

OBJECT FOLLOWING AUTONOMOUS ROBOT

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439

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We would like to express our appreciation and thanks to all those who gave us the opportunity to complete this project. We would like to thank the National Robotics Competition for giving us the permission to initiate the project in the first instigation, to do the mandatory work and to use department stuff.

We are deeply obliged to our Advisors Dr. Ali Nasir, Engr. Arslan Arif and Col. Sikander Qayyum whose assistance, suggestions and encouragement helped in all time of project making and thesis writing.

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A special appreciation to the rest of Lab staff, that helped us in our project. The whole department really brought us together to appreciate the true sense of friendship and respect to each other.

Last but not least we would like to express our deepest appreciation to our families that supported us in every step of life.

PREFACE

As per the requirement criteria of MS Project Management degree program in Bahria University, We have learnt various PM tools and techniques and performed practically implementation. So, to record my efforts, I am providing a comprehensive report consists of two segments.

My project is to manufacture a robot "OBJECT FOLLOWING AUTONOMOUS ROBOT" for national robotics competition using Primavera P6, a modern world software to implement the best PM Practices dictated by PMI. Primavera is enterprise project management software. It involves project management, product management, collaboration and control abilities and integrated with the other enterprise software such as Oracle and SAP's ERP systems. Report involves the brief history and introduction of the project, context in which project was carried. Report also involves the necessary data supporting the literature, conclusions and recommendations which are being rendered after having work on Primavera and understanding the issues with latest features that was realized during working on Primavera.

In this report Various reports are generated during this project. The reports are graphically displayed with the help of Primavera.

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Chapter 1

Introduction

For human-robot interaction, the robot needs to focus on the same desired targets that the human wants. This project is about building an autonomous mobile robot which will follow its target on the basis of the readings coming from the sensors employed in it. The robot follows the movement of any detectable object that is in its range.

An object following robot need to sense its environment in order to find its target that is in its specified range and follow its movement. This technique can also be adopted for automated guided vehicles when it comes to track any object. Generally our robot is integrated with the microprocessor for controlling its actions. It also makes use of a position feedback system for travelling in the desired path. This feedback system employs an IMU and a set of ultrasonic sensors.

1.1 Background

Nowadays mobile robots are becoming more and more common in our lives. They have made special importance in the industry sector. One of the very successful examples of an industrial mobile robot is a warehouse robot.



Figure 1.1 Kiva Warehouse Robots

A warehouse robot perform several actions including moving the whole racks f goods from one place to another. In order to perform these functions these robots follow predefined paths. The one shown above is a warehouse robot, specifically known as *kiva*, working in the Amazon's warehouse. Another example of autonomous robots is the *Google Car*, which can drive automatically and have the abilities like obstacle avoidance and automatic parking.

Any kind of mobile robot that is being made has to solve three common problems, which are *Localization*, *Mapping* and *Path Planning*. Once these problems are solved the robot is successful otherwise it's a failure. The robot must know where it is (localization), must have a sketch of its surrounding (mapping) and should know the path to be followed (path planning). Obviously the path planning can only be done if the robot have a sound information about its surrounding.

1.2 PROJECT CHARTER

General Project Information

Project Name	Object Following Autonomous Robot
Project Manager	Saad Saeed
Sponsor	National Robotics Competition
Email Address	saad_saeed@ucp.edu.pk
Phone Number	92-314-3983001
Organizational Unit	Manufacturing
Area Of Focus	Object Following Robot
Expected Start Date	01/08/2018
Expected Completion Date	January 1, 2019
Estimated Costs	40000Rs
Estimated ROI	\$0

Describe the background, goals, objectives, and deliverables of this project

Buisness Case	Build an object following robot for the National Robotics competition which will follow the object placed in fron of its sensor .
Buisness Impact	New Technology will be introduce in market which can facilitate industry environment .
Scope	Object Following Robot
Expected Deliverables	Finalized Budget , Finalized Job Desription , Team On Board , Object Following robot
Risk Plannig	R & D of Structural Design of Object Following Autonomous Robot so that it be abl;e to track and follow every object placed in front of it.

Team Member

Name	Function
Saad Saeed	Team Lead
M.Rumman Khan	R & D Officer
Umer Khan	Mechanical Engineer
M.Farhan Ali Khan	Electrical Engineer

Define the Project Resources and Costs

Project Investment	40,000/- Rs
Support Resources	Competition Advisors & Co-Advisors , Engineering Lab Instructors

Special Needs	Software coding , Micro-Controller
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Measureable Target	Target Date
Finalize organizational chart	01/08/2018
Finalize & Approve Budget	01/08/2018
R & D	01/09/2018
Team Traning	10/09/2018
Execution	15/09/2018
Testing	01/11/2018

Describe Project Risks	Building an autonomous mobile robot which will follow its target on the basis of the readings coming from the sensors employed in it.
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Risks	• Bugs in coding • Sensor may not be able to sense the object. • Readings Variation from Sensor. • Slow Movement of Robot w.r.t object. • Short Circuit Of Wiring. • Detection between two objects.
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Prepared by:

Date:

1.3 Block diagram

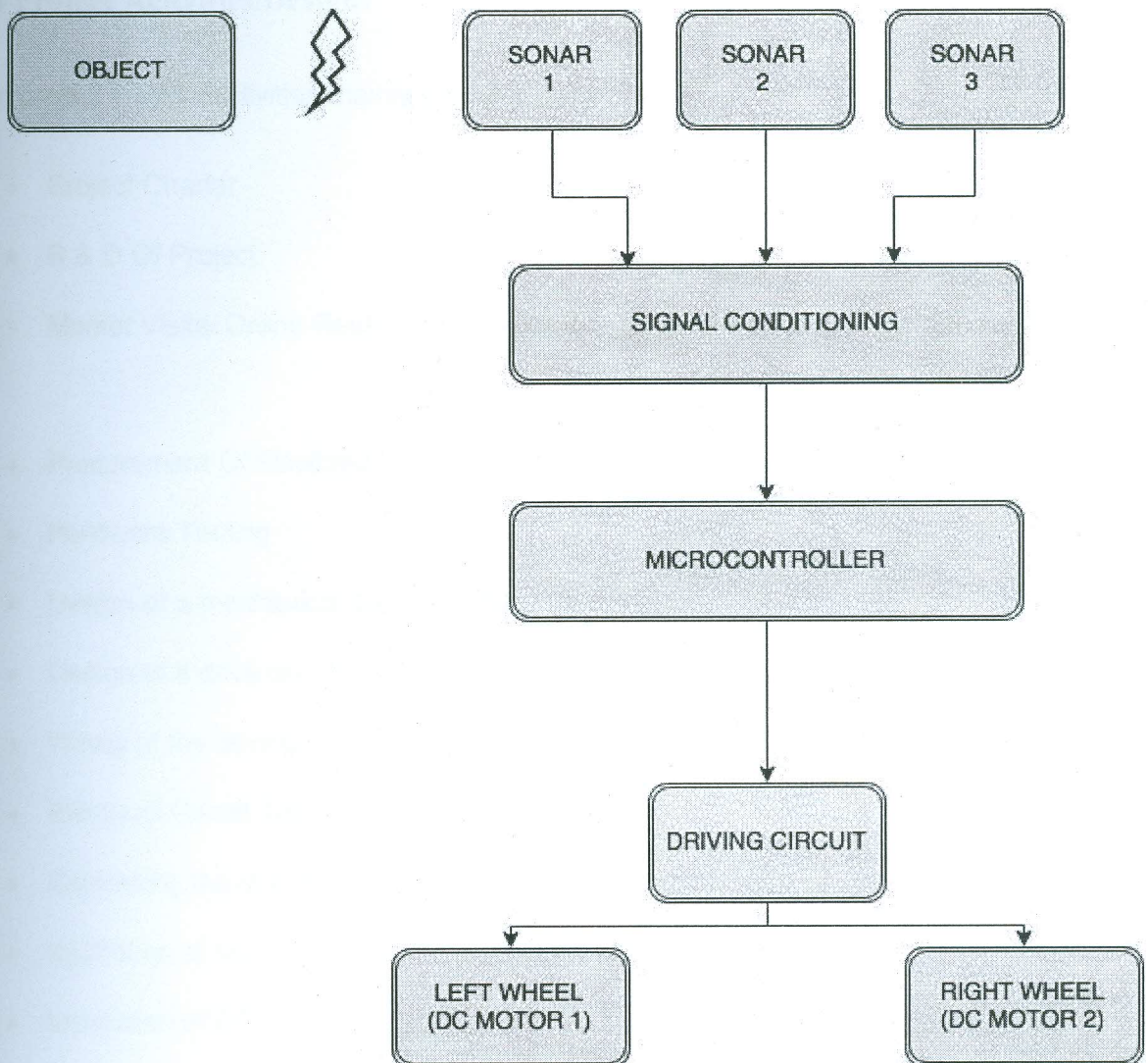


Figure 1.2 Block Diagram

1.4 Project Activities/Design:

The project Design/Activities mainly consists of:

- Project Charter
- R & D Of Project
- Market Visits/ Online Research to check and confirm the availability of required hardware
- Procurement Of Finalized Hardware
- Hardware Testing
- Design of a mechanical base structure for the robot
- Design of a drive circuit for the motors On PCB Board
- Wiring of the driving circuit
- Electrical Circuit Testing
- Controlling the direction of rotation of the motors
- Instillation of Microcontroller Arduino UNO R3
- Instillation of DC motors
- Instillation of Ultrasonic sensors
- Instillation of Motor driving circuits
- Instillation of Regulator
- Interfacing of L293D with DC motors
- Integration of all sensors
- Installation Of Batteries
- Installation of Tires

- Sensors Testing
- Sensors Reading Record
- Software Coding
- Testing of software coding
- Removing bugs from coding
- Aligning Sensors Output with Coding
- Testing of robot with multiple objects
- Final Testing of the Robot and approval from Advisor

1.5 Applications

This project find its application in industrial sector where transfer of goods is required from one place to another. This robot is different from the above described *kiva* robot in a sense that any human can make it follow himself a loaded robot taking goods to the desired location rather than predefined path as in the case of *kiva* robots.

If mounted with a camera it can be used as a surveillance device. It can keep an eye at any specific object under consideration by following its position.

It can also be used as a room robot to move loads from one place to another by following persons. While it finds its applications in military too like following a platoon with their luggage loaded onto the robot.

1.6 Literature Survey

A lot of work has been done in the field of object following robots. A review of previous work by Jesus Pestana ^[1] et al shows a reliable visual based object tracking and following using a cheap GPS-denied multirotor.

Similarly, Kuk Cho presented a paper in which he implemented object tracking with enhanced data association using a 3D range sensor for an unmanned ground vehicle ^[2]. There is another paper presented by IEEE which shows the implementation of object following and obstacle avoidance using a laser scanner in the outdoor mobile robot *Auriga-a* ^[3].

Similarly, Yoshimi T et al developed a person following robot with vision based target detection ^[4]. Their robot can accompany a person using vision based target detection and avoid obstacles with ultrasonic sensors while following the person. Another exceptional work in this field is done by Kobilarov M et al. They have developed a people tracking and following mobile robot using an omnidirectional camera and a laser ^[5].

Chapter 2

Hardware Description

As the name indicate this chapter contains all the details of the hardware that being use in this project. This chapter will cover all of the project hardware and their features. Our project include the following components:

Electrical Components:

- Arduino Board
- Ultrasonic sensors
- DC gear motors
- L293D
- LM7805
- Batteries

Mechanical Components:

- Wheels
- Acrylic sheets
- Metal rods

2.1 Arduino Board

Arduino board is a prototyping platform which uses a microcontroller ATmega328. The Arduino board that we are using in our project is Arduino Uno R3. It consist of the following features:

The user just have to connect it to a computer or turn it on by using a separate dc voltage source.

It requires 7-12v as supply voltage while it works on 5v.

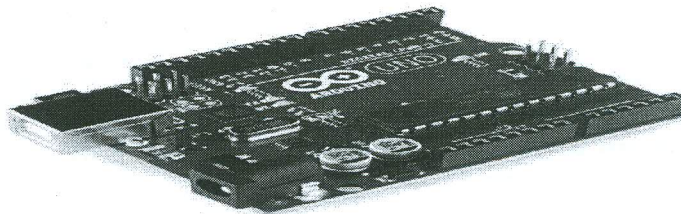


Fig 2.1 Arduino Board

2.2 Ultrasonic Sensor

The ultrasonic sensor that we have used in this project is HC-SR04. This sensor is used to detect objects in its range and send their localization information to the microcontroller where all the decisions are being made on the basis of its information.

This module consist of 4 pins:

- Supply voltage (5v)
- Trigger pulse input
- Echo pulse output
- Ground

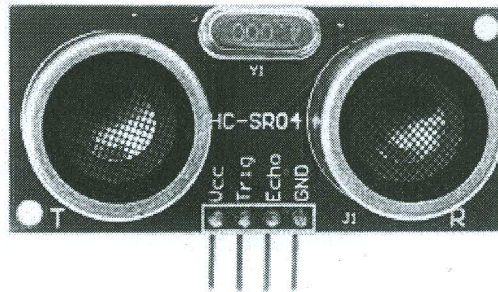


Figure 2.3 Ultrasonic Sensor

This sensor provides up to 5m (app.) non-contact measurement function. The module itself include an ultrasonic transmitter, receiver and a control circuit. The basic working principle:

- Sending a high pulse of at least 10 us at the trigger input
- The module automatically send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo pin
- If the signal comes back, one can calculate the range through the time interval between sending trigger signal and receiving echo signal by the formula:

$$\text{Range} = \text{High level time} * \text{velocity of sound} / 2$$

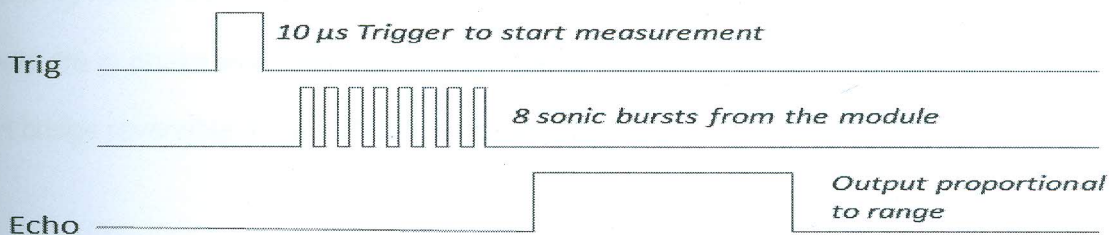


Fig 2.4 Timing Diagram of HC-SR04

2.3 DC motor

Two DC motors are being used in our project. One for the right wheel other for the left wheel. It takes 5v~9v dc supply voltage and draws 100mA~120mA current respectively. RPM is up to 240.

2.4 L293D

L293D is a quadruple high current Half H Bridge driver. This IC is being used in our project I order to drive two dc motors in both directions. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

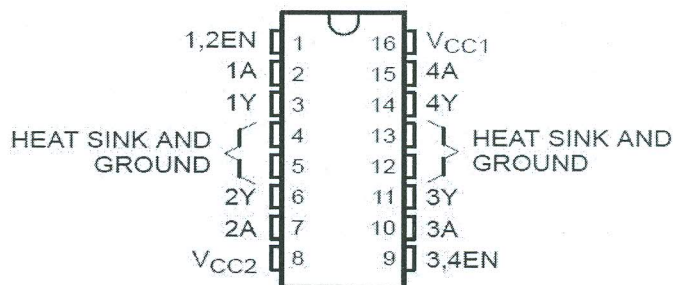


Fig 2.5 L293d (Top View)

In this IC drivers are enabled I pairs driver 1 and 2 are enabled by 1,2EN and drivers 3,4 are enabled by 3,4EN. Whenever an enable input is high the respected drivers are enabled and their outputs are in phase with their inputs. With the proper data inputs, each pair of drivers forms a full-H bridge reversible drive suitable for motor applications.

2.5 Voltage Regulator (LM7805)

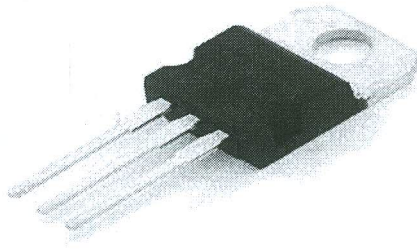


Figure 2.6 LM7805

A regulator is being used in the robot to convert the supply voltage to 5 volts. This regulated voltage was fed to IC's and wherever 5 volts supply needed.

Chapter 3

Software Details

3.1 Arduino

As discussed earlier in chapter 2, we have used an Arduino board for the purpose of programming. In order to access the Arduino board there comes a software program that interacts with the arduino environment. This software allows the programmer to manipulate the input/output ports of the Arduino. One can tell the Arduino what to do by writing code in Arduino programming language i.e. C/C++.

For the physical connection between the Arduino board and the PC we use a standard USB data cable (A plug to B plug).

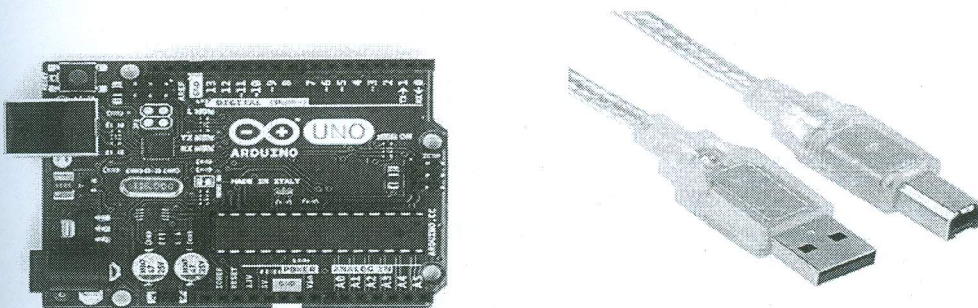


Figure 3.1 Arduino board & USB Cable

3.1.1 Description

Detection mode:

In detection mode the microcontroller trigger all the sensors at the same time with specific time interval. The program gathers data from the sensors and investigate the presence of an object.

If the object is detected the program enters into the follow mode otherwise it keep looking for the object.

Follow Mode:

Once the object has been detected, the program has to check several conditions. These conditions goes as follows:

In the first step the robot inquires about the location of the object i.e. which sensor detects the object. If the object is detected by the sensor 1 the robot should turn to the right side unless the robot aligns itself with the object i.e. turn such that the object gets in front of sensor 2 (the middle one). After that it would check for the distance between itself and the object. If the distance is greater than the threshold then it will move forward up to the specified distance threshold. Otherwise it will move in reverse direction unless the distance threshold is satisfied.

If the object is detected by the sensor 2, the robot will check for the distance threshold. If the distance is greater than it is specified in the program it will move forward up to the specified distance otherwise move backward to satisfy the condition. Similarly if the object is detected by the sensor 3 the robot should turn to the right side until the robot aligns itself with the object i.e. turn such that the object gets in front of sensor 2. After that it would check for the distance between itself and the object. If the distance is greater than the threshold then it will move forward up to the specified distance. Otherwise it will move in backward direction unless the distance threshold is satisfied.

Now if the object is detected by sensor 1 and sensor 2 the robot should turn right and then move towards the object as described earlier. Similarly if sensor 2 and sensor 3 detects the object at the same time robot should turn left and move towards the object.

There is also a possibility that the sensors 1 and 3 detects the object at the same time. Now here the program will compare the distance value coming from both sensors and follow the nearest object i.e. if the distance from sensor 1 is less than sensor 3 then it will turn right and move towards object otherwise it will turn left and move towards object.

Chapter 4

Integration of Software & Hardware

In this chapter we will be discussing the hardware connections, IC pin configuration and how the software and hardware are interfaced. One of the major part of our project is programming. Both the hardware and software are important to be managed properly and their interfacing with each other is the most essential part. Our software and hardware needs to be compatible to each other for the proper and precise working of the project. Interfacing between all the devices, conversion of signal, transmission of signal, and connections to output circuitry i.e. in short all the hardware is dependent upon its integration with the software. So, through the given description, we have tried to explain how the hardware and software are working together to get the desired output.

4.1 Pin Configuration of Arduino

Figure 4.1 shows the pin configuration of Arduino board.

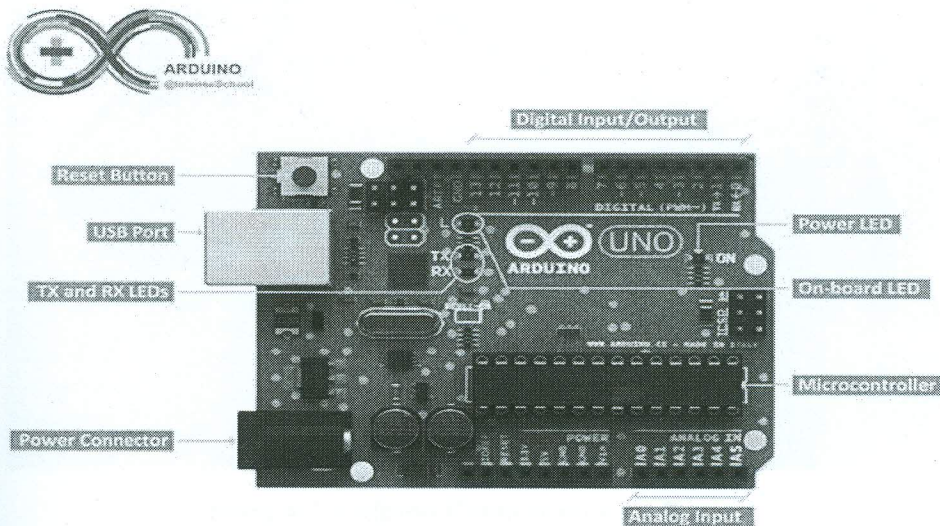


Figure 4.1 Pin Configuration of Arduino

Arduino has 14 digital input/output ports. It also has 6 analog input ports which can also be used as digital I/O ports. We are concerned with the following parts of arduino:

- USB port for loading the code from laptop to the arduino.
- Power connector for external power supply
- Analog input panel to gather the sensors' data.
- Digital I/O ports panel for integration of the hardware with the code.
- Arduino also has a panel of power supplies which includes a 3.3v and a 5v power supply slot.

Arduino is simply connected with the laptop using the USB cable as shown in the figure below. Blinking LED code was burned into the Arduino and tested successfully as illustrated in the previous chapter.

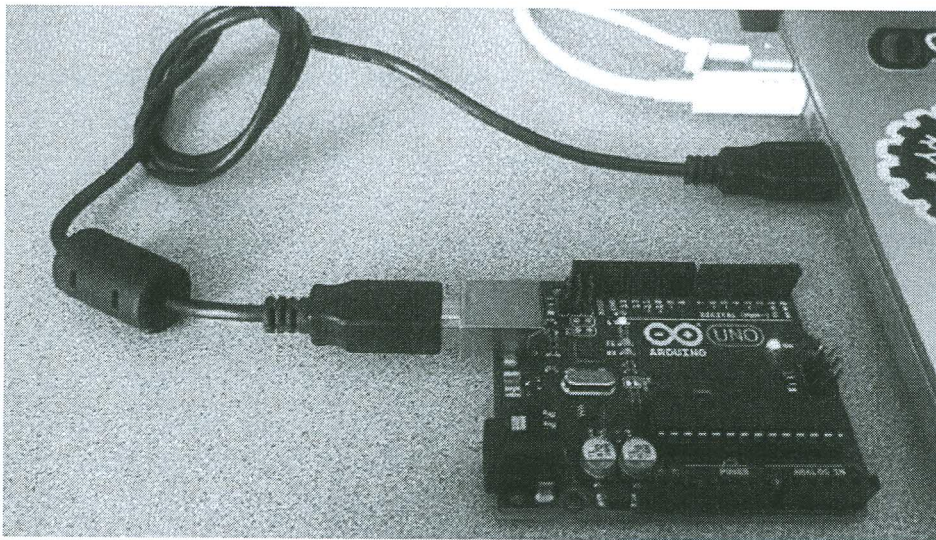


Figure 4.2 Arduino Connection with Laptop

The power LED in green will light up to confirm the connectivity.

4.2 Interfacing of Ultrasonic sensor

The working of the ultrasonic sensor is such that a triggering pulse is applied at the trigger pin to send 8 sonic bursts from the module to start measuring. Meanwhile the echo pin goes high to receive the reflected sound waves if any. In this way we can calculate the distance of the object. This phenomenon is shown in the figure below.

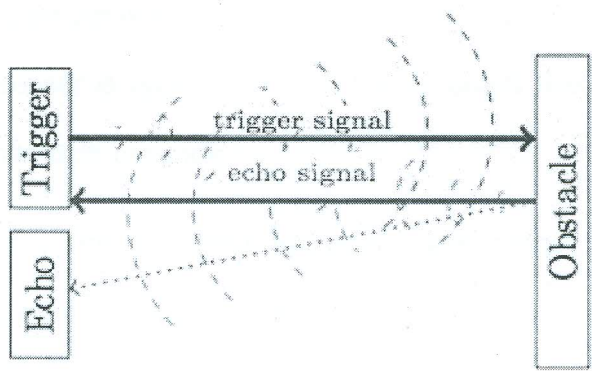


Figure 4.3 Object Detection

The working of this sensor is already been discussed in detail in chapter 2. In this chapter we will focus on its integration with the software.

4.2.2 Connection with Arduino

The figure 4.5 shows the connection of ultrasonic sensor with the arduino board.

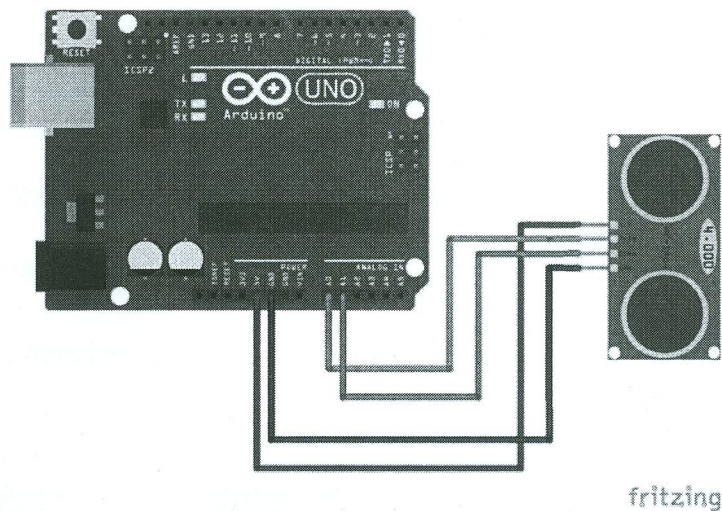


Figure 4.5 Ultrasonic Sensor with Arduino

In the figure above the trigger pin is attached to the analog pin A0 and echo pin is connected to the analog pin A1. The sensor is applied 5v from the on board power supply available at the arduino board and common both grounds.

This is the connection of one sensor. Similar to that we have connected two more sensors with the arduino. The sensor 2 echo and trigger pins connected to analog pins A2 and A3 respectively and similarly sensor 3 echo and trigger pins are connected to analog pins A4 and A5 respectively.

All these sensors are placed at specific angles to have maximum area coverage. Each sensor spread a beam at an angle of 30 degrees. Therefore the side sonars are placed at an angle of 30 degrees with respect to the middle one. The figure below illustrates the placement.

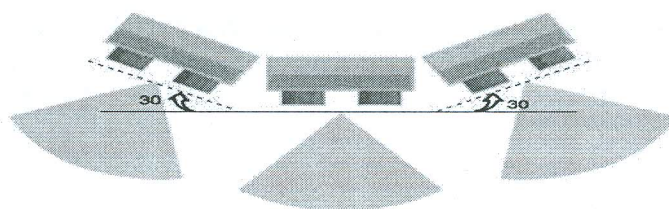


Figure 4.6 Sensor Placement

4.2.3 Integration of all sensors

To make all the three sensors trigger and receive at the same time we have written a program in arduino that make the sensors perform actions simultaneously. This program records the data from all the three sensors at the same time.

The results achieved from the program can be seen in the snapshot below:

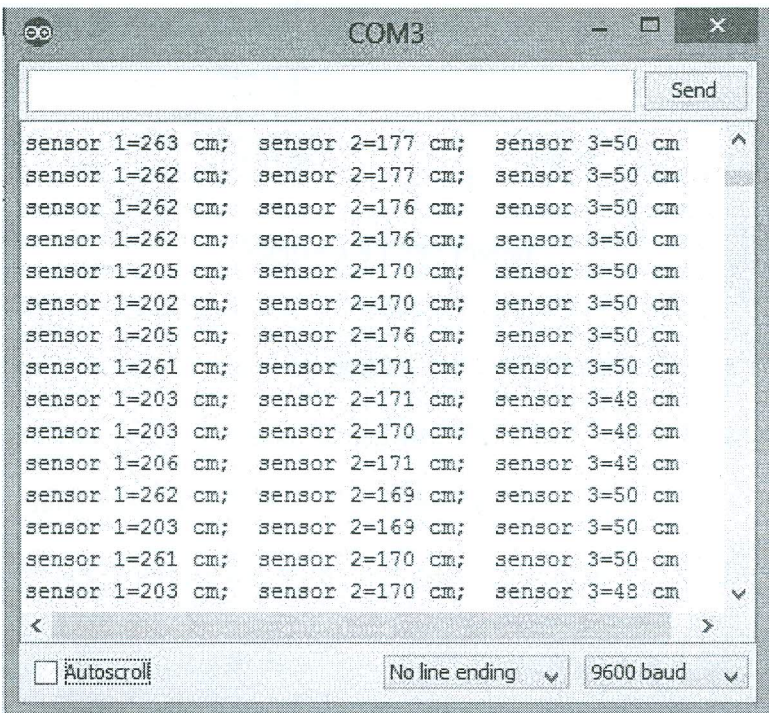


Figure 4.7 Raw data from sensors

These are some raw readings obtained from the three sensors working simultaneously. Sensor 1 is placed at the right side, sensor 2 is the middle one and sensor 3 is placed at the left side. All the sensors are working perfectly.

4.3 Interfacing of L293D with DC motors

L293d is perfect solution for driving two dc gear motors using microcontroller. Let us have a look at its pin configuration in order to understand it in a better way. It can support motors up to the rating of 36v.

4.3.1 Pin Configuration

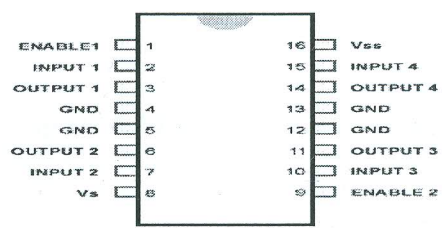


Figure 4.8 L293 Pinout

Enable 1 and enable 2 requires logic 1 to enable the controls of both the motors respectively. Vss is applied 5 positive volts to make IC active. Vs is the supply voltage to the motors, it depends upon the rating of your motor. In our case, we need to apply 9v here. The left half of the IC controls one motor whereas the right have of the IC controls the other motor.

Input 1 and input 2 are the two controls which needs to be connected with the microcontroller, whereas output 1 and output 2 are the two terminals of the motor 1. Similarly on the right hand side, input 3 and input 4 are the two controls which needs to be connected with the microcontroller, whereas output 3 and output 4 are the two terminals of the motor 2.

4.3.2 Connection with arduino

The figure below shows the connection of the IC with the arduino board.

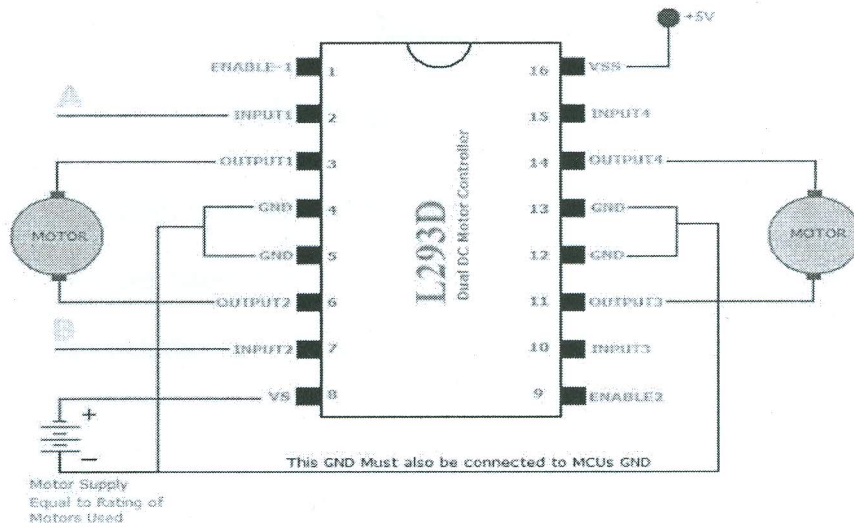


Figure 4.9 L293d with DC motors

In the figure above the terminals of input 1,2,3 and 4 leads to the microcontroller digital pins. From where we can control the direction of the motors. As it can be seen motor supply is connected with the IC and 5 volts are applied externally to the IC.

Chapter 5

Testing and Results

Testing of every component is very important. This chapter includes details of testing of each and every component we used in our project and it will also illustrate the procedure of a successful test. It also includes compilation of results which will conclude our testing.

5.1 Testing of Arduino

Testing of arduino can be done by performing the following steps:

- Connect the arduino with the laptop using the USB cable.
- Check if the power LED of the arduino is on or not. If it is there is no connectivity issue.
- Open the software (Arduino 1.0.5) in the laptop and burn an example code in it.
- We perform the blink test on the arduino and the LED was blinking as it should.
- So we had a successful testing.

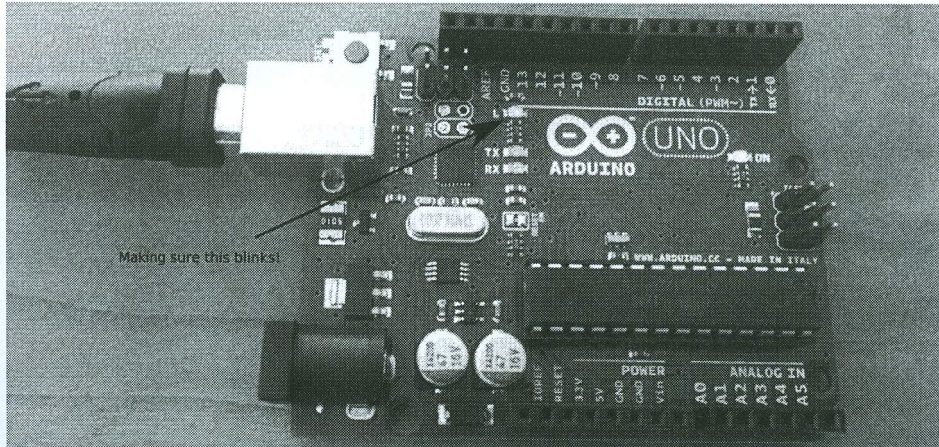


Figure 5.1 Blink Test

Result: The LED starts blinking.

5.2 Testing Ultrasonic Sensor

The testing of ultrasonic sensor includes:

- Connectivity test
- Range test
- Sensitivity test

First of all we connected the sensor to the arduino. After that we burned the test code into the arduino. Then we make an arrangement like the one shown in the figure below with the help of a ruler and record different readings.

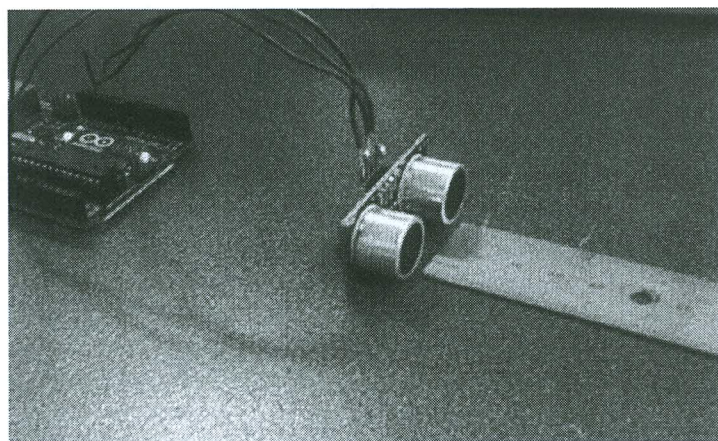


Figure 5.2 (a) Sensor Testing

We fixed the distance of the object and varied the angle of the object with respect to the sensor.

The implementation of this test can be illustrated with the help of the figure below.

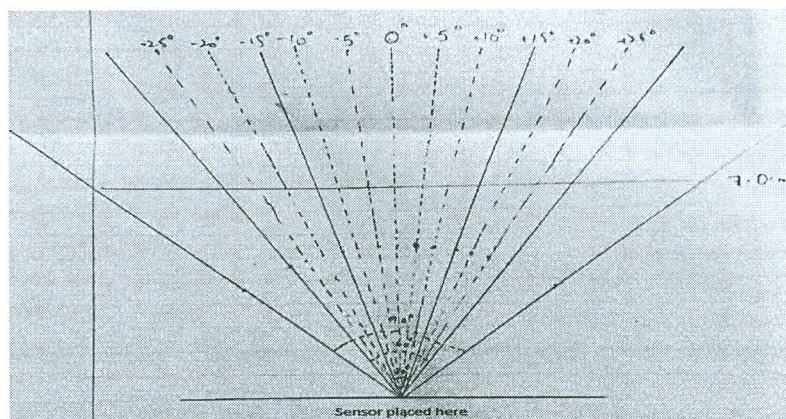


Figure 5.2 (b) Sensor Testing

The object was placed at the 7cm line drawn in figure above and displaced along that line to vary the angle with respect to the sensor.

The observations we get are as follows:

Deviation angle of object (degrees)	Actual distance of object (cm)	Measured distance (cm)
+25	7 cm	8.16 cm
+20	7 cm	7.5 cm
+15	7 cm	7.09 cm
+10	7 cm	7.02 cm
+5	7 cm	6.93 cm
0	7 cm	6.98 cm
-5	7 cm	6.99 cm
-10	7 cm	7.04 cm
-15	7 cm	7.1 cm
-20	7 cm	7.5 cm
-25	7 cm	8.28 cm

Table 5.1 Observation Table

Result: The conclusion we have drawn from these test is that the ultrasonic sensor has best measurement results within 30 degrees of its beam. Beyond this range the measurement drastically changes which can cause error.

Range Test:As far as range is concerned we have successfully measured the range of 449 cm which is approximately 4.5 meters. It can be seen in the snapshot of the range test given below that sensor 2 is successfully measuring 449 cm.

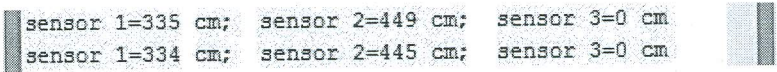


Figure 5.3 Range Test

Sensitivity Test:The sensitivity of the sensor can be increased or decreased by varying the time delay between the trigger pulses. We have set time delay to be 15ms. This time delay makes

the sensor to get optimized measurement with very much appreciable sensitivity without missing any measurements.

5.3 Testing of DC Gear Motors

The DC gear motors that we have used in our project operates at 5~9v. We have applied 9v. At no load motor draws current about 100mA. The motor responds quickly to any changes in signal. Also the current was easily controllable when the load is applied hence it was a successful test.

5.4 Testing of L293d

L293d was connected with the motors and arduino as illustrated in the previous chapter. After the done with the connections we uploaded a simple test code which moves the car forward for one second and then rotate it around itself for two seconds.

Result: The test was successful as the robot moves in the same manner as it was expected to.

This test confirmed that the IC and motors are working fine.

5.5 Testing of LM7805

The voltage regulator was tested in the following manner:

- Power supply i.e., 9V was applied to its first terminal
- Second terminal was grounded
- The output was taken from the third terminal.

Result: 5v were present at the output terminal.

Chapter 6

Primavera

The standard for the administration of elite project Primavera P6 Professional Project Management, handles huge scale, exceedingly complex and multifaceted projects. Sort out activities of up to 100,000 exercises with unlimited number of resources.

6.1 LOGICAL RELATIONSHIP B/W ACTIVITIES USED IN THIS PROJECT

Finish to start relationship is applied In this project because most of the activities are dependent upon successor activities.

6.2 RESOURCES USED IN CURRENT PROJECT

Below are some of the resources which are used for current project but not limited to these.

6.3 WBS LEVELS.

WBS structured network provides us framework for scheduling, budgeting, measuring and reporting a project status and the performance. It's importance is that Project Manager is well aware of high and low levels of WB. The WBS gives us a roadmap to plan Project. A WBS also provides us summary level check list of activities that needs to be completed.

6.4 WBS MILESTONE PERCENT COMPLETE

This option can be selected form the WBS and it's measurement is based on completion of the WBS elements weighted milestones.

6.5 S CURVE

S- Curve is used to show cost, man hour, units w.r.t time in the form of a plot.

6.6 IF ANALYSIS OF CURRENT PROJECT

If an analysis compares two projects and their influence on both projects

6.7 CALENDAR SETTING

Customize Calendar settings are applied for this project. Calendar is designed at global level as well as project level to fulfil all the requirements.

Resources

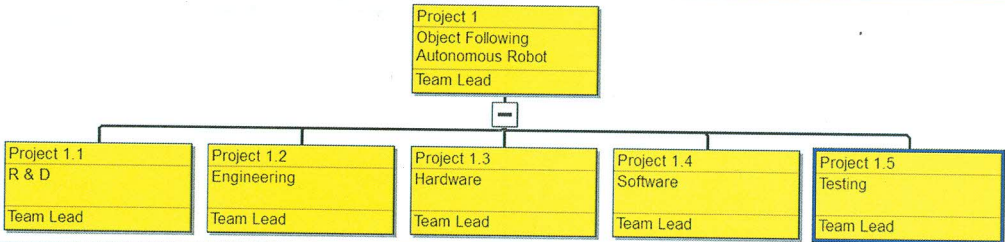
Resources

Activities WBS Reports Resources Projects

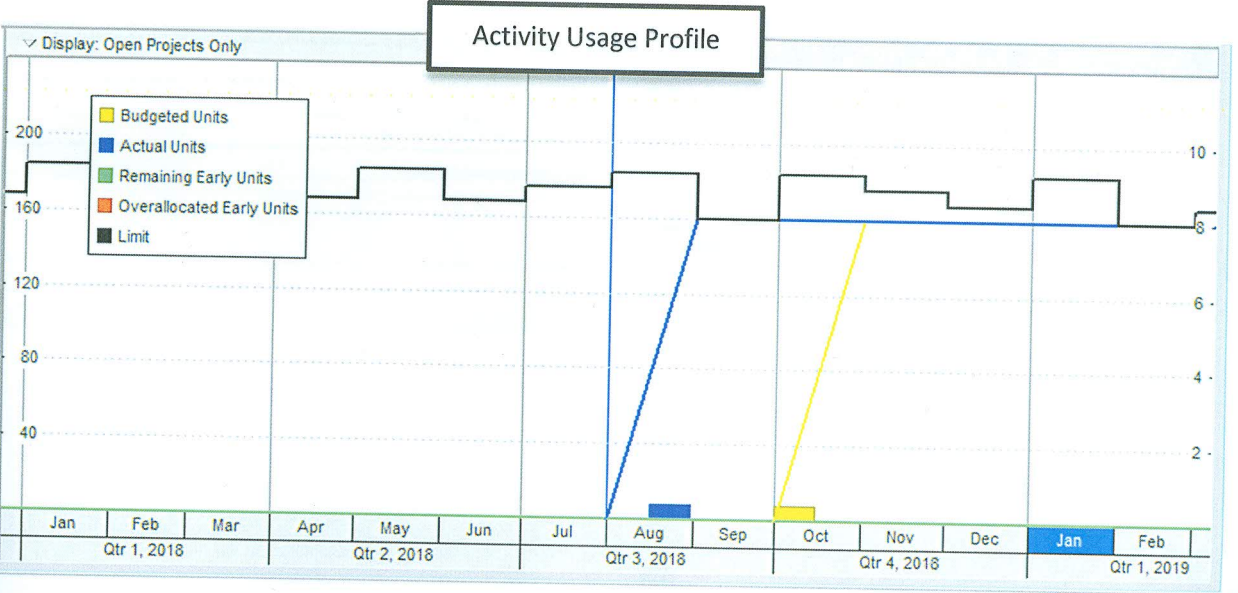
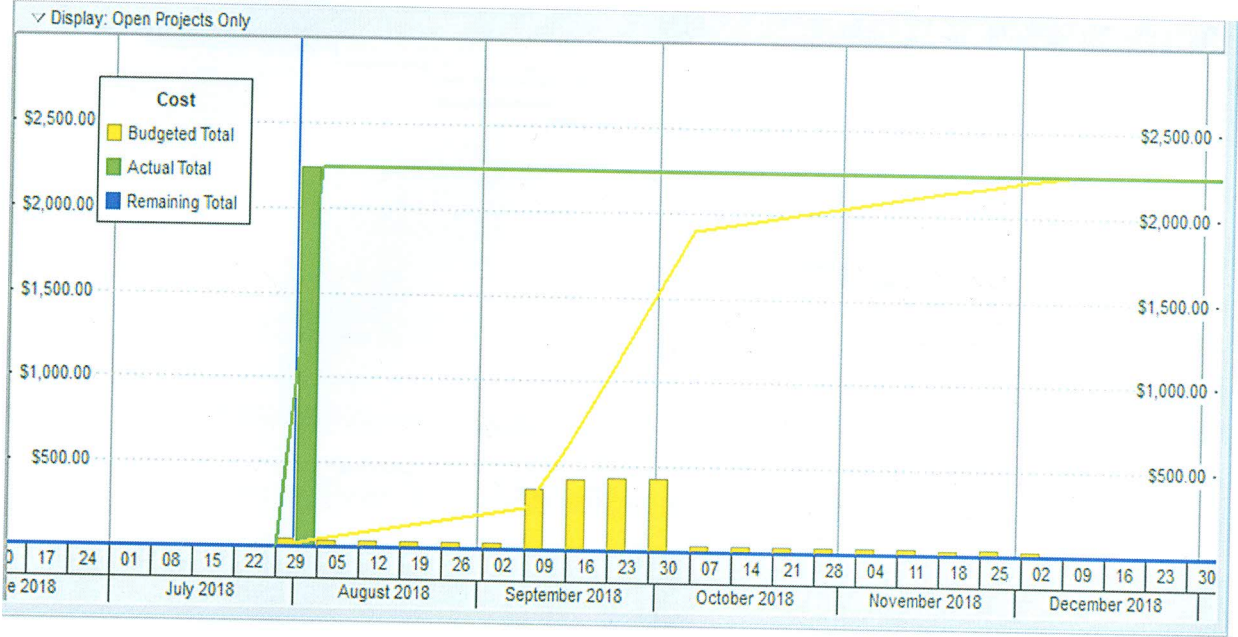
▼ Display: Current Project's Resources						
Resource ID	Resource Name	Resource Type	Unit of Measure	Primary Role		Default Units / Time
Software Engineer	Rumman Khan	Labor				8/d
Mechanical Engineer	Umer Khan	Labor				8/d
Electrical Engineer	Faihan Ali Khan	Labor				8/d
Team Lead	Saad Saeed	Labor				8/d
Micro Controller	Aurdino	Material				8/d
Regulator	L293D	Material				8/d
Motors	DC	Material				8/d
Wiring	Electrical Wires	Material				8/d
Sensor	UltraSonic Sensor	Material				8/d
VoltageRegulator	LM7805	Material				8/d
Batteries	DC Batteries	Material				8/d
Tires	base tires	Material				8/d

WBS

▼ Layout WBS

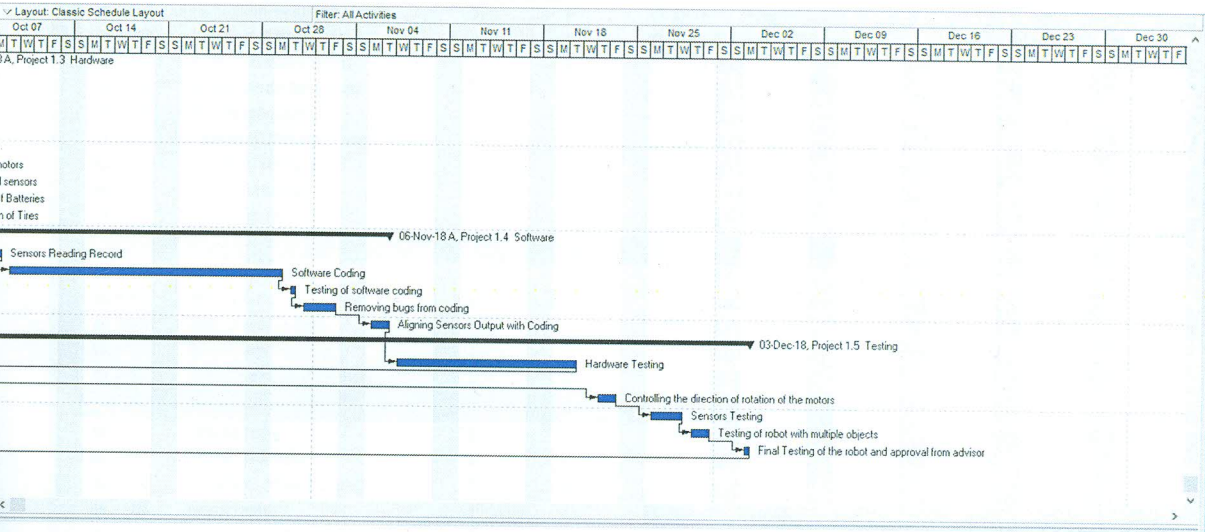
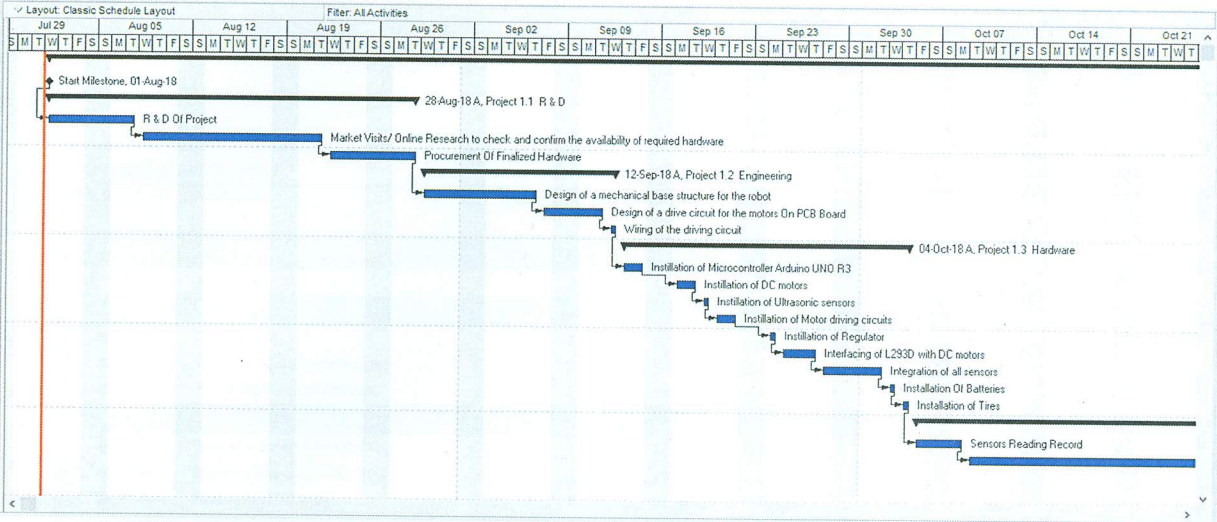


S CURVE



Resource Usage Profile

Gantt Chart



Baseline Schedules

Object Following Autonomous Robot		Classic Schedule Layout					22-Jan-19 14:28	
Activity ID	Activity Name	Original Dura	Remaining Dura	Schedule Comple	Start	Finish	Total Fk	
Project 1 Object Following Autonomc		85	0	0%	01-Aug-18	03-Dec-18	100	
A1230	Start Milestone	0	0	0%	01-Aug-18		100	
Project 1.1 R & D		20	0	0%	01-Aug-18	28-Aug-18		
A1210	R & D Of Project	5	0	0%	01-Aug-18	07-Aug-18		
A1200	Market Visits/ Online Research to chec	10	0	0%	08-Aug-18	21-Aug-18		
A1190	Procurement Of Finalized Hardware	5	0	0%	22-Aug-18	28-Aug-18		
Project 1.2 Engineering		11	0	0%	29-Aug-18	12-Sep-18		
A1170	Design of a mechanical base structure	7	0	0%	29-Aug-18	08-Sep-18		
A1160	Design of a drive circuit for the motors	3	0	0%	07-Sep-18	11-Sep-18		
A1150	Wiring of the driving circuit	1	0	0%	12-Sep-18	12-Sep-18		
Project 1.3 Hardware		16	0	0%	13-Sep-18	04-Oct-18		
A1120	Instillation of Microcontroller Arduino UI	2	0	0%	13-Sep-18	14-Sep-18		
A1110	Instillation of DC motors	2	0	0%	17-Sep-18	18-Sep-18		
A1100	Instillation of Ultrasonic sensors	1	0	0%	19-Sep-18	19-Sep-18		
A1090	Instillation of Motor driving circuits	2	0	0%	20-Sep-18	21-Sep-18		
A1080	Instillation of Regulator	1	0	0%	24-Sep-18	24-Sep-18		
A1070	Interfacing of L293D with DC motors	3	0	0%	25-Sep-18	27-Sep-18		
A1060	Integration of all sensors	3	0	0%	28-Sep-18	02-Oct-18		
A1050	Installation Of Batteries	1	0	0%	03-Oct-18	03-Oct-18		
A1040	Installation of Tires	1	0	0%	04-Oct-18	04-Oct-18		
Project 1.4 Software		23	0	0%	05-Oct-18	06-Nov-18		
A1020	Sensors Reading Record	2	0	0%	05-Oct-18	08-Oct-18		
A1010	Software Coding	15	0	0%	09-Oct-18	29-Oct-18		
A1004	Testing of software coding	1	0	0%	30-Oct-18	30-Oct-18		
A1003	Removing bugs from coding	3	0	0%	31-Oct-18	02-Nov-18		
A1002	Aligning Sensors Output with Coding	2	0	0%	05-Nov-18	06-Nov-18		
Project 1.5 Testing		85	0	0%	01-Aug-18	03-Dec-18	100	
A1180	Hardware Testing	10	0	0%	07-Nov-18	20-Nov-18		
A1140	Electrical Circuit Testing	1	0	0%	01-Aug-18	01-Aug-18		
A1130	Controlling the direction of rotation of ti	2	0	0%	22-Nov-18	23-Nov-18		
A1030	Sensors Testing	3	0	0%	26-Nov-18	28-Nov-18		
A1001	Testing of robot with multiple objects	2	0	0%	28-Nov-18	30-Nov-18		
A1000	Final Testing of the robot and approval	1	0	0%	03-Dec-18	03-Dec-18		
A1	End Milestone	0	0	0%		01-Aug-18	100	
		Page 1 of 1					TASK filter: All Activities	
							© Orade Corporation	

Chapter 7

Conclusion and Recommendations

7.1 Conclusion

In this project we have designed a prototype of highly demanded industrial robot. This robot is capable of following any object or person. The precise design of the robot allows it to cover maximum area for searching for the object. The DC gear motors were utilized for perfect locomotion of the robot. The ultrasonic sensors worked really well and are the backbone of the project. The batteries used, have been tested under full load conditions and are capable of supplying enough power to the robot to perform all its actions. The robot chassis is smart enough to reach most of the places without any disturbance. All the testing and operation performed on the robot went successful.

7.2 Future Recommendations

First of all the design of the chassis can be improved. It can be made lighter and the motors experience less torque so that the speed of the robot may be increased. The power consumption can be reduced by making a more optimized circuit.

Secondly and most importantly it can be transformed into a surveillance robot if the robot is equipped with a wifi camera. This type of robot will not only follow the object or person but also provide us the visuals wirelessly.

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