DESIGN AND IMPLEMENTATION OF FPGA BASED RESCUE BOT

A PROJECT REPORT

Submitted by

SHANKAR PIRAJIN S (19BEC4191)
SHANMUGAPRIYAN J (19BEC4192)
SUJEETH S (19BEC4211)

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

in

ELECTRONICS AND COMMUNICATION ENGINEERING

M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

ANNA UNIVERSITY: CHENNAI 600 025

APRIL 2023

M.KUMARASAMY COLLEGE OF ENGINEERING, KARUR

BONAFIDE CERTIFICATE

Certified that this project report **"DESIGN AND IMPLEMENTATION OF FPGA BASED RESCUE BOT"** is the bonafide work of **"SHANKAR PIRAJIN S (19BEC4191), SHANMUGAPRIYAN J (19BEC4192), SUJEETH S (19BEC4211)"** who carried out the project work under my supervision in the academic year 2022-2023**.**

SIGNATURE
HEAD OF THE DEPARTMENT
Dr.S.Palanivel Rajan, M.E., M.B.A., Ph.D., D.Litt (USA).,
Professor,
Department of Electronics and Communication Engineering,
M.Kumarasamy College of Engineering,
Thalavapalayam, Karur-639113

SIGNATURE
SUPERVISOR
Mr.K.Sudhakar, M.E.,
Assistant Professor,
Department of Electronics and Communication Engineering,
M.Kumarasamy College of Engineering,
Thalavapalayam, Karur-639113

This project report has been submitted for the **18ECP107L - Project Work** Viva Voce Examination held at M.Kumarasamy College of Engineering, Karur on __________________.

INTERNAL EXAMINER **EXTERNAL EXAMINER**

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully engaged, learner - centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: **Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation andability to engage in independent and life-long learning in the broadest context oftechnological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrialexpectations.

Abstract	Matching with POs, PSOs
Obstacle blocks, Passive infrared sensor, Radio frequency, Direct current	PO1, PO2, PO3, PO5, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2

ACKNOWLEDGEMENT

Our sincere thanks to **Thiru.M.Kumarasamy, Chairman** and **Dr.K.Ramakrishnan, Secretary** of **M.Kumarasamy College of Engineering** for providing extraordinary infrastructure, which helped us to complete this project in time.

It is a great privilege for us to express our gratitude to **Dr.B.S.Murugan., B.Tech., M.Tech., Ph.D., Principal** for providing us right ambiance to carry outthis project work.

We would like to thank **Dr.S.Palanivel Rajan, M.E., M.B.A., Ph.D., D.Litt (USA)., Professor and Head**, **Department of Electronics and Communication Engineering** for his unwavering moral support and constant encouragement towards the completion of this project work.

We offer our wholehearted thanks to our **Project Supervisor, Mr.K.Sudhakar,M.E.,** Assistant Professor, Department of Electronics and Communication Engineering for his precious guidance, tremendous supervision, kind cooperation, valuable suggestions and support rendered in making our project tobe successful.

We would like to thank our **Project Co-Ordinator, Mr.K.Sheikdavood, M.E., [Ph.D]., Assistant Professor,** Department of Electronics and Communication Engineering for his kind cooperation and culminating in the successful completion of this project work. We are glad to thank all the **Faculty Members** of the **Department of Electronics and Communication Engineering** for extending a warm helping hand and valuable suggestions throughout the project. Words are boundless to thank our **Parents** and **Friends** for their motivation to complete this project successfully.

ABSTRACT

Presently the surveillance of international border areas is Very daunting task. The security forces are patrolling the border in hostile conditions. They are getting help from surveillance cameras already mounted but they cover very limited areas. The cameras already mounted at a fixed position, is not of much use as we cannot change the camera view in real time. Also, it is not possible to mount the cameras in the forest areas as the trees obstruct the view of the camera. This paper explains how to design and implement wireless robot which will enable us to control the robot with the help of internet and it will be able to detect the living bodies with the help of PIR sensor. It will help in rescue operation and user can access the video transmitted from the remote area such as the sensitive areas or areas which are beyond our reach. The total system contains mobile robot, controlled with the Internet, which has camera mounted on it and also it has a PIR sensor for detection of living bodies. User will be able to control the robot through internet, thus, providing user with wireless control of robot. Also, information regarding the detection of living bodies will also be given to user on the computer from the PIR sensor and simultaneously user is able access the video transmission from the robot. The camera mounted on the robot is able to move horizontally around its vertical axis and vertically along its vertical axis. Camera movement is controlled through webpage at the user interface, thus, providing user with enhanced view of the surroundings.

TABLE OF CONTENTS

CHAPTER No.	CONTENTS	PAGE No.
	Institution Vision and Mission	iii
	Department Vision and Mission	iii
	Department PEOs, POs and PSOs	iv
	Abstract	viii
	List of Tables	xi
	List of Figures	xii
	List of Abbreviations	xiii
1	**INTRODUCTION**	**1**
2	**LITERATURE SURVEY**	**4**
3	**EXISTING SYSTEM`**	**7**
4	**PROPOSED SYSTEM**	**9**
	4.1 Passive Infrared Sensor	12
	4.2 ZigBee Tx Rx	15
	4.3 Motor Driver	18
	4.4 Metal Detector	21
	4.5 DC Motor	23
	4.6 Camera	24
	4.7 PIC16F877A	25
	4.8 LCD	41
5	**CIRCUIT DIAGRAM DESCRIPTION**	**49**
6	**SOFTWARE DESCRIPTION**	**53**
	6.1 MPLAB IDE	53

	6.2 CCS Compiler	56
	6.3 PIC KIT 2	58
7	**RESULT AND DISCUSSION**	**61**
8	**CONCLUSION AND FUTURE WORK**	**65**
	REFERENCES	**66**

LIST OF TABLES

TABLE No.	TITLE	PAGE No.
4.1	USART Configuration	33
4.2	Pin Configuration	44
6.1	File Formats	57

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
4.1	Block Diagram	11
4.2	Proximity Sensor	14
4.3	Circuit Diagram Proximity Sensor	14
4.4	ZigBee Protocol layer	16
4.5	Two X Bee Networking	18
4.6	L293D IC	19
4.7	L293D Motor Driver Circuit	21
4.8	DC Motor	23
4.9	PIC16F877A Pin Diagram	26
4.10	PIC16F877A Block Diagram	27
4.11	LCD	42
4.12	Mechanical Specifications	44
4.13	Circuit Connections	45
4.14	LCD Commands	46
4.15	Interfacing LCD with the Microcontroller	48
5.1	Circuit Diagram	52
6.1	MPLAB IDE	53

LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
CPU	-	Central Processing Unit
GPR	-	General Purpose Registers
GUI	-	Graphical User Interface
LCD	-	Liquid Crystal Display
PIR	-	Passive Infrared
PWM	-	Pulse Width Modulated
RF	-	Radio Frequency
SFR	-	Special Function Registers
SPI	-	Serial Peripheral Interface
USART	-	Universal Synchronous and Asynchronous Receiver - Transmitter

CHAPTER 1

INTRODUCTION

The advent of new high-speed technology and the growing computer Capacity provided realistic opportunities for new robot controls and realization of new methods of control theory. This technical improvement together with the need for high performance robots created faster, more accurate and more intelligent robots using new robots control devices, new drivers and advanced control algorithms. A mobile robot is a machine that is basically place or mounted on a movable platform and can be with the help of certain instructions. In today TMs world a lot of fields use mobile robots. Many of the complex robots that we now see have originated from the simpler mobile robots. his technology has increased many new applications in the industry. The combination of mobile devices and robots are leading to new ideas in lots of fields. The mobile devices are now being used in many of the industrial applications this is mainly because of the reason that they are portable and have a longer battery life as compared to a laptop. Also, they have a data plan through a cell phone carrier which is convenient as we can interact with the mobile robot once the connection is established. Mobile Robots: The mobile robots can be classified into different types. The track robot is the robot that uses tracks to move around. However, such robots are costly to build. Also, they are not as flexible as the wheeled robots.

The wheeled robots are the robots which use wheels for moving. Such robots can move only on smooth flat surfaces. The third type is the legged robots which are based on human form. They have legs which helps them to move around. These robots are very difficult to design Robots are being used in variety of industrial applications for various activities like pick and place, painting, assembling of subsystems and in hazardous places for material handling etc. Robots are becoming more and more intelligent as technology advances in the areas of CPU speed, sensors, memories etc. And there is ever demanding applications even in defense. With the rapid growth of the Internet, more and more intelligent devices or systems have been embedded into it for service, security, and entertainment, including distributed computer systems, surveillance cameras, telescopes, manipulators and mobile robots. Although the notion of Internet robotics or web-based robotics is relatively new and still in its infancy, it has captured the huge interest of many researchers worldwide. Except for operating in hazardous environments that are traditional telerobotic areas, Internet robotics has opened a completely new range of real- world applications, namely tele-manufacturing, tele-training, tele-surgery, museum guide, traffic control, space exploration, disaster rescue, house cleaning, and health care. Automated video surveillance is an important research area in the commercial sector as well. Surveillance cameras are already prevalent in commercial establishments, with camera output being recorded to tapes that are either rewritten periodically or stored in video archives. In this implementation of robotic system, when a person enters a monitored area, PIR motion detectors are commonly used in conjunction with different parts of the war field. When someone enters secured places, immediately it will send an indication to the control room section through wireless communication and is indicated to the control room through alarm. The concerned people can understand that an eventuality has happened in the host section. At the same time web camera connected to the microcontroller keeps on capturing what is going on there at the host place and saves it into the computer. When the security people in supervisory room, get an indication to the host section by alarm, they log into the host section computer through internet, and view all information of the war field section videos by PC.

CHAPTER 2

LITERATURE SURVEY

Complete autonomous robot which can perform varieties of tasks is still under development. Therefore, research all over the world work towards the design and development of such robot, so as to simplify our works in various fields. Dr. M. Meenakshi presents a paper which include validation of vision based autonomous robotic system for military application. Sum of Absolute Difference (SAD) algorithm is used. This paper verifies the implementation of proposed image processing algorithm on the basis of image subtraction. The developed algorithm is validated in real time by change based moving object detection method. So, this type of work is effectively taking main role in the application of detection of mines in the war field. This autonomous robot presentsa novel vision-based technique for obstacle identification and path planning on the principle of image processing algorithm. Whatever images are clicked by wireless camera are undergoing the process using Sum of Absolute Difference (SAD) algorithm and then obstacle are identified. Author Swetha N. It presents a paper that proposes a model of a robot based on "Human Interface Device" utilizing hand gesture. This hand gesture used to communicate along with embedded system for tracking of enemies at war ground. The input of embedded system is 3-axis accelerometer is selected for the sack of capturing the human arm behaviors.

The 3- axis accelerometers offer the possibility to control a robot via wireless camera. The 3-axis accelerometer offer to control system with the help of ZigBee communication. This work system so much easy that a non- perfect robot programmer can also control robot fluently in easier way. This paper include ZigBee network technology is preferable for long distance communication.

This paper consists of LCD display which displays the voltage value at y- axis and x-axis. If the 3- axis accelerometer move to any one of the directions and if obstacle are near about it then the LCD Displays the distance measuring from the obstacle and direction of the robot. The speed of robot also controls by 3-axis accelerometer. In this work system two microcontroller are used .one is act as an master at transmitter end and another can act as an slave at receiving end. The master microcontroller is sending the signal to the slave microcontroller from one point to another. Whatever signal are transmitted from one end to another this are execute by using slave microcontroller and according that action or movement are carry out by robot. Ankita Patel invents a paper on the basis of touch screen which control multifunctional spy robot. For the sack of long-distance communication ZigBee network is used. This work system include microcontroller for collecting data from various places and accordingly movement of robot it can control the direction of robot. This paper consists of geared motors which include two wheels attached to it.

The motor is started with the help of relay and going to control touch screen. The signal is send from touch screen to be executed by microcontroller at receiver section. It includes component like gripper, camera, video screen and sensors. The methodology of this paper is divided into two sections. Hardware and software implementation. At hardware development various component are uses such as touch screen sensor, ZigBee, LCD, intelligent robot. In software implementation microcontroller is prefer. A microcontroller having ability to use large amount of memories such as RAM, ROM. also it having own ports i.e., I/O port, timer. All this embedded on a single chip. At hardware section touch screen, tuner card, antenna, ZigBee technology are used. At programming section USART communication, analog to digital convert programming and LCD character module programming are prefer.

All of this programming is done in C language Programming are preferred. Prerna Jain hasdesigned a paper on the base of RF technology used for spying in war field. The innovation added here that is color sensor. The color sensor senses the color according to surrounding environment and changes its color. So, the robot easily changes its color and because of this feature the enemy can’t easily predicted.

CHAPTER 3

EXISTING SYSTEM

The existing system suffered many problems like high cost to set up communication between robot and rescue control unit, noisy wireless communication link between robot and control unit which ultimately stopped robot to function etc. The proposed system is able to solve all these problems. Thefield of surveillance robots is very popular. A lot of work was done in the algorithms and the navigation control System wireless surveillance robots. A common subject is also the use of a camera on the robot to receive live feedback of the video. As seen in all documents and previous research they use webcams. Web cams requires Internet, one of our applications is under the supervision of the tragedies and terrorist attacks. Internet system or communication fails these situations because of traffic so there is no use of webcam so here we use AV camera that does not depend on third party network but depends on its own network. For a long-distance communication according to previous documents, they used the Internet or Bluetooth control, but Bluetooth has only 10 meters range. So instead of Bluetooth, ZigBee is the best solution. The first surveillance robot which is to be used for security purpose was “Mobile Detection Assessmentand Response System (MDARS)” From then there has been tremendous improvement in the research and development in surveillance robots. Now surveillance robots are used in all military and security applications. Basically, surveillance robot is nothing but the ordinary robot with the navigation mechanism along with some cameras, thermal sensors, and the communication devices like GSM, GPS modules. These robots can be navigated using servo motors to get theaccurate navigation.

CHAPTER 4

PROPOSED SYSTEM

The modern era of technology has changed communication with innovations like Android and GSM. Nowadays, the majority of people have access to mobile, making the world truly a global village. Any particular person can be reached at any time using a mobile phone. It can encourage new inventions and ideas that will improve its capabilities. A topic of developing interest is remote administration of various home and office appliances, and in recent years, we haveseen many systems offering such capabilities. Robots that can move and interface with their surroundings, as opposed to being fixed in one spot, are said to be mobile robots. Because of their enormous potential and wide range of applications in business, the military, security, and entertainment, mobile robots are the focus of many labs and research groups from numerous universities and businesses. The robot was created specifically for surveillance. Along with the capability of video transmission, the control system is available. Practically, high-speed picture transmission is used to transmit video. The robot will first be outfitted with a Mobile phone that will be used to record the situation ahead of it and send the photographs to a server where the user may manage and view the live broadcast. This study outlines a novel, cost-effective approach to robot control systems. In general, wired networks are used to control robots. If there are any changes to theproject, the robot must be reprogrammed, which takes time.

As a result, they did not cater to user preferences and were not user pleasant. Robots are made to be user-commanded in order to make them more user-friendly and provide the user control over the multimedia tone. To do this, contemporary technology must be used. All consumers should be aware of how to use new technology before it can be implemented. The android smartphone is a multimedia, user-friendly gadget that we are employing to control our robot in order to meet and fully satisfy all these needs. This notion serves as both the inspiration and central concept of the project. Everyone utilizes smartphones in today's world; they are an integral part of daily life. Their everyday activities include reading the newspaper, keeping up with current events, using social media, and using apps for things like home automation, car security, human anatomy, health maintenance, etc. These apps can all be put on their portable smart phones with ease. This study used mobile devices to control robotic locomotion. By utilizing location-based services, the suggested architecture provides an answer to such issues. In other words, users do not need to visit numerous e-commerce websites in order to purchase the desired product. Consumer can purchase the necessary thing without visiting numerous e-commerce websites or wasting their time on them. Location-Based Smart Shopping on Android gives the client a stage where they may acquire information about a certain product that is offered in local retailers. Furthermore, a user is offered with a navigation tool that will take him to the business from which he wishes to purchase the product. The suggested embedded robotic system recognizes alive human bodies in disaster scenarios, which is extremely useful for rescue operations.

The robotic device is made up of a PIR sensor and a camera that can be moved both horizontally and vertically. The PIC16F877A is utilized to drive the dc motors that power the robot wheels and the camera movement. The PIC16F877A is also utilized to collect information from PIR sensor in order to detect a living body. The Raspberry Pi is used to process video and deliver it to the consumer through the internet. The MAX232IC is used to communicate between the PIC16F877A (Microcontroller) and the ZigBee.

Motor driving circuit are utilized in the operation of motors. The LCD screen is utilized for testing, specifically to evaluate the communication between the hand unit and the robotic unit. A PC with an internet connection serves as the user unit. A software GUI is created with features for controlling dc and stepper motors. It displays the environment's live video streaming. There is also the option of informing the user if the PIR system senses any living body near the robot. The below Fig. 4.1 represents the Block Diagram for clear understanding.

Block Diagram:

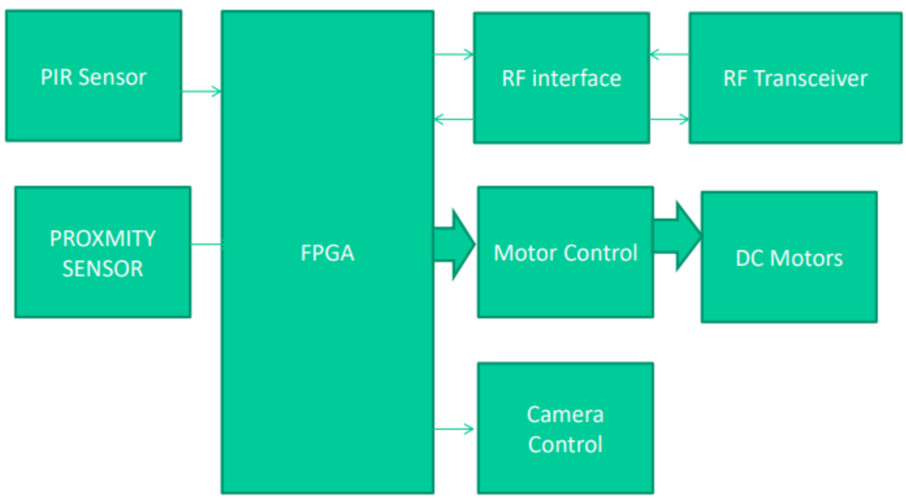


Fig. 4.1 Block Diagram

4.1 PASSIVE INFRARED SENSOR:

An infrared proximity sensor is a type of sensor that is commonly used to detect the presence of an object in its proximity without physical contact. The sensor emits an infrared beam of light and measures the reflection of the light that bounces back from the object.

The sensor typically consists of an infrared light emitting diode (LED) that emits a beam of infrared radiation and a photodiode that detects the reflected radiation. The LED emits a continuous or pulsed beam of infrared light, which has a wavelength of around 850 nanometers. The photodiode is designed to detect this infrared light and convert it into an electrical signal.

When an object comes within the range of the sensor, the infrared radiation emitted by the LED bounces off the object and is detected by the photodiode. The sensor then calculates the distance between the sensor and the object based on the time it takes for the infrared radiation to travel to the object and back. This is known as the time-of-flight method.

Infrared proximity sensors can detect objects at a distance of up to several meters, depending on the design of the sensor and the reflectivity of the object being detected. They are commonly used in a variety of applications, including robotics, automation, and security systems, to detect the presence of objects and trigger actions accordingly.

CONSTRUCTION:

The working principle of an infrared sensor is similar to the object detection sensor. This sensor includes an IR LED & an IR Photodiode, so by combining these two can be formed as a photo-coupler otherwise optocoupler. The physics laws used in this sensor are planks radiation, Stephan Boltzmann & weins displacement.

IR LED is one kind of transmitter that emits IR radiations. This LED looks similar to a standard LED and the radiation which is generated by this is not visible to the human eye. Infrared receivers mainly detect the radiation using an infrared transmitter. These infrared receivers are available in photodiodes form. IR Photodiodes are dissimilar as compared with usual photodiodes because they detect simply IR radiation. Different kinds of infrared receivers mainly exist depending on the voltage, wavelength, package, etc.

Once it is used as the combination of an IR transmitter & receiver, then the receiver's wavelength must equal the transmitter. Here, the transmitter is IR LED whereas the receiver is IR photodiode. The infrared photodiode is responsive to the infrared light that is generated through an infrared LED. The resistance of photo-diode & the change in output voltage is in proportion to the infrared light obtained. This is the IR sensor's fundamental working principle.

Once the infrared transmitter generates emission, then it arrives at the object & some of the emission will reflect back toward the infrared receiver. The sensor output can be decided by the IR receiver depending on the intensity of the response. As shown in the Fig 4.1 and Fig 4.2 with specification.

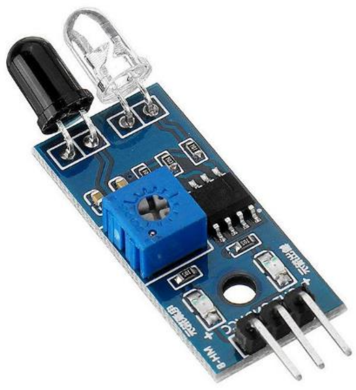


Fig. 4.2 Proximity Sensor

SPECIFICATION

- The operating voltage is 5VDC
- I/O pins – 3.3V & 5V
- Mounting hole
- The range is up to 20 centimeters
- The supply current is 20mA
- The range of sensing is adjustable
- Fixed ambient light sensor

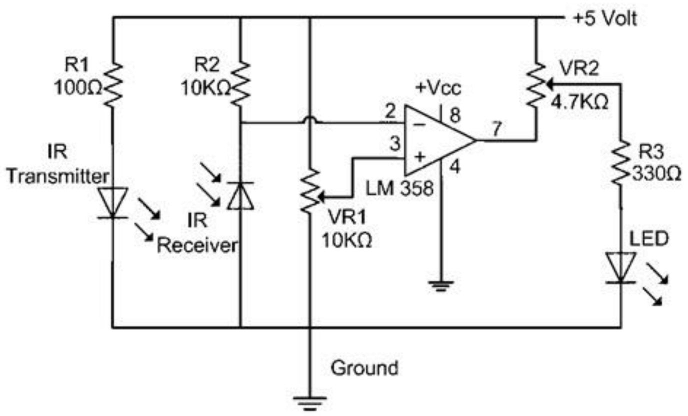


Fig. 4.3 Circuit Diagram Proximity Sensor

4.2 Zigbee Tx Rx:

The X Bee RF module is the product based on ZigBee protocol. So, it also uses IEEE 802.15.4 standards. It can support a wireless sensor network which requires low-cost and low power. For the X Bee RF module, it does not need too much power and it can provide a reliable way to communicate between two or more devices. It interfaces to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate with any logic and voltage compatible UART; or through a level translator to any serial device (for example through an X Bee Adapter). The controlling with the X Bee RF module is very easy with the AT commands.

The X Bee RF module can be configured with the AT (Application Transparent) mode or API (Application Programming Interface) mode but in this thesis implementation, only the AT mode is used. So, in the next chapters, this thesis concentrates on the AT commands. A key component of the ZigBee protocol is the ability to support mesh networking. In a mesh network, nodes are interconnected with other nodes so that multiple pathways connect to each node. In this project, three X Bee RF modules were used to build a small mesh network. In this wireless network, all of them could communicate with each other with a suitable configuration

- **ZigBee Protocol and Communication:**

ZigBee operates in the worldwide 2.4 GHz ISM (Industrial Scientific Medical) band. Proprietary radios are the primary competitor of ZigBee today. ZigBee is based on the IEEE

802.15.4 networking. The protocol stack can be divided into two parts: IEEE 802.15.4 and the ZigBee Alliance. The physical layer (PHY) and the MAC (Medium Access Control) layer are defined by the IEEE. 802.15.4 specification. The ZigBee stack's NWK (Network) layer of the ZigBee stack and all layers above it are under the control of the ZigBee Alliance specification. A typical ZigBee stack is organized in the fashion shown in Fig. 4.5.

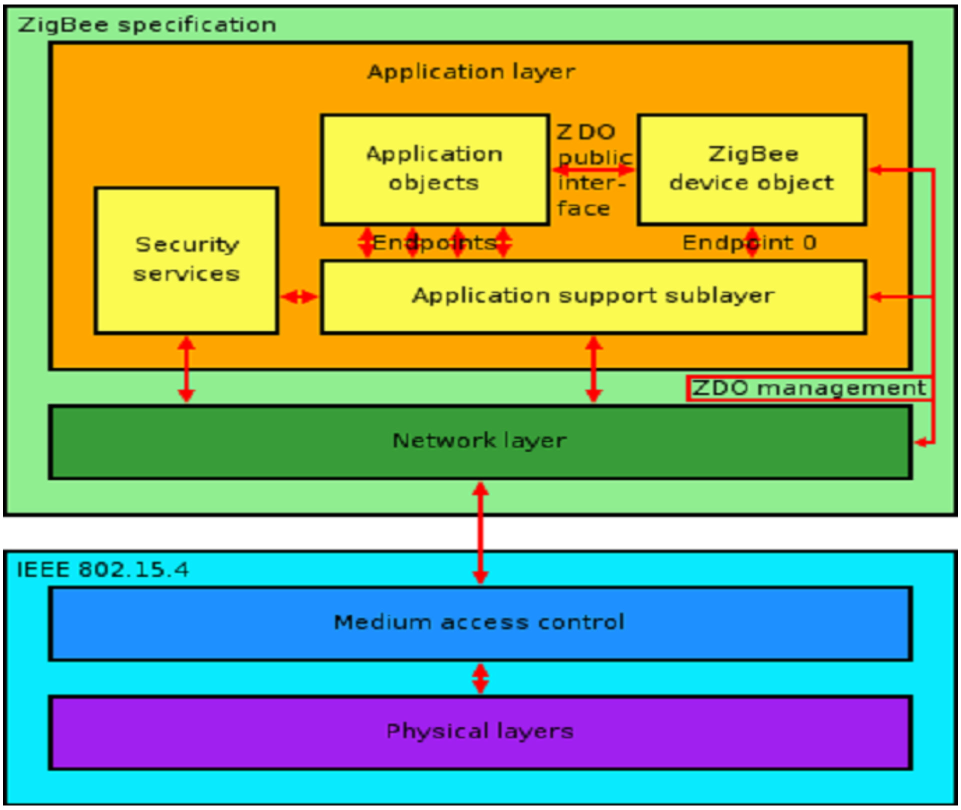


Fig. 4.4 ZigBee Protocol Layer

In a nutshell, the IEEE 802.15.4 standard defines the characteristics of the physical and MAC layers. ZigBee builds upon the IEEE 802.15.4 standard and defines the network layer specifications and provides a framework for application programming in the application layer.

- **UART Serial Communication:**

The Universal Asynchronous Receiver/Transmitter (UART) controller is the key component of the serial communications subsystem of a computer.

The UART 14 takes bytes of data and transmits the individual bits in a sequential fashion. At the destination, a second UART re-assembles the bits into complete bytes. In this project, the communication between Raspberry Pi and X Bee RF module is the UART serial communication. Raspberry Pi can transmit and receive bytes of data from X Bee RF module.

- **Two X Bee Networking:**

As shown in Figure 4.6, there coming data from remote module typically includes: source address, destination address, error checking values, and other pertinent information needed by the protocol. The data which is sent by one node will encompass here with the other information, so that the other node will receive it.

In networking terms, the packaging of the data use point- to-point transmission. When the information comes from one microcontroller, it will first be encompassed by source address, destination address, error checking values, and so on. After these packaging, the remote X Bee module will receive the data out of error. Then the microcontroller which connects to this module will follow the requirements of coming information.

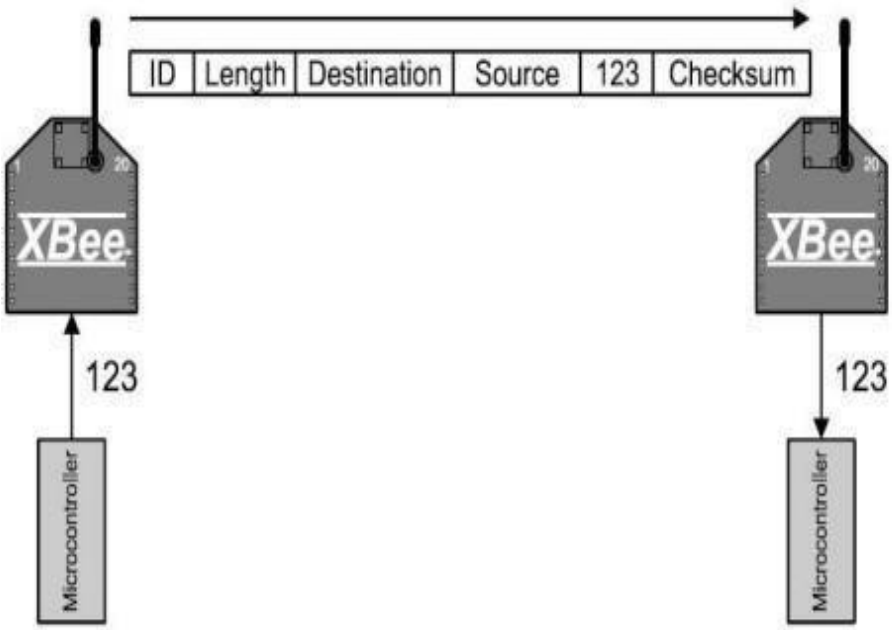


Fig. 4.5 Two X Bee Networking

The X Bee supports both an AT and an API (Application Programming Interface) Mode for sending and receiving data at the controller. Both have their own advantages. Hence it was shown in the above Fig.4.6.

4.3 Motor driver:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction.

It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC). It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H- bridge IC are ideal for driving a DC motor. In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors.Given below is the pin diagram of a L293D motor controller. There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pins 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone ofthe either pin1 or pin9 goes low, then the motor in the corresponding section will suspend working. It’s like a switch which was Shown in the Fig.4.7.

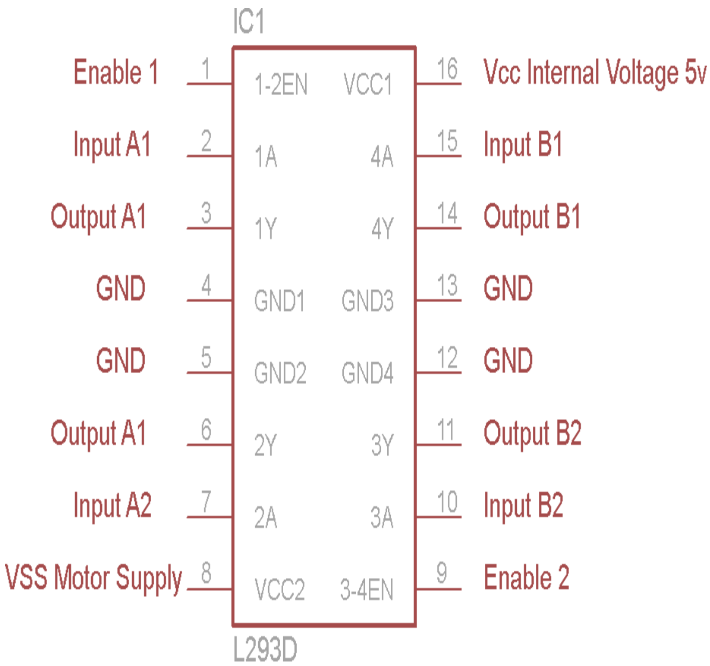


Fig. 4.6 L293D IC

Working of L293D:

There are 4 input pins for L293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right-hand side. The motors are rotated on the basis of the inputs provided across the input pins asLOGIC 0 or LOGIC 1. In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor.

L293D Logic Table:

Let's consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 0** | Clockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 1** | Anticlockwise Direction
- **Pin 2** = **Logic 0** and **Pin 7** = **Logic 0** | Idle [No rotation] [Hi-Impedance state]
- **Pin 2** = **Logic 1** and **Pin 7** = **Logic 1** | Idle [No rotation]

In a very similar way the motor can also operate across input pin 15,10for motor on the right hand side.

VCC is the voltage that it needs for its own internal operation 5v; L293D will not use this voltage for driving the motor. For driving the motors it has a separate provision to provide motor supply VSS (V supply). L293d will use this to drive the motor. It means if you want to operate a motor at 9V then you need toprovide a Supply of 9V across VSS Motor supply. The maximum voltage for VSS motor supply is 36V.

Circuit Diagram For l293d motor driver IC controller:

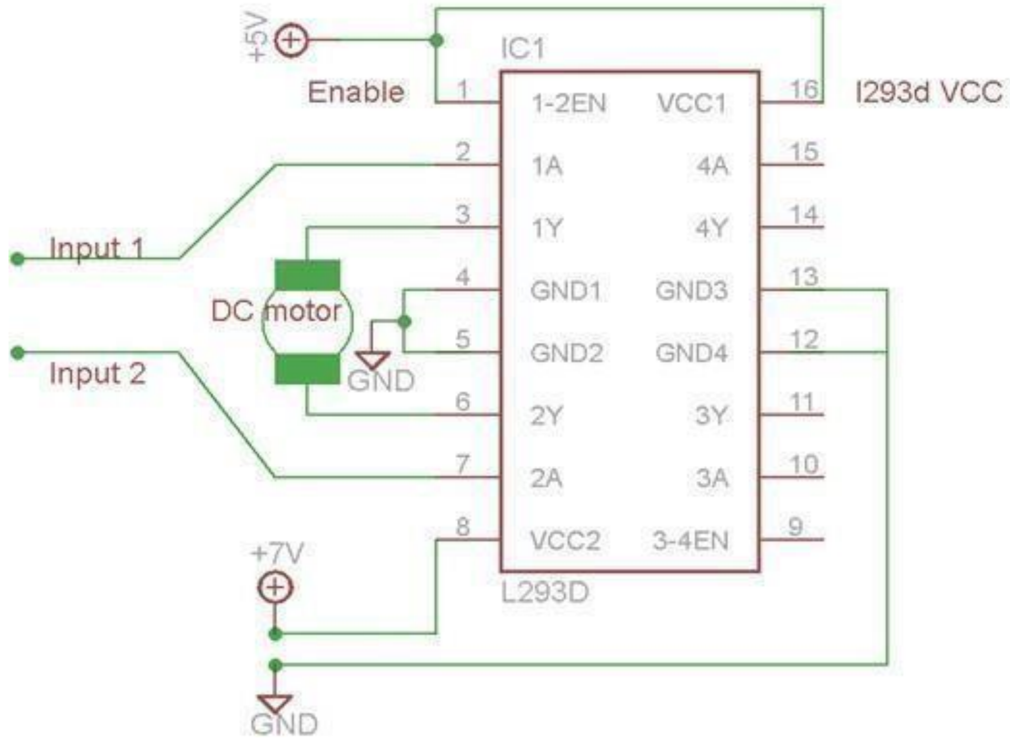


Fig. 4.7 L293D Motor Driver Circuit

It can supply a max current of 600mA per channel. Since it can drive motors Upto 36v hence you can drive pretty big motors with this l293d. VCC pin 16 is the voltage for its own internal Operation. The maximum voltage ranges from 5v and up to 36v.Thus it was shown in the Fig.4.8.

4.4 METAL DETECTOR:

A metal detector is an electronic instrument which detects the presence of metal nearby. Metal detectors is useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator.

Usually, the device gives some indication of distance; the closer the metal is, the higher the tone in the earphone or the higher the needle goes. Another common type are stationary "walk through" metal detectors used for security screening at access points in prisons, courthouses, and airports to detect concealed metal weapons on a person's body.

The simplest form of a metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), thechange in the magnetic field due to the metallic object can be detected. The first industrial metal detectors were developed in the 1960s and were used extensively for mineral prospecting and other industrial applications. Uses include detecting land mines, the detection of weapons such as knives and guns (especially in airport security), geophysical prospecting, archaeology and treasurehunting.

Metal detectors are also used to detect foreign bodies in food, and in theconstruction industry to detect steel reinforcing bars in concrete and pipes and wires buried in walls and floors.

4.5 DC MOTOR:

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. DC motors were the first type widely used, since they could be powered from existing direct- current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

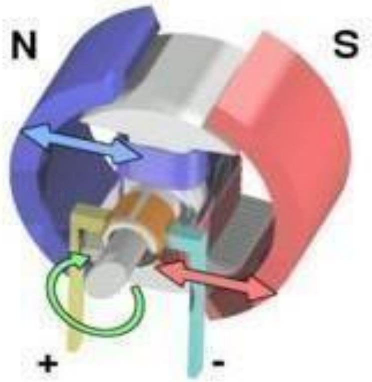


Fig. 4.8 DC motor

Workings of a brushed electric motor with a two-pole rotor (armature) and permanent magnet stator. "N" and "S" designate polarities on the inside axis faces of the magnets; the outside faces have opposite polarities. The + and - signs show where the DC current is applied to the commutator which supplies current to the armature coils.It was shown in the above fig.4.9.

4.6 CAMERA:

A camera is an optical instrument for recording or capturing images, which may be stored locally, transmitted to another location, or both. The images may be individual still photographs or sequences of images constituting videos or movies. The camera is a remote sensing device as it senses subjects without physical contact. The word camera comes from camera obscura, which means "dark chamber" and is the Latin name of the original device for projecting an image of external reality onto a flat surface. The modern photographic camera evolved from the camera obscura. The functioning of the camera is very similar to the functioning of the human eye. A camera may work with the light of the visible spectrum or with other portions of the electromagnetic spectrum. A still camera is an optical device which creates a single image of an object or scene and records it on an electronic sensor or photographic film. All cameras use the same basic design: light enters an enclosed box through a converging lens/convex lens and an image is recorded on a light-sensitive medium(mainly a transition metal-halide).

A shutter mechanism controls the length of time that light can enter the camera. Most photographic cameras have functions that allow a person to view the scene to be recorded, allow for a desired part of the scene to be in focus, and to control the exposure so that it is not too bright or too dim.[3] A display, often a liquid crystal display (LCD), permits the user to view scene to be recorded and settings such as ISO speed, exposure, and shutter speed. A movie camera or a video camera operates similarly to a still camera, except it records a series of static images in rapid succession, commonly at a rate of 24 frames per second. When the images are combined and displayed in order, the illusion of motion is achieved.

4.7 PIC16F877A:

INTRODUCTION:

The PIC16F family of devices is CMOS (Complementary Metal Oxide Semiconductor). CMOS technology offers a number of advantages over other technologies. For example, CMOS circuits consume very little power, operate over quite a wide voltage range and are quite forgiving of bad layout and electrical noise. The name PIC initially referred to **"Peripheral Interface Controller"**.

CORE ARCHITECTURE:

The PIC architecture is characterized by its multiple attributes:

- Separate code and data spaces (Harvard architecture) for devices other thanPIC32, which has Von-Neumann architecture.
- A small number of fixed length instructions
- All RAM locations function as registers as both source and/or destination of math and other functions.

➢ A hardware stack for storing return addresses

➢ A fairly small amount of addressable data space (typically 256 bytes),extended through banking

➢ Data space mapped CPU, port, and peripheral registers

➢ The program counter is also mapped into the data space and writable (this issued to implement indirect jumps). Thus the below Fig.4.10 and 4.11 will provide a detailed idea for the description given above.

PIN DIAGRAM:

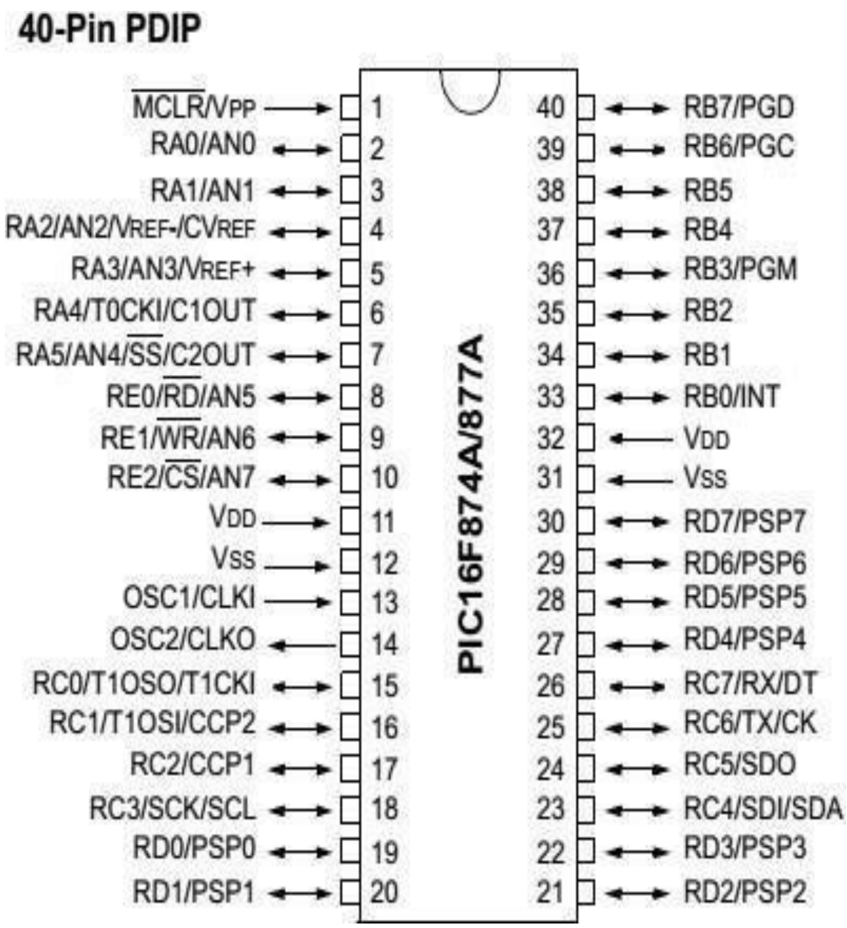
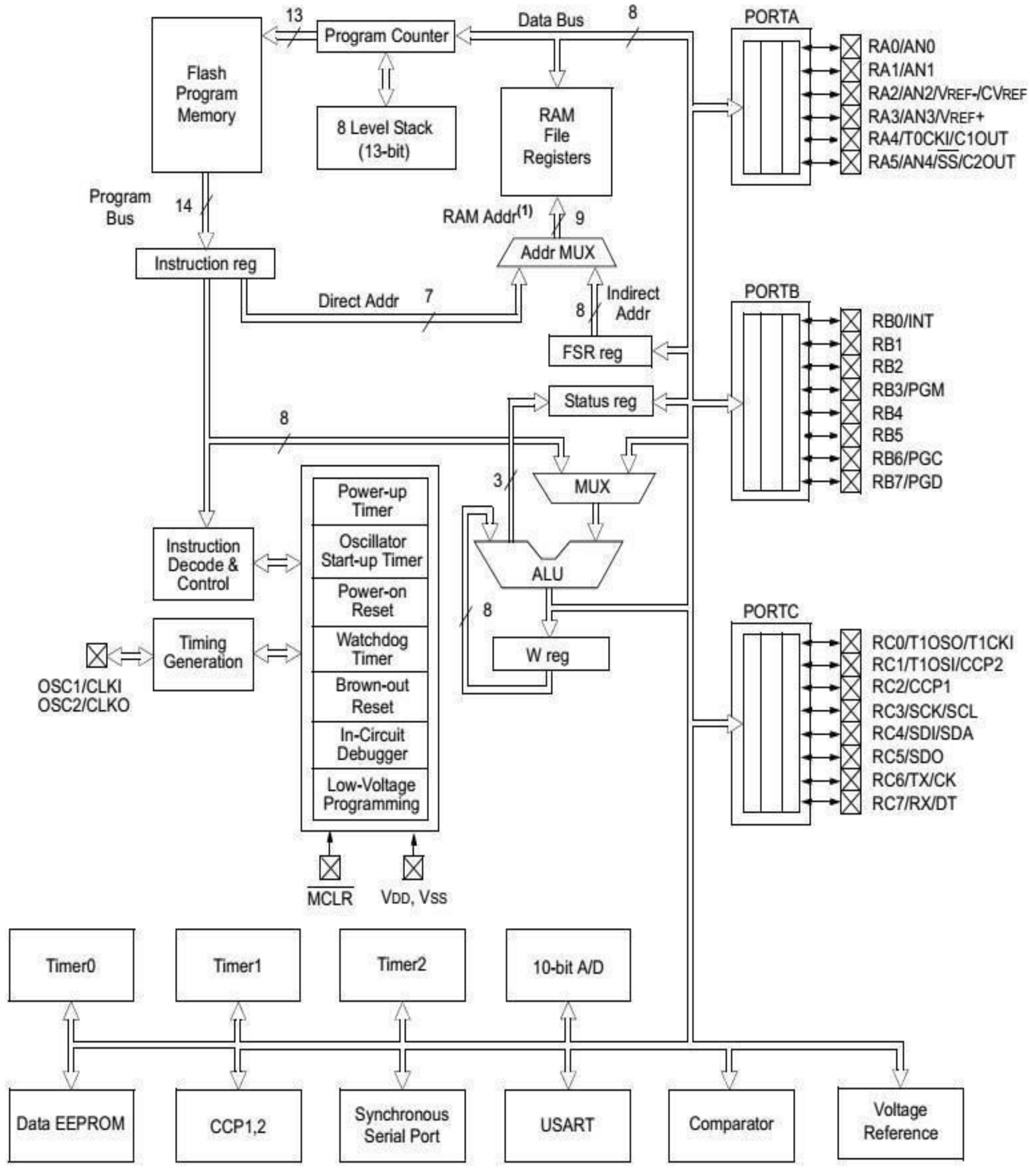


Fig. 4.9 PIC16F877A Pin Diagram

BLOCK DIAGRAM:



Device	Program Flash	Data Memory	Data EEPROM
PIC16F873A	4K words	192 Bytes	128 Bytes
PIC16F876A	8K words	368 Bytes	256 Bytes

Fig 4.10 PIC16F877A Block Diagram

BASIC CHARACTERISTICS OF PIC16F:

The main Features of PIC16F is,

High-performance RISC CPU:

- Lead-free : RoHS - compliant
- Operating speed : 20Mhz, 200ns instruction cycle
- Operating voltage : 4.0-5.5volts
- Industrial temperature range(-40 to +85 degrees)
- 15 Interrupt sources
- 35 single word instructions
- All single-cycle instructions except for program branches

Special microcontroller features:

- Flash memory : 14.3KB(8192 words)
- Data SRAM : 368 bytes
- Data EEPROM : 256 bytes
- Self-reprogrammable under software control
- In-circuit serial programming via two pins
- Watchdog timer with on-chip RC oscillator
- Programmable code protection
- Power-saving code protection
- Selectable oscillator options
- In-circuit debug via two pins

Peripheral Features:

- 33 I/O pins : 5 I/O ports
- Timer0 : 8-bit timer/counter with 8-bit pre-scaler
- Timer1 : 16-bit timer/counter with pre-scaler
- Timer2 : 8-bit timer/counter with 8-bit period register, pre-scaler and post- scaler
- Two capture, compare, PWM modules
- Synchronous serial port with two modes
- USART/SCI with 9-bit address detection
- Parallel slave port
- Brown-out detection circuitry for brown-out reset

Analog Features:

- 10-bit, 8-channel A/D converter
- Brown-out reset
- Analog comparable module

The PIC16F microcontroller consists of following peripherals:

I/O PORTS:

PIC16F877A have 5 (PORTA, PORTB, PORTC, PORTD and PORTE)8-bit input-output ports. PORTB, PORTC & PORTD have 8 I/O pins each. Although other two ports are 8-bit ports, but they do not have eight I/O pins. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin.

MEMORY:

PIC16F877A consists of three different memory sections:

- **FLASH MEMORY**

Flash memory is used to store the program downloaded by a user on to the microcontroller. Flash memory is non-volatile, i.e., it retains the program even after the power is cut-off. PIC16F877A has 8K X 14 words of Flash Memory.

- **EEPROM**

This is also a nonvolatile memory which is used to store data like values of certain variables. PIC16F877A has 256 Bytes of EEPROM.

- **SRAM**

Static Random Access Memory is the volatile memory of the microcontroller, i.e., it loses its data as soon as the power is cut off. PIC16F877A is equipped with 368 Bytes of internal SRAM.

OSCILLATOR:

The PIC16F series has flexible clock options. An external clock of up to 20 MHz can be applied to this series. These controllers also consist of an internal oscillator which provides eight selectable frequency options varying from 31 KHz to 4MHz.

ADC INTERFACE:

PIC16F877A is equipped with 8 ADC (Analog to Digital Converter) channels of 10-bits resolution. ADC reads the analog input, for example, a sensor input and converts it into digital value that can be understood by the microcontroller.

TIMERS/COUNTERS:

PIC16F877A has three timer/counters. There is one 16-bit timer and the remaining timers have option to select 8 bit mode. Timers are useful for generating precision actions, for example, creating precise time delays between two operations.

Timer 0:

The original timer: Timer 0 was the first timer developed and you can find it in all the earliest devices e.g., 16F84 up to the most current e.g., 16F877A. It is an 8 bit timer with an 8 bit pre-scaler that can be driven from an internal (Fosc/4) or external clock. It generates an interrupt on overflow when the count goes from 255 to zero.

Timer 0 always synchronize the input clock .

Timer 1 :

This is a 16 bit timer that generates an overflow interrupt when it goes from 65535 to zero. It has an 8 bit programmable prescaler and you can drive it from the internal clock (Fosc/4) or an external pin. To eliminate false triggering it also has an optional input synchronizer for external pin input. This timer can be used in sleep mode and will generate a wakeup interrupt on overflow.

Timer 1 is also read by the CCP module to capture an event time.

Timer 2 :

This is an 8 bit timer with an 8 bit pre-scaler and an 8 bit post-scaler. It takes its input only from the internal oscillator (Fosc/4). This timer is used for the base of a PWM when PWM is active and it can be software selected by the SSP module as a baud clock.

It also has a period register that allows easy control of the period. When timer 2 reaches the PR2 register value then it resets. This saves having to check the timer value in software and then reset the timer and since it is done in hardware the operation is much faster - so you can generate fast clocks with periods that are multiples of the main clock.

INTERRUPTS:

PIC16F877A consists of only one external interrupts source. There are 14 internal interrupts which are associated with different peripherals like USART, ADC, Timers, and so on.

USART:

The Universal Synchronous Asynchronous Receiver Transmitter (USART) module is one of the two serial I/O modules. The USART can be configured as a full duplex asynchronous system that can communicate with peripheral devices such as CRT terminals and personal computers, or it can be configured as a half-duplex synchronous system that can communicate with peripheral devices such as A/D or D/A integrated circuits, serial EEPROMs etc. Thus it is shown in below Table 4.1.

Table 4.1 USART CONFIGURATION

ICSP	In Circuit Serial Programming	It can be programmed without removing the IC from the circuit.
WDT	Watch dog timer	This is a software error protector.
BOR	Brown Out reset	This detects if the power supply dips slightly and resets the device if so.
POR	Power on reset	This starts microcontroller initialization.
PWRT	Power up Time	A time delay to let Vdd rise.
OST	Oscillator start up timer	Wait for 1024 cycles after PWRT.
SLEEP	PIC microcontroller sleep mode	Enter low power mode.

ICSP and ICD:

PIC16F series controllers have In Circuit Serial Programming facility to program the Flash Memory which can be programmed without removing the IC from the circuit. ICD (In Circuit Debugger) allows for hardware debugging of the controller while it is in the application circuit.

SPI

The SPI mode allows 8 bits of data to be synchronously transmitted and received simultaneously. All four modes of SPI are supported. PIC16F supports 4-wire SPI communication between two devices on a common clock source. The data rate of SPI is more than that of USART.

I^{2}C

PIC16F supports Two Wire Interface (TWI) of I2C communication between two devices. It can work as both Master and Slave device. The MSSP module in I2C mode fully implements all master and slave functions and provides interrupts on START and STOP bits in hardware, to determine a free bus (multi-master function). The MSSP module implements the standard mode specifications, as well as 7-bit and 10-bit addressing.

USB

PIC18F supports full-speed USB with different clock options.

PSP

The Parallel Slave Port to connect the PIC microcontroller directly into a microprocessor system. It provides an 8 bit read/write data bus and RD (read) WR (write) and CS (chip select) inputs – all active low.

This will let you add a PIC microcontroller to a system so that the PIC microcontroller can be treated as a memory mapped peripheral. It will let the microcontroller behave just as though it was another microprocessor building block e.g. some memory or ram but in this case you have full control over exactly what the building block is i.e. you can re-program the PIC microcontroller to do just about anything. This provides an easy route to adding a PIC microcontroller to an 8 bit system that already exists.

CCP

The Capture/Compare/PWM module has three modes of operation:

Capture - Capture the time of an event.

Compare - Generate an output when Timer 1 reaches a value.

PWM

PWM gives you one Pulse Width Modulation output with 10 bit resolution and with no software overhead - once started it operates all by itself unless you want to change the duty cycle.

It uses Timer 2 to define its operation using Timer 2 period register to define the frequency of the PWM.

DATA MEMORY ORGANIZATION

The data memory of PIC16F877 is separated into multiple banks which contain the general-purpose registers (GPR) and special function registers (SPR). According to the type of the microcontroller, these banks may vary. The PIC16F877 chip only has four banks (BANK 0, BANK 1, BANK 2, and BANK4). Each bank holds 128 bytes of addressable memory.

Data memory is made up of the Special Function Registers (SFR) area, and the General Purpose Registers (GPR) area. The SFRs control the operation of the device, while GPRs are the general area for data storage and scratch pad operations.

The data memory is banked for both the GPR and SFR areas. The GPR area is banked to allow greater than 96 bytes of general-purpose RAM to be addressed. SFRs are for the registers that control the peripheral and core functions. Banking requires the use of control bits for bank selection.

These control bits are located in the STATUS Register (STATUS<7:5>). To move values from one register to another register, the value must pass through the W register. This means that for all register-to-register moves, two instruction cycles are required. The entire data memory can be accessed either directly or indirectly. Direct addressing may require the use of the RP1:RP0 bits. Indirect addressing requires the use of the File Select Register (FSR).

Indirect addressing uses the Indirect Register Pointer (IRP) bit of the STATUS register for accesses into the Bank0 / Bank1 or the Bank2 / Bank3 areas of data memory.

GENERAL PURPOSE REGISTERS (GPR)

Some Mid-Range MCU devices have banked memory in the GPR area. GPRs are not initialized by a Power-on Reset and are unchanged on all other resets. The register file can be accessed either directly, or using the File Select Register FSR,indirectly. Some devices have areas that are shared across the data memory banks, so a read / write to that area will appear as the same location (value) regardless ofthe current bank.

SPECIAL FUNCTION REGISTERS (SFR)

The SFRs are used by the CPU and Peripheral Modules for controlling the desired operation of the device. These registers are implemented as static RAM.

The SFRs can be classified into two sets, those associated with the “core” functionand those related to the peripheral functions. All

Mid-Range MCU devices have banked memory in the SFR area. Switching between these banks requires the RP0 and RP1 bits in the STATUS register to be configured for the desired bank. Some SFRs are initialized by a Power-on Reset and other resets, while other SFRs are unaffected. The register file can be accessed either directly, or using the File Select Register FSR, indirectly.

PROGRAMMING

One of the most useful features of a PIC microcontroller is that you can re- program them as they use flash memory. You can also use the ICSP serial interface built into each PIC Microcontroller for programming and even do programming while it's still plugged into the circuit. You can either program a PIC microcontroller using assembler or a high level language and I recommend using a high level language such as C as it is much easier to use (after an initial learning curve). Once you have learned the high level language you are not forced to use the same processor

SPECIAL FEATURES

- **WDT:**

If your software goes haywire, then this timer resets the processor. To stop the reset the well-behaved software must periodically issue the CLRWDT instruction to stop a reset. The WDT runs using its own oscillator. It runs during sleep and shares Timer 0 pre-scaler.

- **POR:**

Power on Reset starts PIC microcontroller initialization when it detects a rising edge on MCLR.

- **PWRT:**

  If you enable this, then 72ms after a POR the PIC microcontroller is started.

- **OST:**

  Oscillator Startup Timer delays for 1024 oscillator cycles after PWRT (if PWRT is enabled) ensuring that the oscillator has started and is stable. It is automatic and only used for crystal oscillator modes and is active after POR or wake from sleep.

- **SLEEP:**

  Sleep mode (or low power consumption mode) is entered by executing the 'SLEEP' command. The device can wake from sleep caused by an external reset, Watch Dog Timer timeout, INT pin RB port change or peripheral interrupt.

SOFTWARE EMULATION:

Commercial and free emulators exist for the PIC family processors.

In-circuit debugging:

Later model PICs feature an ICD (in-circuit debugging) interface, built into the CPU core. ICD debuggers (MPLAB ICD2 and other third party) can communicate with this interface using three lines. This cheap and simple debugging system comes at a price however, namely limited breakpoint, loss of some IO (with the exception of some surface mount 44- pin PICs which have dedicated lines for debugging) and loss of some features of the chip. For small PICs, where the loss of IO caused by this method would be unacceptable, special headers are made which are fitted with PICs that have extra pins specifically for debugging.

In-circuit emulators:

Microchip offers three full in circuit emulators: the MPLAB ICE2000 (parallel interface, a USB converter is available); the newer MPLAB ICE4000 (USB 2.0 connection); and most recently, the REALICE. All of these ICE tools can be used with the MPLAB IDE for full source-level debugging of code running on the target.

The ICE2000 requires emulator modules, and the test hardware must provide a socket which can take either an emulator module, or a production device.

The REAL ICE connects directly to production devices which support in- circuit emulation through the PGC/PGD programming interface, or through a high-speed connection which uses two more pins. According to Microchip, it supports "most" flash-based PIC, PIC24, and ds PIC processors.

The ICE4000 is no longer directly advertised on Microchip's website, and the purchasing page states that it is not recommended for new designs.

PICKit2 open-source structure:

PICKit2 has been an interesting PIC programmer from Microchip. It can program all PICs and debug most of the PICs (as of May-2009, only the PIC32 family is not supported for MPLAB debugging). Ever since its first releases, all software source code (firmware, PC application) and hardware schematic are open to the public. This makes it relatively easy for an end user to modify the programmer for use with a non-Windows operating system such as Linux or Mac OS. In the meantime, it also creates lots of DIY interest and clones. This open- source structure brings many features to the PICKit2 community such as Programmer-to-Go, the UART Tool and the Logic Tool, which have been contributed by PICKit2 users. Users have also added such features to the PICKit2as 4MB Programmer-to-go capability, USB buck/boost circuits, RJ12 type connectors and others.

With paged program memory, there are two page sizes to worry about: one for CALL and GOTO and another for computed GOTO (typically used for table lookups). For example, on PIC16, CALL and GOTO have 11 bits of addressing, so the page size is 2048 instruction words. For computed GOTOs, where you add to PCL, the page size is 256 instruction words. In both cases, the upper address bits are provided by the PCLATH register. This register must be changed every time control transfers between pages. PCLATH must also be preserved by any interrupt handler.

- **ADVANTAGES:**

The PIC architectures have these advantages:

- Small instruction set to learn.
- RISC architecture
- Built in oscillator with selectable speeds.
- Easy entry level, in circuit programming plus in circuitdebugging PICKit2 units available from Microchip.com for less than $50.
- Inexpensive microcontrollers

- Wide range of interfaces including I²C, SPI, USB, USART, A/D, programmable comparators, PWM, LIN, CAN, PSP, and Ethernet.

- **LIMITATIONS:**

  The PIC architectures have these limitations:

- One accumulator
- Register-bank switching is required to access the entire RAM of manydevices.
- Operations and registers are not orthogonal; some instructions can address RAM and/or immediate constants, while others can only use the accumulator.

4.8 LCD:

LCD (liquid crystal display) is the technology used for displays in notebook and other smaller computers. Like light-emitting diode (LED) and gas- plasma technologies, LCDs allow displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it.

An LCD is made with either a passive matrix or an active-matrix display grid. The active matrix LCD is also known as a thin film transistor (TFT) display. The passive matrix LCD has a grid of conductors with pixels located at each intersection in the grid. A current is sent across two conductors on the grid to control the light for any pixel. An active matrix has a transistor located at each pixel intersection, requiring less current to control the luminance of a pixel. For this reason, the current in an active-matrix display can be switched on and off more frequently, improving the screen refresh time (your mouse will appear to move more smoothly across the screen, for example).

Some passive matrix LCDs have dual scanning, meaning that they scan the grid twice with current in the same time that it took for one scan in the original technology. However, active matrix is still a superior technology. Thus from Fig.4.12 to 4.16 and the Table 4.2 shown below gives a clear Idea about the topic.

Introduction:

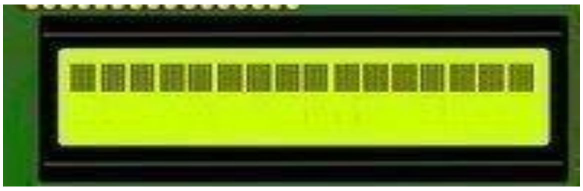


Fig. 4.11 LCD

An LCD is a small low-cost display. It is easy to interface with a micro- controller because of an embedded controller (the black blob on the back of the board).This controller is standard across many displays which means many micro - controllers have libraries that make displaying messages as easy as a single line of code. LCDs with a small number of segments, such as those used in digital watches and pocket calculators, have individual electrical contacts for each segment. This display structure is unwieldy for more than a few display elements.

Small monochrome displays such as those found in personal organizers, or older laptop screens have a passive-matrix structure employing super-twisted pneumatic (STN) or double-layer STN (DSTN) technology the latter of which addresses a color-shifting problem with the former and color-STN (CSTN) wherein color is added by using an internal filter.. The pixels are addressed one at a time by row and column addresses. As the number of pixels (and, correspondingly, columns and rows) increases, this type of display becomes less feasible. Very slow response times and poor contrast are typical of passive-matrix addressed LCDs.

Each pixel has its own dedicated transistor, allowing each column line to access one pixel. When a row line is activated, all of the column lines are connected to a row of pixels and the correct voltage is driven onto all of the column lines.

Features:

- Built-in controller (KS 0066 or Equivalent)
- + 5V power supply (Also available for + 3V)
- 1/16 duty cycle
- B/L to be driven by pin 1, pin 2 or pin 15, pin 16 or A.K (LED), Optional for+ 3V power supply
- 6.61 x 15.8 mm viewing area
- 7.5 x 7 dot matrix format for 2.96 x 5.56 mm characters, plus cursor line
- Can display 224 different symbols
- Low power consumption (1 mA typical)
- Powerful command set and user-produced characters
- TTL and CMOS compatible
- Connector for standard 0.1-pitch pin headers

Mechanical Specifications:

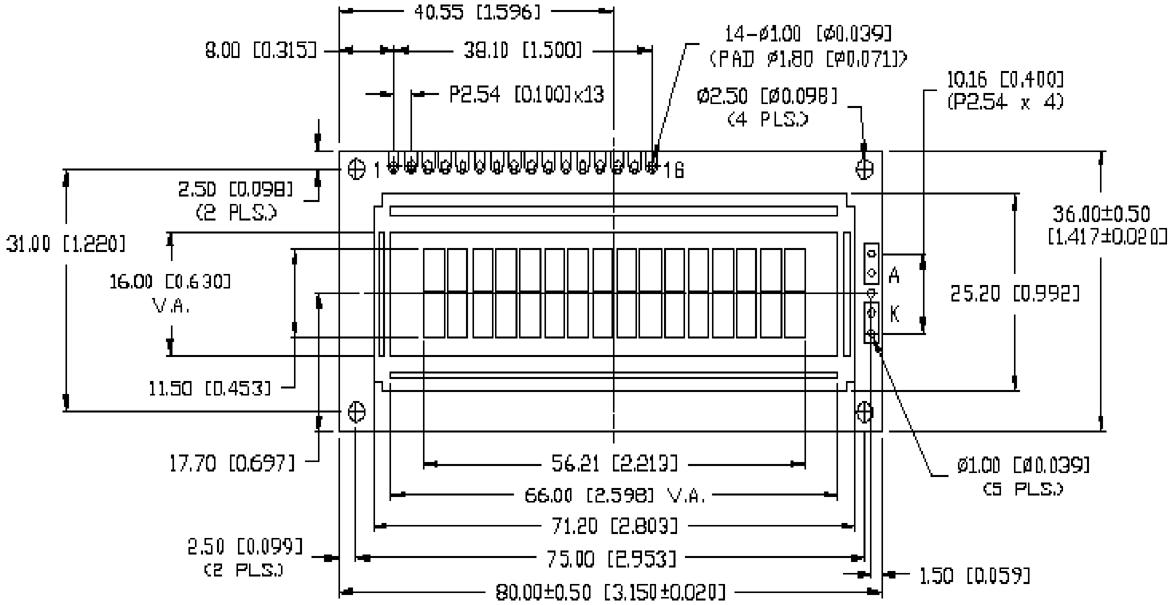


Fig. 4.12 Mechanical Specifications

Pin Configurations:

Table 4.2 LCD PIN CONFIGURATION

Pin No	Symbol	Details
1	GND	Ground
2	Vcc	Supply Voltage +5V
3	Vo	Contrast adjustment
4	RS	0->Control input, 1-> Data input
5	R/W	Read/ Write
6	E	Enable
7 to 14	D0 to D7	Data
15	VB1	Backlight +5V
16	VB0	Backlight ground

Circuit Connections:

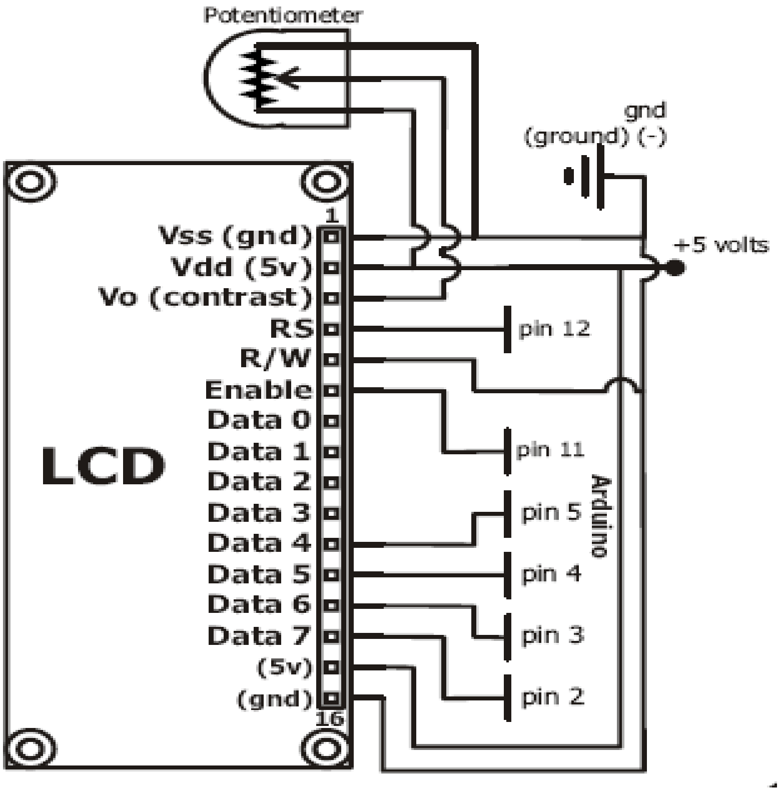


Fig. 4.13 Circuit Connections

Programming:

Algorithm to send data to LCD:

Make R/W low

Make RS=0; if data byte is command .RS=1; if data byte is data (ASCII value) 3.Place data byte on data register

Pulse E (HIGH to LOW)

Repeat the steps to send another data byte

LCD Initialization:

This is the pit fall for beginners. Proper working of LCD depend on the how the LCD is initialized. We have to send few command bytes to initialize the LCD. Simple steps to initialize the LCD

Specify function set: Send 38H for 8-bit,double line and 5x7 dot character format.

Display On-Off control: Send 0FH for display and blink cursor on.

Entry mode set: Send 06H for cursor in increment position and shift is invisible.

Clear display: Send 01H to clear display and return cursor to home position.

- **LCD commands and codes:**

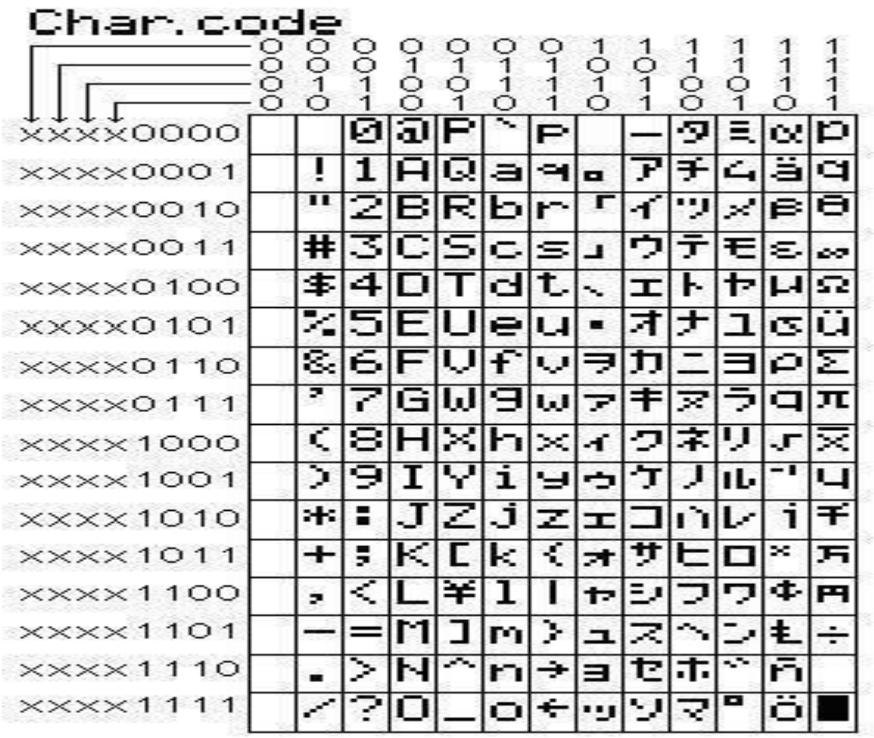


Fig. 4.14 LCD Commands

LCD COMMANDS AND CODES:

1	Clear display screen
2	Return Home
4	Decrement cursor (shift cursor to left)
5	Increment cursor (shift cursor to right)
6	shift display right
7	shift display left
8	Display off, cursor off
A	Display off, cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to the beginning of 1st line
C0	Force cursor to the beginning of 2nd line
38	2 lines and 5 x 7 matrix.

- **Interfacing LCD with the Microcontroller:**

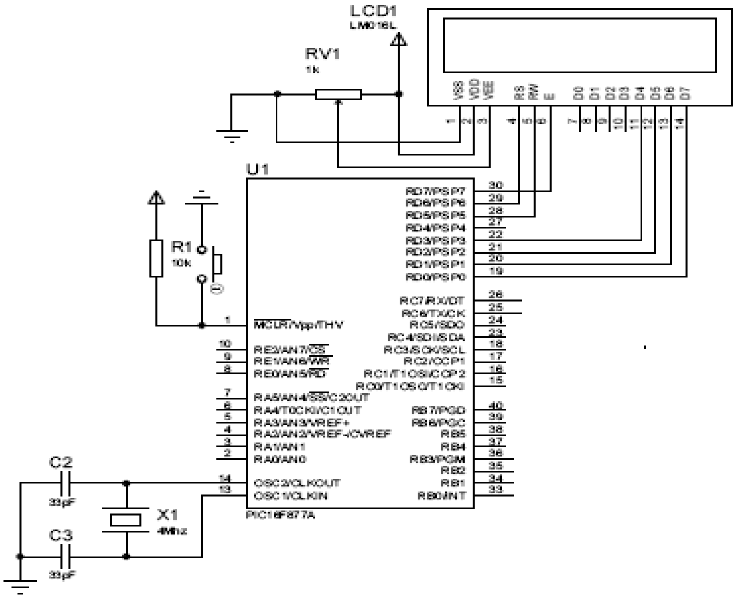


Fig. 4.15 Interfacing LCD with the Microcontroller

- **Circuit Explanation:**

The LCD we have used in this project is HD1234. This is an alphanumeric type of LCD with 16 pins. Of which Pins 7 to 14 are used as data pins, through which an 8-bit data can be input to the LCD. These Pins are connected to the Port 0 of Micro controller. There are 3 control pins RS (Pin-4), RW (Pin-5) and EN (Pin-6). The RS pin is connected to the 28^{th} Pin of micro controller. The RW pin is usually grounded. The Enable pin is connected to 27^{th} Pin. The LCD has two Rows and 16 Columns. The LCD is powered up with 5V supply connected to Pins 1(Gnd) and 2(Vcc). The Pin 3 is connected to Vcc through a Potentiometer. The potentiometer is used to adjust the contrast level.

CHAPTER 5

CIRCUIT DIAGRAM DESCRIPTION

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/15v is used to perform the step down operation where a 230V AC appears as 15V AC across the secondary winding. In the power supply unit, rectification is normally achieved using a solid-state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow. A commonly used circuit for supplying large amounts of DC power is the bridge rectifier. A bridge rectifier of four diodes (4*IN4007) is used to achieve full wave rectification. Two diodes will conduct during the negative cycle and the other two will conduct during the positive half cycle. The DC voltage appearing across the output terminals of the bridge rectifier will be somewhat less than 90% of the applied RMS value. Filter circuits, which usually capacitor is acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output.

The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device.

Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output. The regulators IC7812 and 7805 are used to provide the +12v and +5v tothe circuit.

PIC16F877A is a 40 Pin DIP pack IC with 33 I/O pins. Out of which 9 pins can be used either as Digital I/O pins or Analog Input pins. The micro controller is having 5 ports Port A, Port B, Port C, Port D and Port E. Here Port A consists of 6Pins and can be used as Analog Pins and Digital Pins, in the same way Port E consists of 3Pins all of them can either be used as Analog Pins or Digital Pins. The Port pins of Port D are connected to LCD pins. RD0 to RD3 pins are data pins and RD5 to RD7 pins are control pins. The Pins 13 and 14 are connected to Oscillators. This Oscillator provides required clock reference for thePIC microcontroller. Either Pins 11 and 12 or 31 and 32 can be used as power supply pins. The 5v supply is given to the 11^{th} and 32 pin and GND is connected to the 12^{th} and 31^{th} pin of microcontroller. Pins 25 and 26 of Port C are used for serial Port communications; these pins are interfaced with MAX232 for PC basedcommunications. Pins 39 and 40 are used for In-Circuit Debugger Operations, with which the hex code is downloaded to the Chip. Pin 33 is used as external Interrupt Pin. Pin 1 is used as Reset Pin. This Pin is connected to Vcc through a resistor.

The LCD we have used in this project is HD1234. This is an alphanumeric type of LCD with 16 pins. Of which Pins 7 to 14 are used as data pins, 11 to 14 pins are connected to port D of

PIC16F877A microcontroller. There are 3 control pins RS (Pin-4), RW (Pin-5) and EN (Pin-6). The RS pin is connected to the 29^{th} Pin of micro controller. The RW pin is usually grounded. The RW is connected to 28^{th} Pin. The EN pin is connected 30^{th} pin. The LCD has two Rows and 16 Columns. The LCD is powered up with 5V supply connected to Pins 1(GND) and2(Vcc). The Pin 3 is connected to Vcc through a Potentiometer. The potentiometer is used to adjust the contrast level. Here in our project we use the PIC controller in 4-bit mode. Here only 4 data pins are connected and are used as Data Port. The RS pin is connected to the 27^{th} Pin of micro controller. The RW pin is usually grounded. The RW is connected to 26^{th} Pin. The EN pin is connected 28^{th} pin. The LCD has two Rows and 16 Columns.

A PIR sensor and metal detectors are interfaced to the ADC port of PIC16F877A microcontroller. The output voltage from the LM35 is linearly proportional to the measuring values. The internal ADC converts the output voltages from the LM35 into digital signals The 2^{nd} pin and 3^{rd} pin (output) of metal detector and PIR sensor is connected to the 2^{nd} pin of PIC16F877A microcontroller.

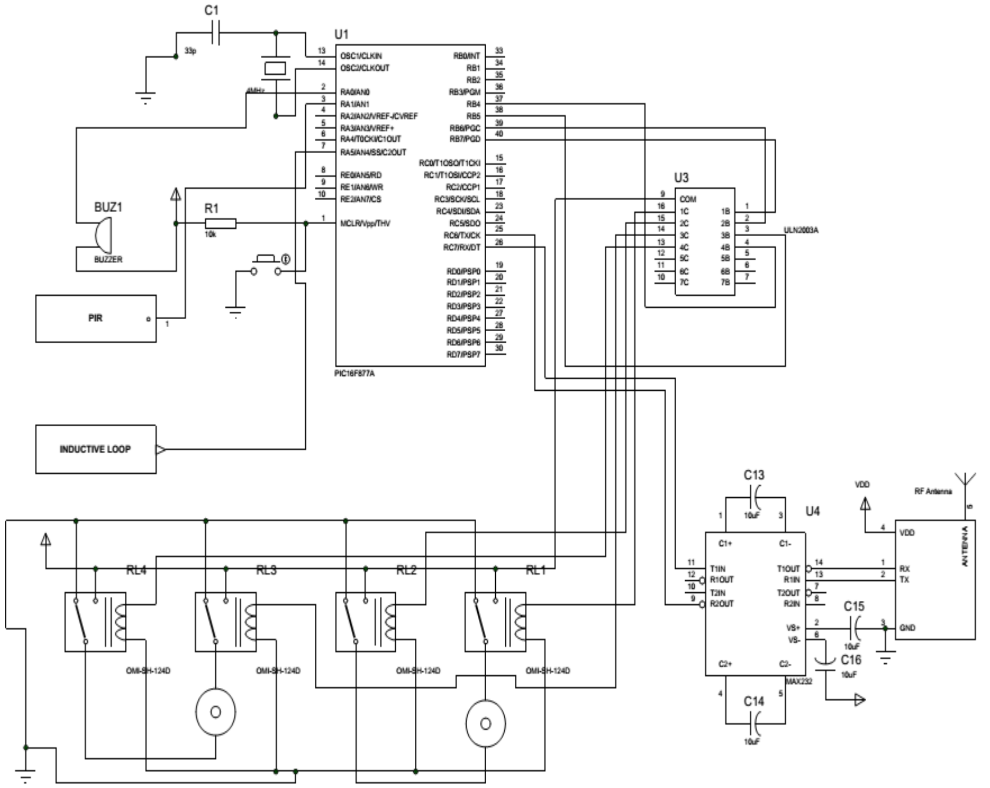


Fig. 5.1 CIRCUIT DIAGRAM

There are 4 input pins for L293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right-hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1. In simple you need to provide Logic 0 or 1 across the input pins for rotating the motor which forward and reverse. Thus the circuit diagram description is shown above as Fig.5.1.

CHAPTER 6

SOFTWARE DESCRITION

6.1 MPLAB IDE:

MPLAB Integrated Development Environment (IDE) is a free, integrated toolset for the development of embedded applications employing Microchip's PIC and dsPIC microcontrollers. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools.

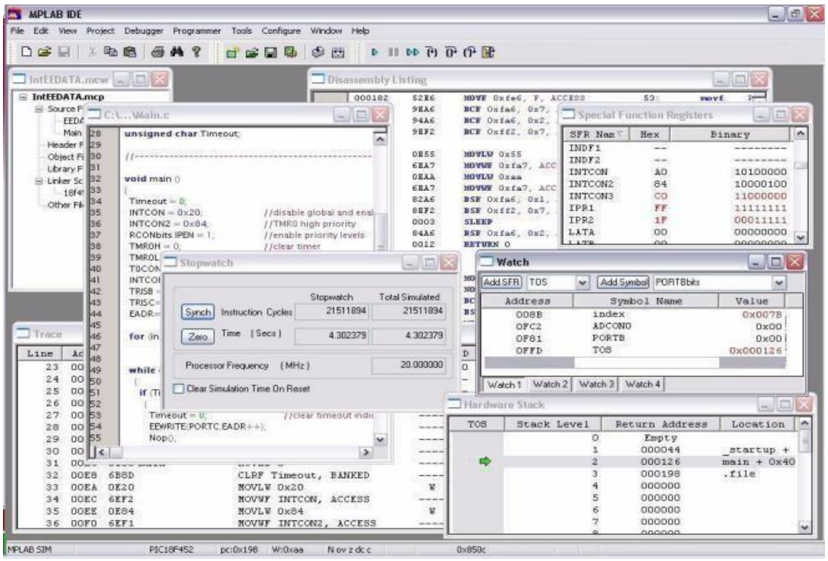


Fig. 6.1 MPLAB IDE

Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools is shown in above fig.6.1.

MPLAB IDE features include.

FLEXIBLE CUSTOMIZABLE PROGRAMMER'S TEXT EDITOR

Fully integrated debugging with right mouse click menus for breakpoints, trace and editor functions ,Tabbed editor option or separate source windows, Recordable macros , Context sensitive color highlighting for assembly, C and BASIC code readability, Mouse over variable to instantly evaluate the contents of variables and registers , Set breakpoints and trace points directly in editor to instantly make changes and evaluate their effects , Graphical project manager , Version control support for MS Source Safe, CVS, PVCS, Subversion.

FREE COMPONENTS

Programmer’s text editor

MPLAB SIM, high speed software simulator for PIC and dsPIC devices with peripheral simulation, complex stimulus injection and register logging Full featured debugger MPASM™ and MPLINK for PIC MCUs and dsPIC DSC devices HI-TECH C PRO for PIC10/12/16 MCU Families running in lite mode CCS PCB C Compiler Lab center Electronic’s Proteus VSM spice simulator Many Powerful Plug-Ins including

- AN851 Boot loader programmer
- AN901 BLDC Motor Control Interface
- AN908 ACIM Tuning Interface
- KeeLoq support

SIMPLE, POWERFUL SOURCE LEVEL DEBUGGING

Auto alignment of breakpoints after source code modification Mouse-over variable inspection Drag and drop variables to watch windows Watch variables, structures and arrays Mixed source code/disassembly view Stack symbolic return label display Automatic single- step "animate" feature.

Pass counts and break on PIC18F, PIC24 and dsPIC file register R/W forMPLAB ICD 2

Step-Out-Of function Customhot keys.

Powerful simulator stimulus generator.

Trace to source correlation to compare real time data collected with original source code and comments.

BUILT IN SUPPORT FOR HARDWARE AND ADD-ON COMPONENTS

MPLAB C Compilers (free student editions available for download)

MPLAB REAL ICE™ in-circuit emulator

MPLAB ICD 2 and MPLAB ICD 3 in-circuit debuggers and engineeringprogrammers for selected Flash devices

PICkit 2 and PICkit 3 Debug Express economy debug/programmers

PICSTART Plus development programmer

MPLAB PM3 device programmer

Third Party tools, including HI-TECH, IAR, Byte Craft, B. Knudsen, CCS,Micrium, micro Engineering Labs, Lab center, MATLAB, Segger A host of low cost starter boards, demonstration and evaluation kits

6.2 CCS Compiler:

The PCB, PCM, and PCH are separate compilers. PCB is for 12-bit opcodes, PCM is for 14-bit opcodes, and PCH is for 16-bit opcode PIC® microcontrollers. Due to many similarities, all three compilers are covered in this reference manual. Features and limitations that apply to only specific microcontrollers are indicated within.

When compared to a more traditional C compiler, PCB, PCM, and PCH have some limitations. As an example of the limitations, function recursion is not allowed. This is due to the fact that the PIC® has no stack to push variables onto, and also because of the way the compilers optimize the code. The compilers can efficiently implement normal C constructs, input/output operations, and bit twiddling operations.

6.2.1 File Formats:

The compiler can output 8-bet hex, 16-bit hex, and binary files.

Three listing formats are available:

1) Standard format resembles the Microchip tools, and may be required by other Third-Party tools.

2) Simple format is generated by compiler and is easier to read.

3) Symbolic format uses names versus addresses for registers. The debug files may be output as Microchip .COD file, Advanced Transdata .MAP file, expanded .COD file for CCS debugging or MPLAB 7.xx .COF file.

All file formats and extensions may be selected via Options File Associations option in Windows IDE. Thus, the table 6.1 is shown below.

Table 6.1 FILE FORMATS

.C	This is the source file containing user C source code.
.H	These are standard or custom header files used to define pins, register, register bits, functions and preprocessor directives.
.PJT	This is the project file which contains information related to the project.
.LST	This is the listing file which shows each C source line and the associated assembly code generated for that line.
.SYM	This is the symbol map which shows each register location and whatprogram variables are stored in each location.
.STA	The statistics file shows the RAM, ROM, and STACK usage. It provides information on the source codes structural and textual complexities using Halstead and McCabe metrics.
.COF	This is a binary containing machine code and debugging information.
.RTF	The output of the Documentation Generator is exported in a RichText File format which can be viewed using the RTF editor or wordpad.
.RVF	The Rich View Format is used by the RTF Editor within the IDE to view the Rich Text File.
.DGR	The .DGR file is the output of the flowchart maker.
.ESYM	This file is generated for the IDE users. The file contains Identifiers and Comment information. This data can be used for automatic documentation generation and for the IDE helpers.
.OSYM	This file is generated when the compiler is set to export a relocatableobject file. This file contains a list of symbols for that object.

6.3 PIC KIT 2:

The PICkit™ 2 Development Programmer or Debugger is a low-cost development tool with an easy-to-use interface for programming and debugging Microchip's Flash families of microcontrollers. The full featured Windows® programming interface supports baseline (PIC10F, PIC12F5xx, PIC16F5xx), midrange (PIC12F6xx, PIC16F), PIC18F, PIC24, dsPIC30, dsPIC33, and PIC32 families of 8-bit, 16-bit, and 32-bit microcontrollers, and many Microchip Serial EEPROM products. With Microchip's powerful MPLAB Integrated Development Environment (IDE) the PICkit™ 2 enables in-circuit debugging on most PIC® microcontrollers. In-Circuit-Debugging runs, halts and single steps the program while the PIC microcontroller is embedded in the application. When halted at a breakpoint, the file registers can be examined and modified.

The PICkit 2 introduced in May 2005 replaced the PICkit 1. The most notable difference between the two is that the PICkit 2 has a separate programmer/debugger unit which plugs into the board carrying the chip to be programmed, whereas the PICkit 1 was a single unit. This makes it possible to use the programmer with a custom circuit board via an In Circuit Serial Programming (ICSP) header. This feature is not intended[3] for so-called "production" programming, however the PICkit 2 uses an internal PIC18F2550 with Full Speed USB. The latest PICkit 2 firmware allows the user to program and debug most of the 8 and 16 bit PIC micro and dsPIC members of the Microchip product line.

The PICkit 2 is open to the public, including its hardware schematic, firmware source code (in C language) and application programs (in C# language). End users and third parties can easily modify both the hardware and software for enhanced features. e.g. GNU/Linux version of PIC Kit 2 application software, DOS style CMD support, etc. The PICkit 2 has a programmer-to-go (PTG) feature, which can download the hex file and programming instructions into on-board memory (128K byte I2C EEPROM or 256K byte I2C EEPROM), so that no PC is required at the end application.

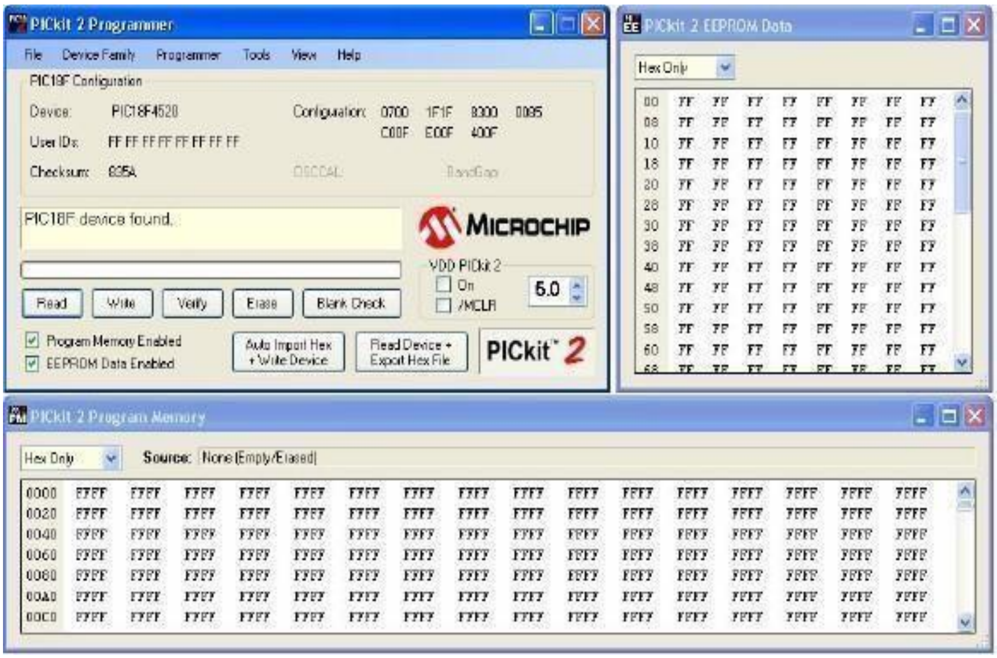


Fig. 6.2 PIC KIT 2

The Microchip version of PICkit 2 has a standard 128K byte memory. 256K byte memory can be achieved by modifying the hardware or from third party. Additionally, a 500 kHz three-channel logic analyzer and a UART tool is built into the PICKit 2. These features are missing from the PICkit 3. Since releaseof V2.61, PICkit 2 PC software now support maximum 4M bytes of memory for programmer-to-go feature. This modification makes the PICKit 2 support 8x more memory than the PICKit 3. This enhancement has been contributed by Au Group Electronics and the PICkit 2 firmware is also reported to be submitted to Microchip PICkit 2 team in the middle of March 2009. Hopefully this enhancement will be integrated into future firmware releases too. Thus, it is shown in the above Fig.6.2.

CHAPTER 7

RESULT AND DISCUSSION

FPGA is a 140 Pin DIP pack IC with 33 I/O pins. Out of which 8 pins can be used either as Digital I/O pins or Analog Input pins. The micro controller is having 5 ports Port A, Port B, Port C, Port D and Port E. Here Port A consists of 6Pins andcan be used as Analog Pins and Digital Pins, in the same way Port E consists of 3 Pins all of them can either be used as Analog Pins or Digital Pins. The Port pinsof Port D are connected to LED pins. RD4 to RD7 as data pins and RD0 to RD2 as control pins. The Pins of Port B are connected to relay drivers, which in turn drives the relays. The Pins 13 and 14 are connected to Oscillators. This Oscillator provides required clock reference for the FPGA. Either Pins 11 and 12 or 31 and32 can be used as power supply pins. Pins 25 and 26 of Port C are used for serial Port communications; these pins are interfaced with MAX232 for PC based communications. Pins 37,38,39 and 40 are used for In-Circuit Debugger Operations, with which the hex code is downloaded to the Chip. Pin 33 is used asexternal Interrupt Pin. Pin 1 is used as Reset Pin. This Pin is connected to Vcc through a resistor.

A relay is an electrically operated switch. Current flowing through the coil of therelay creates a magnetic field, which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. For example, a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical. here in our project the relays are connected to the micro controller through ULN 2003 relay driver IC. The input from the micro controller is 5V and the output form the ULN is 12V. this output is used to drive the relay. The output is fed to the coil supply of the relay. The ULN IC has 7 input Pins 1- 7. The output is taken from Pins 9-15. The ULN consists of Darlington arrays. Here in our project the micro controller pins are connected to ULN through Pins.

Using these RF transmitter & receiver circuits with a Micro controller would be simple. We can simply replace the switches used for selecting data on the HT- 12E with the output pins of the micro controller. Also, we can use another output pin to select TE, or transmit enable on the HT-12E. By taking pin-14 LOW we cause the transmitter section to transmit the data on pins 10-13. To receive information simply hooks up the HT-12D output pins to the micro controller. TheVT, or valid transmission pin of the HT-12D could signal the micro controller to grab the 4-bits of data from the data output pins. The HT-12D data output pins will LATCH and remain in this state until another valid transmission is received. Each of the Holtek chips have resistors attached to pins 15 and 16. These resistors must be the exact values shown in the schematic. These resistors set the internal oscillators of the HT-12E/HT-12D. It is recommended that we can choose a 1% resistor for each of these resistors to ensure the correct circuit oscillation.

RELAY is a static switching device in most of the DC based applications. The RELAY has 3 pins named Source, Drain and Gate. As long as the Gate Pin is applied with a Positive voltage of above 3V, the voltage applied to the source will be available to drain. If the Gate is cut, then the drain will be Cut-off from Source. With this we can able to increase or decrease the mean voltage available at the load end. The RELAY’s Gate is applied from the CCP1 pin of the PIC micro controller. This pin is configured as the PWM output. We can set the frequency by configuring the timer2 of the PIC controller. By varying the duty cycle of the output, we can vary the mean voltage in the load end.

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/15-0-15v is used to perform the step-down operation where a 230V AC appears as 15V AC across the secondary winding. In the power supply unit, rectification is normally achieved using a solid-state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow. A commonly used circuit for supplying large amounts of DC power is the bridge rectifier. A bridge rectifier of four diodes (4*IN4007) is used to achieve full wave rectification. Two diodes will conduct during the negative cycle and the other two will conduct during the positive half cycle. The DC voltage appearing across the output terminals of the bridge rectifier will be somewhat less than 90% of the applied RMS value. Filter circuits, which is usually capacitor acting as a surge arrester always follow the rectifier unit. It is used not only to ‘short’ the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output. The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output. IC7812 and 7805 are used in this project for providing +12v and +5v DC supply.

CHAPTER 8

CONCLUSION AND FUTUTE WORK

Using this proposed technology, it gives a helping hand to our security forces in detection of intruders. This robotic system can also be used in high altitude areas where it is difficult for humans to survive as some of our border areas fall into high altitude areas. The proposed robotic system can also be used in finding the injured persons during disasters such as earthquakes, collapsing of building and also in the mining fields and it can be used as a spy robot. The surveillance robot was designed with PIC microcontroller using embedded platform. It monitors and secure a place from the adversaries which can be done by surveillance robot all the times with great accuracy and high precision. An IP camera is used which continuously monitors the place and sends the information to the control station. The Servo motor used provides the movement of robot with greater speed control compared to the conventional method. The future scope of the project has many openings that could be continued for various future applications in monitoring and controlling etc., This robot can also be used in time of environmental disasters where the robot detects whether a human is present alive in that area. Domestic applications like home security can also be implemented using this methodology.

REFERENCES

1. Aishwarya Patil, (2013) “Haptic Robotic Arm Using Voice and Gesture Recognition”: International Journal of Advanced Research in Computer and Communication Engineering, volume 2, issue 3.

2. Ankita Patel, (2014) “Touch Screen Controlled Multi-purpose Spy Robot Using Zigbee”: International Journal of Advanced Research in Computer Engineering and Technology (IJARCET) ,volume 3, issue 4.

3. Dhiraj Sing Patel, (2013) “Mobile Operated Spy Robot” :International Journal of Emerging Technology and Advance Engineering, volume 3, special issue 2.

4. Dr. Meenakshi, (2014) “Vision Based Robotics System for Military Application- Design Real Time Validation”: Fifth International Conference on Signal and Image Processing .

5. Dr. S. Bhargavi, (2011) “Design of an Intelligent Combat Robot for War Field” International Journal of Advance Computer Science and Application, volume 2, no.8.

6. Dr. Shantanu K. Dixit, (2014) "Design and Implementation of e-surveillance Robot for Video Monitoring and Living Body Detection": International Journal of Scientific and Research Publication, volume 4, issue 4, ISSN 2250 3153.

7. I.E.M.D. Goonethileke, (2012) "Wireless RF Based Surveillance Robot Controlled via Computer" :volume 7.

8. Kalyanee N. Kapadnis et al (2014) "RF Based Spy Robot" Int. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 4(Version 2), pp.06-09.

9. Pratush G. (2013) "GSM Controlled Topple Resistant Spy Robot" : IEEE Transaction 2013 no-978-0- 7695_5146-3/13.

10. Sweta N, (2013) "Design and Implementation of Accelerometer Based Robot Motion and Speed Control with Obstacle Detection": International Journal of Science Engineering and Technology Research, volume 2.