Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Second Engineering Scientific Conference
College of Engineering –University of Diyala
16-17 December. 2015, pp. 441-452

DESIGN AND IMPLEMENTATION OF A REMOTE SENSOR-BASED ACCESS CONTROL SYSTEM USING PIC-MICRO CONTROLLER

Mohammad S. Saleh*, Zeyad Assi Obaid*and Zuhair S. Al-Sagar**
*****College of Engineering-Diyala University-Iraq.
**Baqubah Technical Institute, Middle Technical University, Baghdad, Iraq

ABSTRACT: - This project presents the Design and Implementation of Access control System using PIC Microcontroller. The design is coded and implemented using MikroC language for the purpose of implementation inside the PIC Microcontroller. This design consists of a remote sensor which is used to detect the feedback signal. Automatic door system is used as an industrial application for the access control system where presented by this paper. The automatic door system model is designed and implemented with PIC-16F877A micro controller, laser sensor and DC motor and custom designed structure for its automatic door system. MikroC programmer is used to test the design codes, and Protus Simulation program is used for the purpose of simulation for the schematic of the design. The design needs maximum clock frequency of 4 MHz. Therefore, the proposed design will be able to cover a wide range of applications with a high sampling rate. Enhancements are made for the design to decrees the memory size in order to get fast execution time. The used ROM is 600 Byte (7.3%) from 8191 Byte and the used RAM is 93 Byte (26%) from 368 Byte of the memory size of PIC Microcontroller. Experimental results show a fast execution time for detecting the interrupts of the remote sensor. Therefore, the proposed Access Control System can be used with different industrial applications. It is very convenient system for consumers and has extensible and flexible characteristics. It can also be used for home doors with additional sensor devices.
Keywords: PIC Microcontroller, Access control system, Remote Sensing.

1. INTRODUCTION

Automatic door system has been widely used as one of the most popular digital consumer devices that replacing the conventional doors because of the user's convenience and at an affordable price. It is a kind of control access system that operates by a laser sensor, the automatic door system is digital device appropriate for checking the access information and controlling the door on or off because the sensor Affected by everyone go to inside or out.

PIC Microcontrollers are small computer on a chip with some special properties [1-4]:

1. CPU, code memory, data memory and IO ports all included on a single chip.
2. Dedicated to one task.
3. Small and low cost.
4. Embedded in many consumer devices.

PICs are popular with developers due to:-

1. Low cost.
2. Wide availability.
3. Large user base.
4. Extensive collection of application notes.
5. Availability of low cost or free development tools.
6. Serial programming capability.

The most typical LCD screen is 2*16 LCD screens, 2*16 indicate that it has 2 rows and 16 columns. The 2*16 LCD was used in the proposed design because of an embedded controller (the black blob on the back of the board) and is easy to interface with the PIC-microcontroller.

There is a wide range of applications for different types of microcontroller in the industry, researchers, etc., As follows:

1. Lights on-Off.
2. Digital Input-Pushbuttons.
3. Controlling Motion.
4. Digital Display.
5. Measuring Rotation.
6. Measuring Light.
7. Frequency and Sound.
8. Electronic Building Blocks.
9. Robotics.

The aim of this paper is to design and implement an automatic door system, which is a simple implementation of control access concept using PIC-Microcontroller.

To achieve this aim, the following points are addressed:

1. To design a PIC Microcontroller-based digital electronic control circuit that provides high flexibility.
2. To design the proposed algorithm using MikroC

2. SOFTWARE PROGRAM

The software for this project was built with simplicity, flexibility and robustness in mind. The most important aspects of the software are the access control system by the external effect which is a remote sensor. The software would control the state of the door. At the first operation, if the door was opened, then the software would check the sensor was interrupted, then keep hold, otherwise it would close the door and begin another normal operation which is opening the door if the sensor was interrupted. PIC of the type (PIC16F877A) was used because it has better properties than the other types where PICs are popular with developers due to low cost, wide availability, large user based, and extensive collection of application notes, availability of low cost or free development tools and serial programming capability and MikroC programming language to program the PIC. All this mount to area feasible solution: if there is more than one person, then the software should remain the door open until all persons passing and then close it, but if the person was still in front of the door more than the normal time, the software gives some time for waiting before close the door.

A. Mikro C Programming language

Mikro C was allowed to develop and deploy complex application, MikroC offers unmatched power and flexibility in programming microcontrollers. Mikro C adds even more power with an array of libraries, specialized for PIC HW model and communication.

1- Write the source code using the highly advanced code editor.
2- Use the MikroC libraries to dramatically speed up the development data acquisition, memory, display, conversions, and communication.
3- Monitor the program structure, variables, and function in the code explorer. Generated commented, human readable assembly, and standard HEX compatible with all programs.
4- Inspect program flow and debug executable logic with the integrated debugger. Get detailed reports and graphs on code statistics, assembly listing, and calling tree.

It provided plenty to expand, develop, and use as building bricks Figure axis labels are often a source of confusion.

B. Software Algorithms and Feature References

The software offers a high degree of flexibility with many integrated features when the program is started; it checks the state of the door if it was:

1. Open.
2. Close.

If the door was opened and there is some person in front of the door, then keep hold until the person was passed, then close the door and check if there was a person in front of the door, then open it, if there are some person still stand in front of the door for a long time the software close it and wait five seconds and open it again and continue the normal sequence of software.

C. Programming the PIC-microcontroller

The PIC16F877A it has 40 pins and there is a number of commands such as TRISA and TRISB (TRIS: the command; A, B: the port), these command must be written in capital letter, further more in micro c programming language, it must be observable of capital and small letters, TRISEA: mean that each of the pins had become the input and each one had become the output.

1 means the input

```
Movlw 0B00000000
TRIS portB
Movlw 0B00000001
Movwf portB
Fin:goto fin
```

Now look at the actual CPU instruction in the program, namely
What the program needs to do is set up port B for output, place a 1 into the lowest bit of port B (causing pin B0 to go higher), and stop. Consider the last of these first. How do you stop a program? Note by making the LED would turn off, nor by exiting to the operating system, because there isn't an operating system. The program has the PIC all to itself; the way to stop this program is by putting it in an endless loop.
That's accomplished by the instruction

Fin: GOTO fin

Which simply jumps back to itself over and over? Now look at the previous step. How do 1 been placed in the lowest bit of the port B? From the CPU's viewpoint, port B is an 8 bit register and it had wanted to place binary 00000001 in it. But there is no CPU instruction to place to specified value (a" literal") directly into a port. Instead, the program placed 00000001 into the W register using movlw instruction ("move to file register").

Note that assembly language, "move" always means "copy".That is, every move instruction actually copies data from one place to another, leaving the original unchanged. This is true of all the assembly language. I've seen regardless of the kind if CPU.

Note also that in PIC assembly language, the name of the port B is PORTB (all capitals), not portable (lower case).

In order to work port B as intended, it has to be set up as an output port. Actually, each of its eight bits can be set as input or output, independently of the others, but in this program, all eight bits of output. This is done by zeroing the corresponding bit in TRISB special function register. Deprecated instruction-Error message to ignore Deprecated instruction: an instruction that works perfectly well, but which the assembler tells the user not to use that TRIS, the instruction that copies W into that special function register. To set up port B for output, it must be use the instruction

```
Movlw 0B00000000
TRIS PORTB
```

And the second of these always generates warning message. The reason for warning message is that some other PICs lack the TRIS instruction, and in the interest of the program portability, Microchip instruction, would like us not to use it. Instead, they would to want to do something a good bit more complicated, involving switching over to different bank of register, and then addressing the TRISB register by its address. The TRIS instruction is fully supported

on f877L; there is nothing wrong with using it, it is not unreliable or risky in any way. It just generated an error message you have ignored. The same is true of the option instruction, which lets you set some CPU configuration options without switching register bank. Example of MicroC programming language:

```
Void main()
{
TRISB=0;
PORTB=0B00111000;
}
```

Example 1:

Here port b is an output;

Example 2:

```
Void main ()
{
TRISB=0;
PORTB=0XFF;
delay_ms(1000);
PORTB=0;
delay_ms(1000);
}
```

TRISB=0: The port b is an output.
PORTB=0XFF: all the pins of the port b is an input, (0X: means the code has been written in the hexadecimal; FF: means all the pins of the port b have been assigned to ones).
Delay_ms (1000): means the wait 1000 milliseconds, then assigned the port b to another state.
There are a number of command that had been used them in the programming operation such as:

```
While(1)
{
The instruction that would be repeated continuously.
}
For (x=0;x<30;x++)
{
The instruction that would be repeated 30 times.
}
If(condition)
{
Execute the instruction while the previous condition is true.
}
Else
{
Execute the other instruction while the previous condition is false.
}
```

The PIC-chip was programmed using MikroC programming language which shown in Fig.1.

The automatic door system model requires a DC battery 12 volt source, bridge for input signal,5 volt regulator, Quartz 4M Hz crystal resonator, push buttons Microprocessor PIC (16f877a), resistors and capacitors. LEDs, liquid crystal display (LCD) "lm016l", Transistors and relays, DC 12 volt motor And IR.

A. Remote Sensing Circuit

The remote sensing circuit was designed using Infrared IR LED and it demodulator, this IR simple system is manufactured for remote control devices which represents the input

signal to the microcontroller, it consists of IR LED which is the transmitter and a Photo diode at the receiver see Fig.2. This circuit can be replaced any other remote sensor like laser sensor without any changes inside the PIC chip, to provide high flexibility in the remote sensing circuits available to the designer.

As seen in Fig.2 the demodulator is connected in parallel with the Photo diode so if: there is cutting to the IR light the photo diode works as short circuit and the demodulator has (0) volts output, but if there is a cut IR line the photo diode will be open circuit and the demodulator gives (5) volts in the simulation normal switch instead of IR was used for the purpose of simulation only.

B. Liquid Crystal Displays (LCD)

There are many types of LCD screen available some are big, some are small, some are monochrome and some are rich with some colors. The most typical LCD screen is the 2*16 LCD screen. 2*16 indicates that it has 2 rows and 16 columns. A LCD is a small low cost display. It is easy to interface with a microcontroller because of an embedded controller (the black blob) on the back of the board). This controller is standard across many displays (HD44780) which mean many microcontrollers (including the Adriano) have libraries that make displaying massage as easy as a single line of code.

C. Programming of PIC-chip

A microcontroller is a kind of miniature computer that you can find in all kinds of gizmos, some examples of common, and every day products that have microcontrollers. If it has buttons and a digital display, chances are it also has programmable microcontroller brains. Here are some examples: if your clock radio goes off, and it had been hit the snooze button a few times in the morning, the first thing must be done in now a day is interacting with a microcontroller.

Heating up some food in the microwave oven and making a call on a cell phone also involve operating microcontroller. That's just the beginning. Here are a few more examples: turning on the television with a handle remote, playing a handheld game, using a calculator, and checking the digital wristwatch. All those devices have a microcontroller inside them that interact with the user [4].

Programming of PIC chip has typical steps by using a PIC programmer in order to download the MikroC code inside the chip. Figure (4) Showing that .

D. The Regulator

Every PIC microcontroller needs 5 volts DC as input signal and it's the same voltage for output signal so a 7805 regulator was needed, which takes 12 volts DC to provide the 5 volts required by the PIC chip. Figure (5) Showing that.

Standard double capacitors (0.1uf) were needed in parallel with the regulator and third capacitor of 470uf was used to smoothing the input DC from the bridge as in the figure (6).

E. Crystal Resonator

Every microcontroller needs a clock frequency to operate and process the input data, 4M Hz quartz resonator which means 4 million in the figure (7) operations in one second was used in this design.

E. DC Motor Drive

The motor is needed to support the moving mechanism associated with four transistors as switches. The figure below shows the full schematic of this part. At the beginning the Q1 and Q4 work together to supply 5 volts to the DC motor to work in a direction, the Q2 and Q3 are open, therefore the Q2 and Q3 in the figure (8) works together to supply 5 volts the DC motor acts reverse polarity and the motor goes in the opposite direction, the Q1 and Q4 open.

IV. PROGRAMMING AND SIMULATION RESULTS

MikroC language was used as a programming language in this paper; this language is easy to use and is applicable for the purpose of implementation on the PIC microcontroller. Fig.9 shows the first result that generated using MicroC compiler, the used ROM is 600 Byte

(7.3%) from 8191 and the used RAM is 93 Byte (26.4%) from 368 Byte size of the memory of the PIC Microcontroller as shown in Fig.9.

Fig.10 shows each instruction and its memory location, this figure showing that how many memory locations required for every instruction.

The simulation results were generated using a proteus program for the purpose of simulation of the proposed design. This step is referring to the simulation of the hardware implementation after getting the programming results and successfully compiling the proposed algorithm as shown in Fig.11.

Fig.11 shows the whole design circuit of the proposed circuit in proteus program. Initially, the person will pass through the door, making interrupt in the switch button shown in the previous figure with **number 3** and the LCD that have shown with the **number 2** will display ***open***, and the DC motor with **number 4** will be turned around. If restarting is needed, is can done by pressing on the switch button shown with the **number 7**. If there is someone standing in the middle of the door, then the micro switch showed with **number 8** will sense this interrupt and the door will be opened. **Number 1** shows the PIC 16F877A chip, and **number 5** shows the 4MHZ oscillator, and **number 6** shows the capacitor of 22pf, and **number 9** shows the 470 ohm resistor, and **number** the **10** refers to the 5V power supply that used in this paper.

V. IMPLEMENTATION RESULTS

After successfully compiling the design and getting the proper simulation results, the third step is to implement the whole design circuit based on PIC microchip. The main components are PIC microcontroller, DC motor, LCD and the DC power supply which represented by 12V DC battery. Fig.12 shows the internal organization of the (8-bit) 2 x 16, and **number 2** shows the PIC-chip; **number 3** shows the 7805 regulators where used to get 5V VCC. **Number 4** shows the input power and **number 5** shows the 5MHZ oscillator circuit, **number 6** shows the relay circuit, and **number 7** shows the LEDs, and **number 8** shows the resistors. Figurer (12) showing that. Operation of an automatic door system is divided into four modes, Closed, Door opening, Door Opener, Door will close:

A. Closed Mode

When there is no event at the remote sensor the door is already closed and if the door was opened and no new interrupt available the door is closed as shown in Fig.13.

B. Opened Mode

When someone cuts the IR line, the door will be in open mode for 5 seconds and gives and identification on the LCD as “Opened Mode” as shown in Fig.14 a and b.

C. Door Will Be Closed Mode

If there are no interrupts in the remote sensor after 5 seconds from the open mode, the LCD gives attention that the door will be in “closed mode” can see it in fuger.15 where is initiated by the PIC chip to start the closed mode.

VI. CONCLUSION

From the design and simulation results, it can be concluded that: Higher execution speed versus small chip size is achieved by designing the proposed circuit with PIC-microcontroller of the family PIC16F877A. The design needs maximum clock frequency of 4MHz. Therefore, the proposed design will be able to cover a wide range of applications with a high sampling rate. Higher flexibility versus acceptable accuracy is achieved by designing the proposed system using mikroC language. Sufficient design accuracy can be achieved with microC in particular. MicroC is superior to another in the purpose of implementation inside the PIC-chip since it presents higher accuracy versus moderately low target device utilizations. The used ROM is 600 Byte (7.3%) from 8191 Byte and the used RAM is 93 Byte (26%) from 368 Byte memory size the PIC Microcontroller. Therefore, the proposed Access Control System can be used by different applications. It is a very convenient system for consumers and has extensible and flexible characteristics. It can also be used for home doors with additional sensor devices. Therefore, it can be a good practical product for realization of access monitoring and control

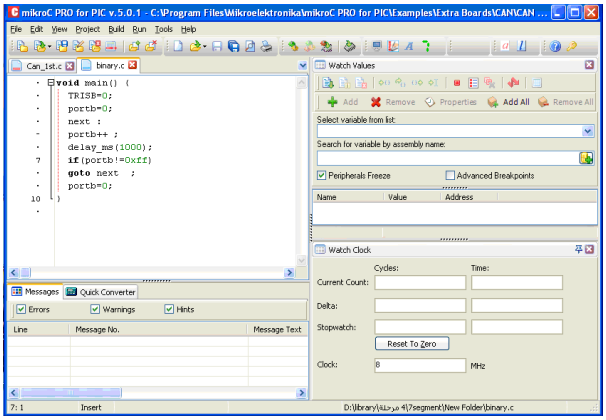
system. It can be also applied to the real market for home networking system.

ACKNOWLEDGMENT

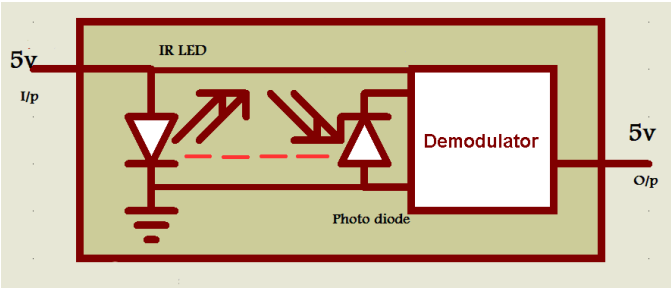
The authors would like to thank firstly, our god, and all friends who gave us any help related to this work. Finally, the most thank is to our families and to our countries which born us.

REFERENCES

1) D. Ibrahim, "PIC Basic Projects: 30 projects using PIC Basic and PIC Basic PRO" Elsevier, 2006.
2) Mikroelektronika user manual sheet, "Mikro, making it simple, C COMPILER FOR MICROCHIP PIC MICROCONTROLLER, 2006. www.mikroe.com
3) Student Guide, "What's microcontroller", version 2, www.parallelax.com
4) N. Matic, "PIC Microcontroller for beginners", PIC Book, 2000.
5) Peter Van Der Linden, "Expert C PROGRAMMING, DEEP C SECRETS".
6) I-K Hwang and J-W Baek "Wireless Access Monitoring and Control System based on Digital Door Lock" IEEE Transactions on Consumer Electronics, Vol. 53, No. 4, November 2007.
7) H-G Yeh and T. M. Nguyen "Design and Implementation of A Tms320c25-Based Hybrid Digital Phase-Locked Loop-An Application to Tiwwsponder Receiver Breadboard" Jet Propulsion Laboratory California Institute Technology.
8) F. Cheng and Ch. Meinel "Design of Lock-Keeper Federated Authentication Gateway" 2009 ICACT 2009.

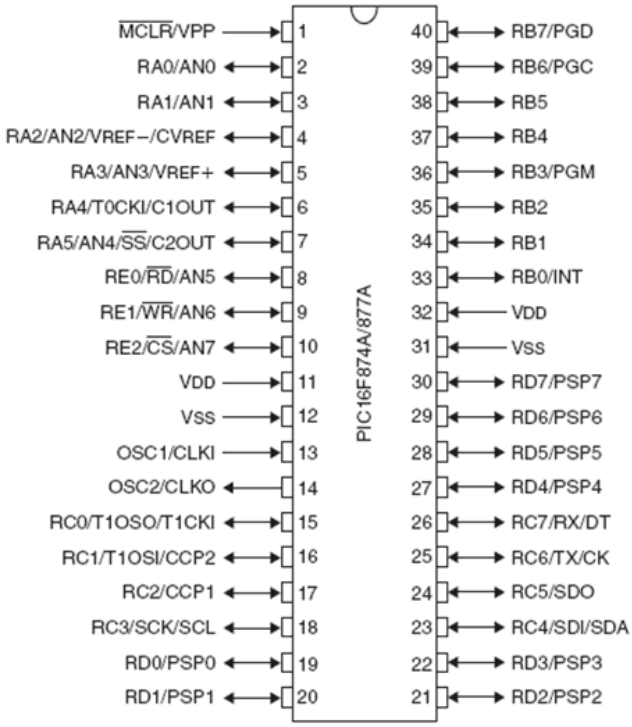


Figuer.1: Mikro C program window.

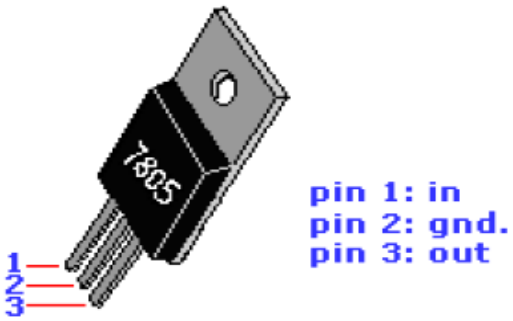


Figuer.2: Remote Sensing Circuit

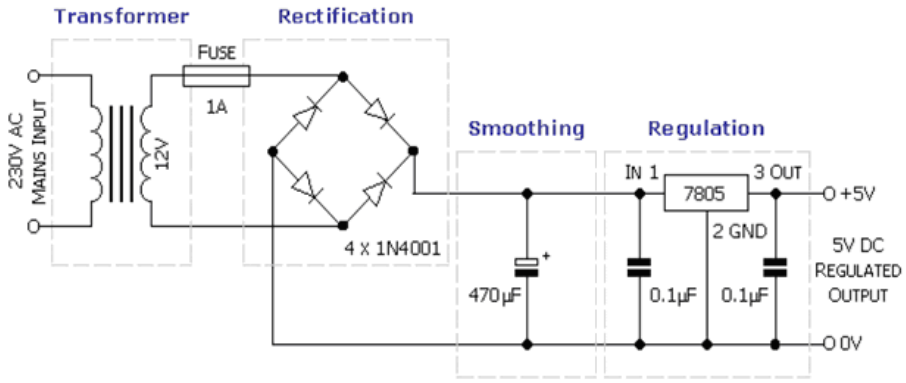
Figuer.3: (2*16 LCD)



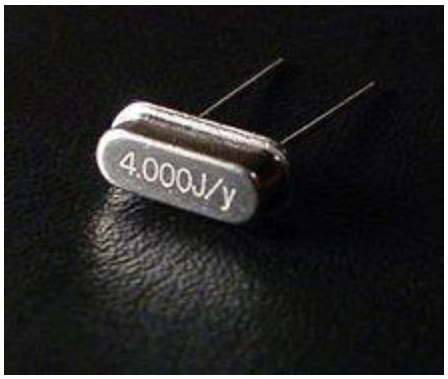
Figuer.4: PIC16F877A Microcontroller



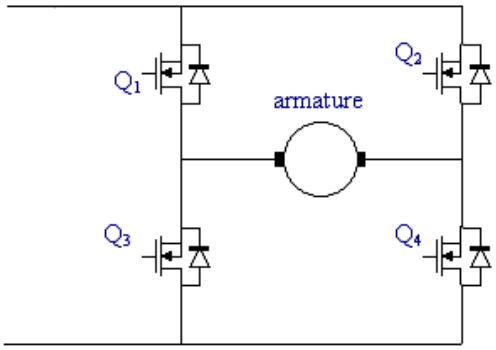
Figuer.5: Regulator diagram



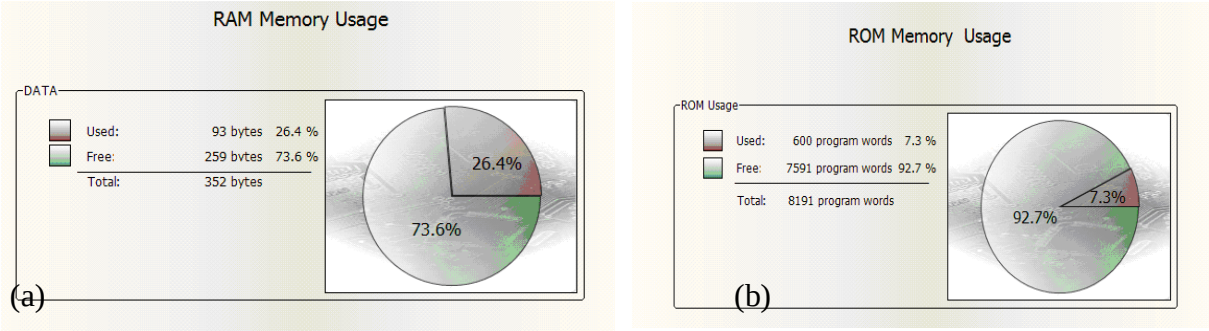
Figuer.6: Input Signal Implementation



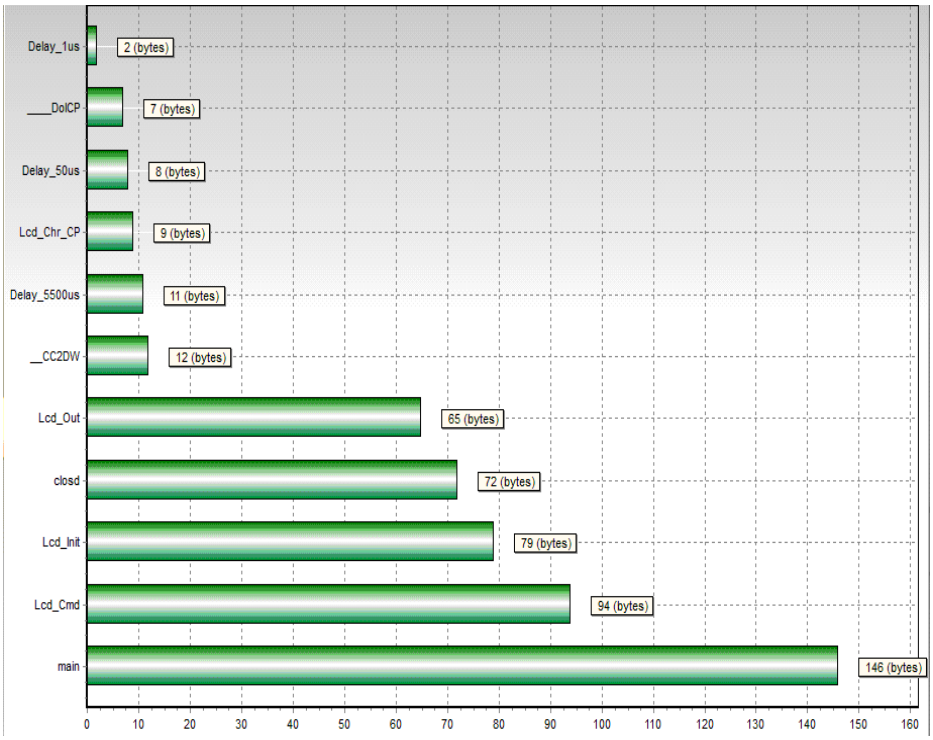
Figuer.7: Crystal Resonator



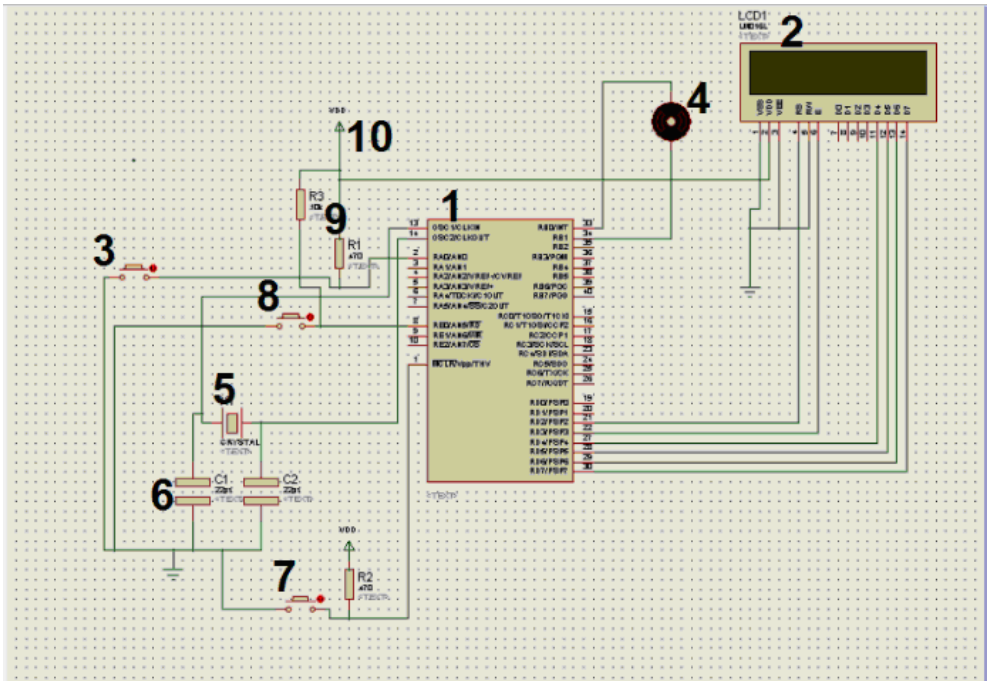
Figuer.8: DC Motor Drive



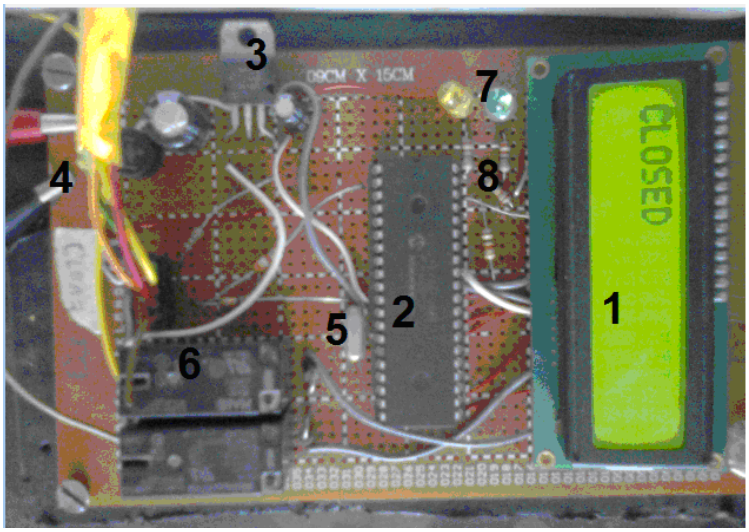
Figuer.9: Memory Graph used in PIC, (a) RAM, (b) ROM



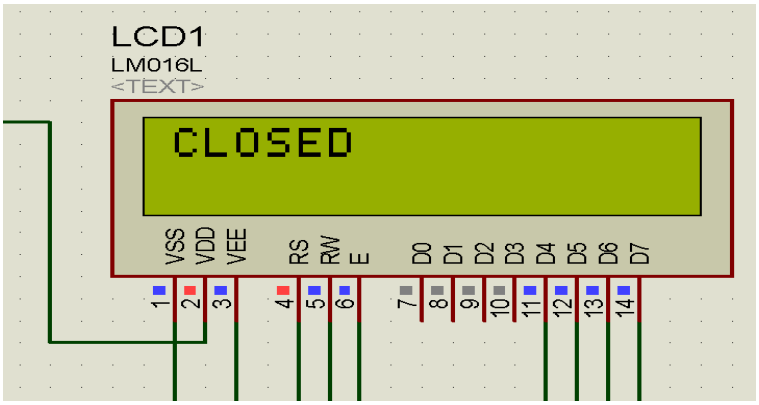
Figuer.10: Procedure Size in the Proposed Algorithm



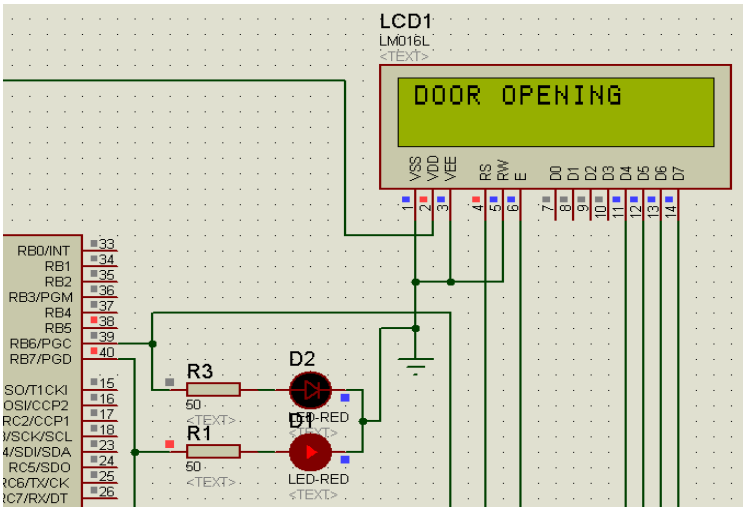
Figuer.11: Full Custom Design in Proteus Program for the Purpose of Simulation



Figuer.12: Internal Hardware Implementation



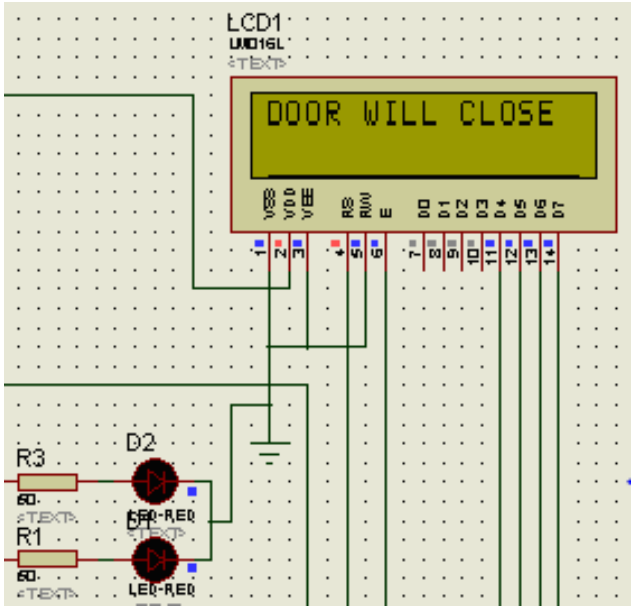
Figuer.13: Closed Mode



(a)

(b)

Figuer.14: Open Mode (a) Simulation Result (b) Implementation Result



Figuer.15: Door Will Be Closed Mode