "Fan" in order to turn the fan/heater to its fan mode. User's voice will be recognized by HM2007 after comparison with the prerecorded voices, the result which is a binary digit will be displayed on the seven segments and at the same time enters to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will be displayed on the LCD and also activate the relay which is connected to the fan button of the remote controller also an indicator will be displayed on the emote LCD which shows the fan mode is on as shown in **Figure 4.4.**
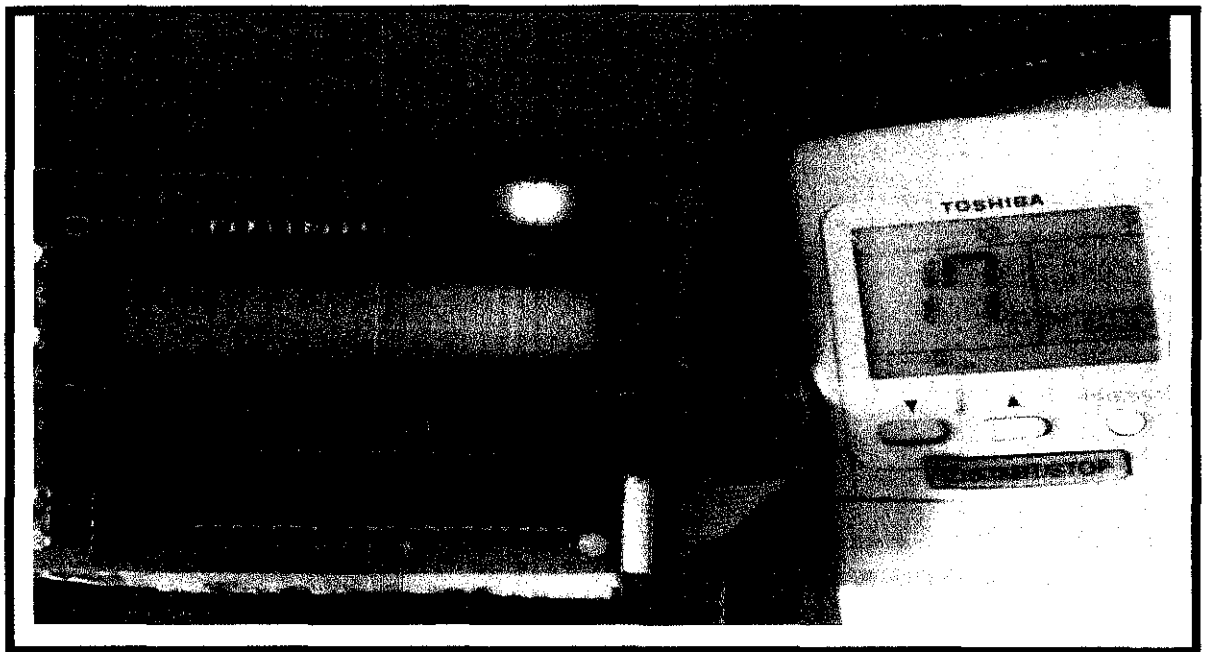
Figure 4.4: Remote turns to its fan mode after user says the word "Fan".

4.5 High Power

The fifth word of the SR-07 kit is allocated to high power command (number 5). After training the kit, remote will be ready to be used. Whenever user wants to use the powerful mode of the fan/heater device, he/she should say the word "High power". The user's voice will be recognized by HM2007 after comparison with the prerecorded voices, the result which is a binary digit will be displayed on seven segments and also it enters to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will activate the relay which is connected to the high power button of the remote controller as shown in **Figure 4.5**.Also a pointer will blink on the remote control whenever the button pressed.

Figure 4.5: Remote turns to its high power mode after user says the word "High power".

4.6 Mode

The sixth word of the SR-07 kit is allocated to Mode command. This button has been provided to let the remote be in selecting option position in order to let the user to choose the desired mode (fan, AC, heater, Automatic). Whenever user wants to select a different mode of the fan/heater device, he/she should say the word "High power" in order to turn the fan/heater to its powerful mode. User's voice will be recognized by HM2007 after comparison with the prerecorded voices, the result which is a binary digit will be shown by seven segments and also enter to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will activate the relay which is connected to the mode button of the remote controller, **Figure 4.6.**

Figure 4.6: Remote has entered to its mode selection after user says the word "Mode".

4.7 Swing

The seventh word of the SR-07 kit is allocated to swing command (command number 7). This command is used to make the fan/Heater device gates to move to different directions in order to change the temperature of the place sooner and in different directions. After training the kit, when ever user wants the fan/heater gates moving directionally he/she should say the word "Swing". User's voice will be recognized by HM2007 after comparison with the prerecorded voices, the result which is a binary digit will enter to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will activate the relay which is connected to the swing button of the remote controller, also an indicator will blink in response to the pressed button, **Figure 4.7**.

Figure 4.7: Remote has entered to its swing mode after user says the word "Swing".

4.8 Filter

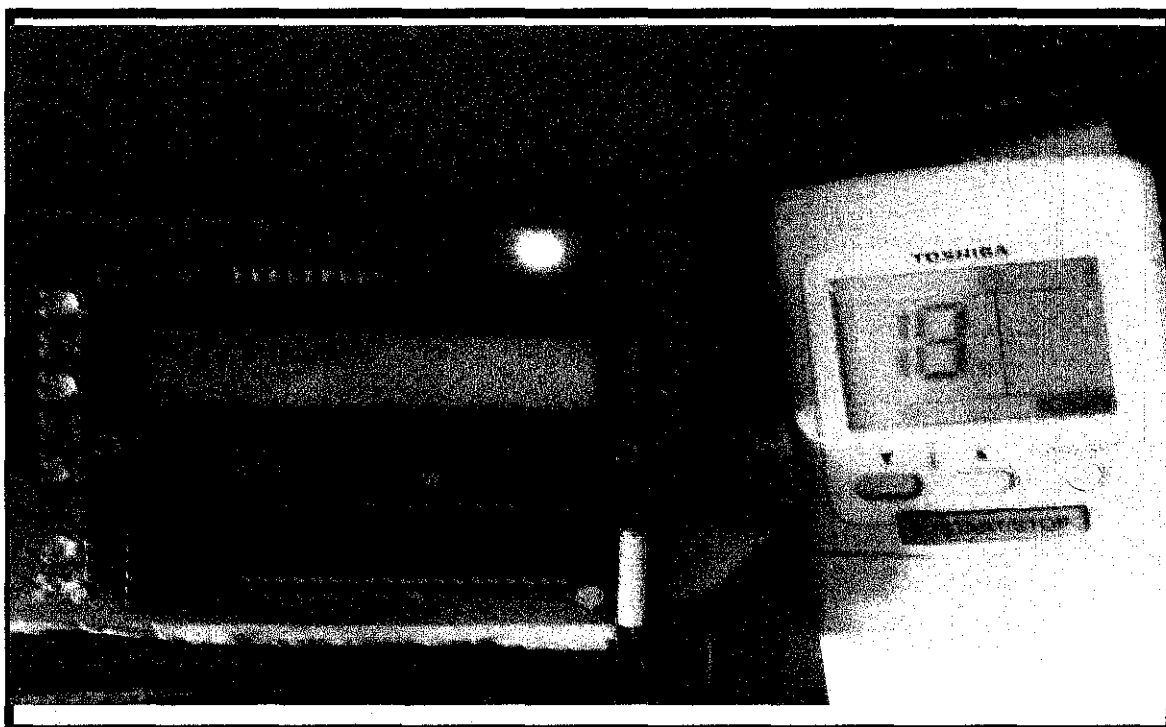The eight word of the SR-07 kit is allocated to high power command (number 8). After training the kit, remote will be ready to be used. When ever user wants to use the filter mode of the fan/heater device which is filterizing the air, he/she should say the word "Filter" in order to turn the fan/heater to its filtering mode. User's voice will be recognized by HM2007 after comparison with the prerecorded voices, the result which is a binary digit will be displayed and enter to the microcontroller board through its input port and microcontroller start executing its program to compare the input binary with the codes and the result of the comparison will activate the relay which is connected to the filter button of the remote controller and indicator will blink in response to the pressed button, **Figure 4.8**.
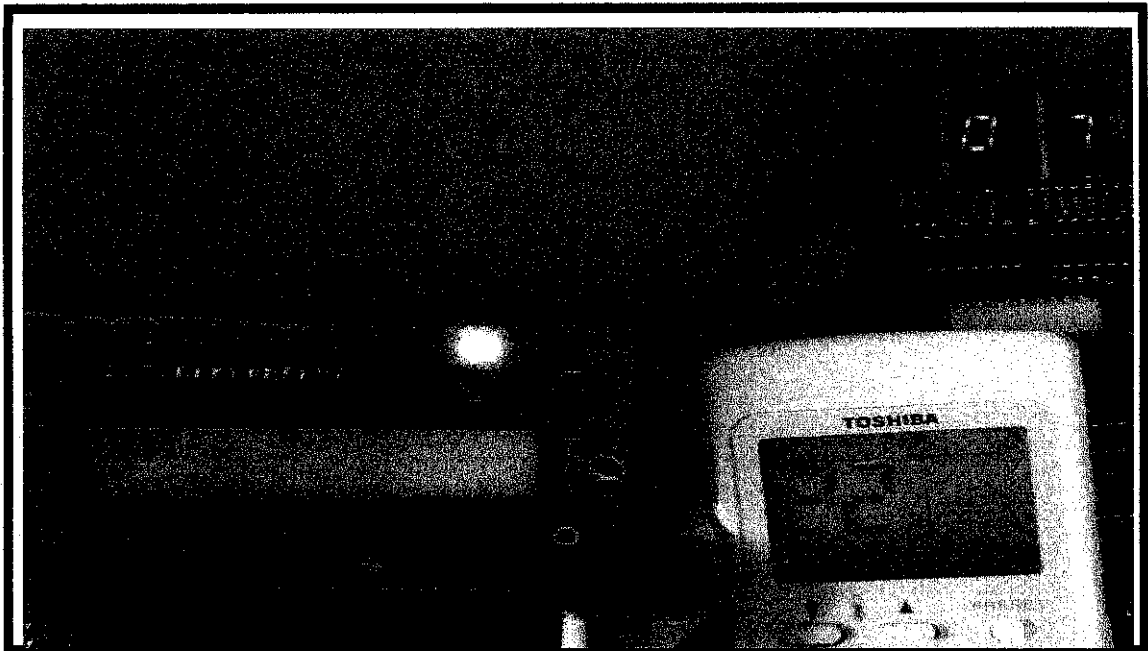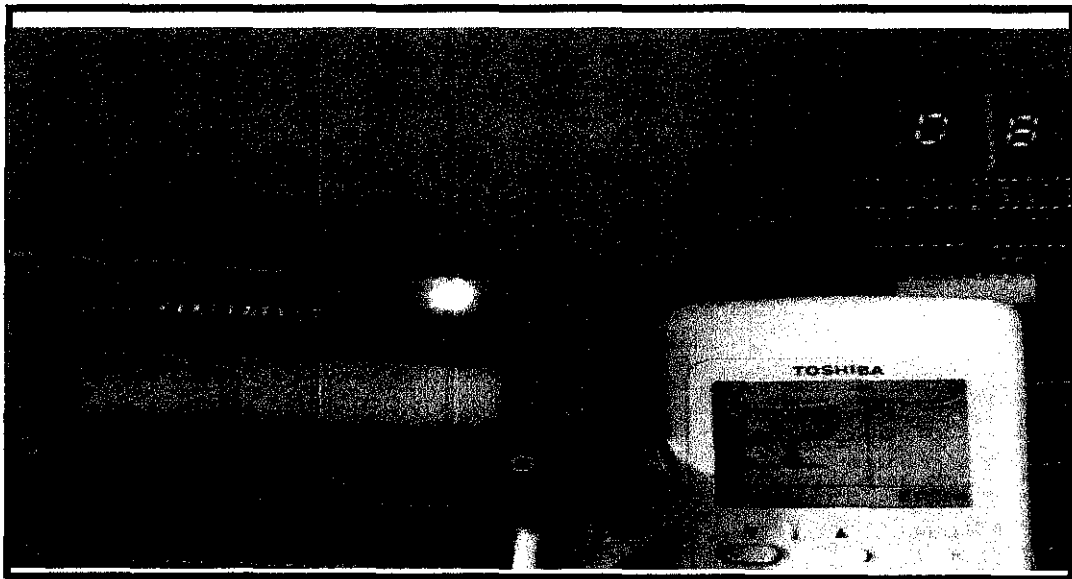

Figure 4.8: Remote has entered to its filter mode after user says the word "Filter".

This remote control is not sensitive to the human's tone, the only parameter which this remote is sensitive to is the user's accent.SR-07 kit gives this opportunity to several user to train the kit .But as tested by the project implementers, we figure out that even if only one user train the kit for example a lady, another male user with his bass tone will be able to use the remote control and it will recognize his commands if and only if he pronounces the words as the female user did. These testing shows that this kit is not much user dependent and it can be used by several people while just trained by one user. This is an added advantage of the project which the remote can be used by several people while trained only by one person but for further reliability and accuracy it is recommend to be trained by the users who wants to use the remote control.

During testing and working with the remote control we figured out sometimes it can not recognize the user's command, and results in user to repeat the command in order for HM2007 to recognize it. As mentioned before this IC has accuracy of 95% in recognizing the commands, but with further working on its recognition part and using more powerful methods of voice recognition it can be further implemented to have higher accuracy. The inaccuracy of the device is also in response to environmental noise. Noise has always been a problem in working, modifying and transmitting signals especially analogue signals. If we are using the remote control in a noisy area it may not clearly understand the command which results in showing the error codes 55, 66 or 77.Code 55 will be displayed when the user's command is too long, error 66 shows the user's command is too short and error 77 shows that users command does not match the prerecorded voices on the SR-07 kit. In order to solve this problem we should further implement the input signal which is the user's voice to be first converted to digital form through sampling and quantizing methods, then it can be sent to the HM 2007 IC for recognition. By working and transmitting digital signals the noise error will be much more reduced which result in better and higher accuracy of the HM2007 IC.

SR-07 kit is using SRAM as its memory in order to save the user's command during the training section, because data are located on the circuit's SRAM ,whenever the SR-07 kit turns off ,its memory will be erased and needs to be re-train again in order to respond to user's commands. In order to prevent this problem the kit has provided a place for locating a 1.5 volt backup battery in order to make the circuit's memory being activated even when the SR-07 is off. By using this back up battery the words entered to the SR-07 memory will be preserved as long as user does not modify them.

This voice activated remote control is capable of accepting 8 users' commands; however it can further implemented to accept more commands by adding decoders and modifying the microcontroller's software programming codes. For example by just adding two 4-line-to-16-line decoders to the microcontroller's output port it can be implemented to accept 32 users commands to be recognized by the kit. By using more decoders and multiplexers, number of commands still can be implemented to fulfill the customer's need. In this project the fan/heater remote control has only 8 important functions mainly used by its customers.

This remote control can be further modified to become a universal voice activated remote control. There are some people who like to have one remote control to be able to work with all their controllable home electrical devices. Further implementation of this remote, will respond to these types of people need. Instead of having different remote controls for fan/heater, TV, DVD and VCR, we can use just one voice remote control to be able to work and control with all these home equipments.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project will provide more comfort for people who are having problem of doing their works alone because of disability or being old; even help other people to become more comfortable for controlling the air conditions at their home, or controlling their home electrical devices. By further improving in this remote control, it will be able to be controlled from longer distances. The success of this project will give more new ideas to other students, engineers, to develop their knowledge and build devices which are more powerful and easier to use. Accomplishing this project gives so much information on the voice recognition techniques and the way to solve problems related to this technique. It also helps the researcher to connect external devices to PIC microcontroller and try to communicate them in order to do some logical operations.

5.2   Recommendation

This project can be further improved to build a fully voice controllable remote by using more powerful devices with higher memory and capabilities. It can be implemented to become a fully independent remote with high accuracy. By adding more powerful microphone the user can control the fan/heater from long distances. Also this project can be more improved to produce a remote control which can control all electrical home appliances like fan/heater. TV, DVD, VCD.

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APPENDICES

APPENDIX A: GAUNTT CHART FOR SEMESTER 1

No.	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Selection of Project Topic	■	■													
	• Topic assigned to students															
2	Preliminary Research Work			■	■	■	■	■								
	• Background															
	• Objectives															
	• Literature reviews and theory															
3	Submission of Preliminary Report				●											
4	Project work						■	■	■							
	• Reference/Literature															
	• Collecting information about components availability															
5	Submission Progressive Report								●							
6	Continue with studies								■	■	■	■	■			
	• Understanding HM2007 Voice Recognition Chip															
	• Learning about Microcontroller															
	• Organizing all the researches to use in reports															
7	Submission of Draft Report												●			
8	Submission of interim report														●	
9	Oral Presentation															●

■ Process   ● Suggested Milestone

47

APPENDIX B: GAUNTT CHART FOR SEMESTER 2

No.	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	19
1	Project Work Continue	■	■	■												
	• Practical/Laboratory Work															
2	Submission of Progress Report 1				●											
3	Project Work Continue				■	■	■	■								
	• Practical/Laboratory Work															
4	Submission of Progress Report 2								●							
5	Project Work Continue								■	■	■	■				
	• Practical/Laboratory Work															
6	Submission of Dissertation Final Draft												●			
7	Submission of Final Report (Soft Cover)														●	
8	Oral Presentation															●
9	Submission of Final Report (Hard Cover)															●

■ Process   ● Suggested Milestone

APPENDIX C: Assembly codes for Microprocessor

```
        org    00h
        jmp    main
        org    30h
main: LCALL  SETUP
        mov    35h,#00
        mov    p1,#0ffh
        MOV    P2,#00H
        LCALL  ID
        LCALL  TI1


process:

        mov  a,p1
        cjne a,35h,dff1
        jmp  process
dff1:  mov  r1,a
        mov  35h,a
        cjne a,#55h,xq1
        lcall long
        lcall ti1
        jmp    process
xq1:   cjne a,#66h,xq2
        lcall short
        lcall ti1
        jmp    process
xq2:   cjne a,#77h,xq3
        lcall nomatch
        lcall ti1
        jmp    process
xq3:
        mov  a,r1
        anl  a,#00001111b
        cjne a,#0fh,start
        jmp  process
start: lcall check
        jmp  process

check: cjne  a,#1,zs1
        lcall up
        jmp   zs8
```

```
zs1:    cjne   a,#2 ,zs2
        lcall  down
        jmp    zs8


zs2:    cjne   a,#3 ,zs3
        lcall  power
        jmp    zs8

zs3:    cjne   a,#4 ,zs4
        lcall  fan
        jmp    zs8

zs4:    cjne   a,#5,zs5
        lcall  highpower
        jmp    zs8

zs5:    cjne   a,#6,zs6
        lcall  mode
        jmp    zs8

zs6:    cjne   a,#7,zs7
        lcall  swing
        jmp    zs8

zs7:    cjne   a,#8 , zs8
        lcall  filter
        jmp    zs8

zs8:    nop
        ret



up:  lcall  up1
     setb   p2.0
     lcall  stop
     clr    p2.0


     ret

down: lcall  down1
      setb   p2.1
      lcall  stopdown
```

```asm
        clr    p2.1

        ret


power:  lcall  power1
        setb   p2.2
        lcall  ti1
        clr    p2.2
        ret




fan:    lcall  fan1
        setb   p2.3
        lcall  ti1
        clr    p2.3


        ret




highpower: lcall highpower1
        setb   p2.4
        lcall  ti1
        clr    p2.4


        ret




mode:   lcall  mode1
        setb   p2.5
        lcall  ti1
        clr    p2.5


        ret
```

```
swing:  lcall    swing1
        setb     p2.6
        lcall    ti1
        clr      p2.6


        ret




filter:  lcall  filter1
         setb  p2.7
         lcall  ti1
         clr   p2.7

         ret


stop:   mov   a,p1
        mov   r1,a
        cjne  a,#55h,xq11
        lcall long
        lcall stp
        lcall ti1
        jmp   stop
xq11:   cjne  a,#66h,xq12
        lcall  short

        lcall  stp
        lcall  ti1
        jmp   stop
xq12:  cjne  a,#77h,xq13
        lcall nomatch

        lcall  stp
        lcall  ti1
        jmp   stop
xq13:
        mov  a,r1
        anl  a,#00001111b
        cjne  a,#01h,start1
        clr   p2.0
```

```
        lcall ti1
        setb  p2.0
        lcall ti1
        jmp   stop
start1: cjne  a,#9,ds11
        jmp   ds2
ds11: jmp    stop


ds2: nop
ret


stopdown:mov  a,p1
        mov   r1,a
        cjne  a,#55h,xq111
        lcall long
        lcall stp
        lcall ti1
        jmp   stopdown
xq111:  cjne  a,#66h,xq112
        lcall short

        lcall stp
        lcall ti1
        jmp   stopdown
xq112:  cjne  a,#77h,xq113
        lcall nomatch

        lcall stp
        lcall ti1
        jmp   stopdown
xq113:
        mov   a,r1
        anl   a,#00001111b
        cjne  a,#02h,start11
        clr   p2.1
        lcall ti1
        setb  p2.1
        lcall ti1
        jmp   stopdown
start11:  cjne  a,#9,ds111
        jmp   ds21
ds111:
        jmp   stopdown


ds21: nop
```

```
ret


ID:   mov   a,#01h
      lcall  com
      mov   a,#80h
      lcall  com
      mov   a,#'N'
      lcall  dat
      mov   a,#'a'
      lcall  dat
      mov   a,#'z'
      lcall  dat
      mov   a,#'a'
      lcall  dat
      mov   a,#'n'
      lcall  dat
      mov   a,#'i'
      lcall  dat
      mov   a,#'n'
      lcall  dat
      mov   a,#' '
      lcall  dat
      mov   a,#'a'
      lcall  dat
      mov   a,#'m'
      lcall  dat
      mov   a,#'i'
      lcall  dat
      mov   a,#'r'
      lcall  dat
      mov   a,#'i'
      lcall  dat

      mov   a,#0c0h
      lcall  com


      mov   a,#'F'
      lcall  dat
      mov   a,#'i'
      lcall  dat
      mov   a,#'n'
      lcall  dat
      mov   a,#'a'
```

```
        lcall  dat
          mov   a,#'l'
        lcall  dat
        mov   a,#' '
        lcall  dat
          mov   a,#'P'
        lcall  dat
        mov   a,#'r'
        lcall  dat
          mov   a,#'o'
        lcall  dat
        mov   a,#'j'
        lcall  dat
          mov   a,#'e'
        lcall  dat
        mov   a,#'c'
        lcall  dat
          mov   a,#'t'
        lcall  dat
        RET

setup:mov   a,#38h
        lcall  com
        mov   a,#0ch
        lcall  com
        mov   a,#01h
        lcall  com
        mov   a,#80h
        lcall  com
        ret


com: mov    p3,a
     clr    p0.0 ;rs
     setb   p0.1
     clr    p0.1
          MOV   21,#2
HERE1: MOV    20h,#255
HERE0: DJNZ   20,HERE0
     DJNZ  21,HERE1
     ret


dat: mov    p3,a
     setb   p0.0 ;rs
     setb   p0.1
```

```
        clr    p0.1
        MOV    21,#2
h1: MOV    20,#255
RE0: DJNZ    20,RE0
        DJNZ    21,h1
        ret


POWER1: mov    a,#01h
        lcall  com
        mov    a,#80h
        lcall  com
        mov    a,#'P'
        lcall  dat
        mov    a,#'O'
        lcall  dat
        mov    a,#'W'
        lcall  dat
        mov    a,#'E'
        lcall  dat
        mov    a,#'R'
        lcall  dat

        RET


up1: mov    a,#01h
        lcall  com
        mov    a,#80h
        lcall  com
        mov    a,#'T'
        lcall  dat
        mov    a,#'e'
        lcall  dat
        mov    a,#'r'
        lcall  dat
        mov    a,#'m'
        lcall  dat
        mov    a,#'o'
        lcall  dat
        mov    a,#' '
        lcall  dat
        mov    a,#'u'
```

```
    lcall  dat
    mov    a,#'p'
    lcall  dat


    mov    a,#0c0h
    lcall  com
    mov    a,#'c'
    lcall  dat
    mov    a,#'a'
    lcall  dat
    mov    a,#'l'
    lcall  dat
    mov    a,#'l'
    lcall  dat
    mov    a,#' '
    lcall  dat
    mov    a,#'s'
    lcall  dat
    mov    a,#'t'
    lcall  dat
    mov    a,#'o'
    lcall  dat
    mov    a,#'p'
    lcall  dat


    RET




stp: mov    a,#0c0h
    lcall  com
    mov    a,#'c'
    lcall  dat
    mov    a,#'a'
    lcall  dat
    mov    a,#'l'
    lcall  dat
    mov    a,#'l'
    lcall  dat
    mov    a,#' '
    lcall  dat
```

```
        mov   a,#'s'
        lcall  dat
        mov   a,#'t'
        lcall  dat
        mov   a,#'o'
        lcall  dat
        mov   a,#'p'
        lcall  dat
        ret


down1: mov   a,#01h
        lcall  com
        mov   a,#80h
        lcall  com
        mov   a,#'T'
        lcall  dat
        mov   a,#'e'
        lcall  dat
        mov   a,#'r'
        lcall  dat
        mov   a,#'m'
        lcall  dat
        mov   a,#'o'
        lcall  dat
        mov   a,#' '
        lcall  dat
        mov   a,#'D'
        lcall  dat
        mov   a,#'o'
        lcall  dat
        mov   a,#'w'
        lcall  dat
        mov   a,#'n'
        lcall  dat

        mov   a,#0c0h
        lcall  com
        mov   a,#'c'
        lcall  dat
        mov   a,#'a'
        lcall  dat
        mov   a,#'l'
        lcall  dat
        mov   a,#'l'
        lcall  dat
```

58

```
     mov   a,#' '
lcall  dat
mov   a,#'s'
lcall  dat
  mov   a,#'t'
lcall  dat
mov   a,#'o'
lcall  dat
  mov   a,#'p'
lcall  dat



     RET

HIghPOWER1:

     mov   a,#01h
lcall  com
mov   a,#80h
lcall  com
  mov   a,#'H'
lcall  dat
   mov   a,#'I'
lcall  dat
mov   a,#' '
lcall  dat
mov   a,#'P'
lcall  dat
mov   a,#'O'
lcall  dat
   mov   a,#'W'
lcall  dat
   mov   a,#'E'
lcall  dat
mov   a,#'R'
lcall  dat

     RET

SWING1: mov   a,#01h
   lcall  com
   mov   a,#80h
   lcall  com
   mov   a,#'S'
   lcall  dat
```

```
      mov   a,#'w'
      lcall dat
      mov   a,#'i'
      lcall dat
      mov   a,#'n'
      lcall dat
      mov   a,#'g'
      lcall dat


      RET



FILTER1: mov   a,#01h
      lcall com
      mov   a,#80h
      lcall com
      mov   a,#'F'
      lcall dat
       mov   a,#'i'
      lcall dat
      mov   a,#'l'
      lcall dat
      mov   a,#'t'
      lcall dat
      mov   a,#'e'
      lcall dat
      mov   a,#'r'
      lcall dat

      RET



MODE1 : mov   a,#01h
      lcall com
      mov   a,#80h
      lcall com
      mov   a,#'M'
      lcall dat
       mov   a,#'O'
      lcall dat
      mov   a,#'D'
      lcall dat
      mov   a,#'E'
      lcall dat
```

```
        RET


FAN1: mov   a,#01h
      lcall  com
      mov   a,#80h
      lcall  com
      mov   a,#'F'
      lcall  dat
       mov   a,#'A'
      lcall  dat
      mov   a,#'N'
      lcall  dat


        RET

tI1:    mov 20h,#8
        mov tmod,#01
her:    mov tl0,#00
        mov th0,#00
        setb tr0
        jnb  tf0,$
        clr  tr0
        clr  tf0
        djnz 20h,her
        ret



long: mov   a,#01h
      lcall  com
      mov   a,#80h
      lcall  com
       mov   a,#'w'
      lcall  dat
      mov   a,#'o'
      lcall  dat
       mov   a,#'r'
      lcall  dat
       mov   a,#'d'
      lcall  dat
      mov   a,#' '
      lcall  dat
```

```
      mov   a,#'t'
      lcall  dat
       mov   a,#'o'
      lcall  dat
      mov   a,#'o'
      lcall  dat
        mov   a,#'l'
      lcall  dat
      mov   a,#'o'
      lcall  dat
      mov   a,#'n'
      lcall  dat
       mov   a,#'g'
      lcall  dat

      RET

short: mov   a,#01h
      lcall  com
      mov   a,#80h
      lcall  com
       mov   a,#'w'
      lcall  dat
      mov   a,#'o'
      lcall  dat
       mov   a,#'r'
      lcall  dat
       mov   a,#'d'
      lcall  dat
      mov   a,#' '
      lcall  dat
      mov   a,#'t'
      lcall  dat
       mov   a,#'o'
      lcall  dat
      mov   a,#'o'
      lcall  dat
       mov   a,#' '
      lcall  dat
        mov   a,#'s'
      lcall  dat
      mov   a,#'h'
      lcall  dat
      mov   a,#'o'
      lcall  dat
       mov   a,#'r'
```

```
        lcall  dat
         mov    a,#'t'
        lcall  dat

        RET

nomatch: mov    a,#01h
        lcall  com
        mov    a,#80h
        lcall  com

        mov    a,#'n'
        lcall  dat
         mov    a,#'o'
        lcall  dat
        mov    a,#' '
        lcall  dat
         mov    a,#'m'
        lcall  dat
          mov    a,#'a'
        lcall  dat
        mov    a,#'t'
        lcall  dat
        mov    a,#'c'
        lcall  dat
         mov    a,#'h'
        lcall  dat
         RET


        end
```