Water Rescue Robot

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Developer's Submission

"This report is being submitted to the Department of Electrical Engineering of the National University of Computer and Emerging Sciences in partial fulfillment of the requirements for the degree of BS in Electrical Engineering"

Developer's Declaration

"We take full responsibility of the project work conducted during the Final Year Project (FYP) titled **"Water Rescue Robot".** We solemnly declare that the project work presented in the FYP report is done solely by us with no significant help from any other person; however, small help wherever taken is duly acknowledged. We have also written the complete FYP report by ourselves. Moreover, we have not presented this FYP (or substantially similar project work) or any part of the thesis previously to any other degree awarding institution within Pakistan or abroad.

We understand that the management of Department of Electrical Engineering of National University of Computer and Emerging Sciences has a zero-tolerance policy towards plagiarism. Therefore, we as an author of the above-mentioned FYP report solemnly declare that no portion of our report has been plagiarized and any material used in the report from other sources is properly referenced. Moreover, the report does not contain any literal citing of more than 70 words (total) even by giving a reference unless we have obtained the written permission of the publisher to do so. Furthermore, the work presented in the report is our own work and we have positively cited the related work of the other projects by clearly differentiating our work from their relevant work.

We further understand that if we are found guilty of any form of plagiarism in our FYP report even after our graduation, the University reserves the right to withdraw our BS degree. Moreover, the University will also have the right to publish our names on its website that keeps a record of the students who committed plagiarism in their FYP reports."

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Dated: __________

Abstract

Water related emergencies pose significant risks to human lives, necessitating the development of innovative technologies for efficient and timely rescue operations. The current modes of rescue are ineffective and time taking when it comes to rescuing a drowning person. We have designed a water rescue robot to overcome this issue. The primary objective of this robot is to enhance the capabilities of rescue teams by providing an effective and reliable solution for water based emergency scenarios. The design, development, and performance evaluation of this robot highlight its potential as a valuable tool in safeguarding lives during water related emergencies, providing a reliable and adaptable solution for rescue teams worldwide.

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Chapter 1 Introduction

Water bodies can be quite dangerous for humans and getting help to a drowning person can be really challenging at times. Drowning is the 3rd leading cause of unintentional injury death worldwide. Water is capable of sweeping people off their feet due to its high pressure. The water needs to be only 6 inches high for it to cause destruction. Many people are sometimes unable to get timely help and cannot be rescued due to the ineffective modes of rescue operations. Even strong swimmers can find themselves in distress due to factors like sudden changes in water depth or exhaustion. Moreover, certain areas of water bodies may be inaccessible or hazardous for human rescuers to navigate. Under such conditions, saving the drowning people becomes a serious challenge for everyone. Having a water rescue robot will sufficiently reduce these risks and more people will be able to get help in a short span of time. It can quickly reach individuals in distress, providing immediate assistance and helping to prevent drowning incidents. Humans can easily rely on this robot to rescue them from drowning and safely bring them back to land.

Our project, "Water Rescue Robot," has been designed to aid in the search and rescue of humans in scenes like sea, river, lake, and reservoir etc. It will be called into action by emergency response teams. Our robot will be controlled via an RC joystick. With a manually controlled robot, a human operator can make real-time decisions based on the current situation. The user can assess the environment and adapt his/her actions accordingly. This makes the robot more reliable in emergency situations. Our robot will be equipped with an ESP32 camera that will be used to get live video streams from the robot to the user's mobile phone. This will enable the user to see everything, no matter how far the robot goes and will also enable him/her to navigate and control the robot according to the situation. Moreover, a reflective LED strip will ensure that it's easier to see at night or in bad weather. This will ensure that instead of being stuck in flood water, or any water body in general, these people can be rescued in a more effective and faster way.

1.1 Motivation

The motivation behind developing a water rescue robot stems from the need to improve the efficiency and effectiveness of water rescue operations while minimizing risks to human life. The traditional methods we have are often quite time consuming and risky. Therefore, it is essential to develop a mechanism to enhance the safety and effectiveness of water rescue operations and increase the chances of successfully rescuing individuals in distress.

1.2 Problem statement

"Development of a Water Rescue Robot for Efficient and Safe Water Rescue Operations"

About two-thirds of all fatalities in floods and other natural disasters are caused by drowning. Due to the inability to provide timely help, many people lose their lives. This project focuses on designing a smart water rescue robot that aids in rescuing humans. Many lives can be saved using this robot during a flood disaster in a short period of time, which becomes time consuming and unaffected if done manually.

1.3 Literature review

Design and Implementation of Amphibious Smart Rescue Robot:

In this research paper, a new type of rescue robot is designed that can easily run on any rough surface like stairs. It can also float on water and dive underwater. This robot uses the Internet of Things as a communication tool between the operator and robot. The operator sends commands to the robot, and the robot sends the sensor readings (for sensing the environment) and the GPS location to the operator via Bluetooth communication. Simultaneously, real time video is sent from the mobile phone of the robot to the laptop of the operator through Skype. It also has a front arm that can rotate in both directions. This type of structure helps it to overcome obstacles and climb stairs. For underwater operations, it runs autonomously as communication is terminated. This robot is similar to ours, as we will also use remote control mode to control the robot's movement. In this robot, the main communication tool used is the internet but in a disaster situation, the first thing is an internet outage. For this reason, we will make a robot that doesn't use the internet for communication purposes. [1]

Underwater Research and Rescue Robot:

This paper discusses the creation of an underwater robot that has been designed to save lives. This robot travels underwater and then gives necessary feedback from there. A Pi camera has been used to send live feed from the robot to the user's laptop, which is the controlling device. Depending upon the received feed, the user gives the navigation commands to the robot. Our robot will be designed to work on the surface of water and rescue the drowning people from there. Moreover, our controlling device will be a joystick which will allow the user to control the navigation of the robot. The camera will send live feed to the LCD attached on the joystick which will enable the user to see and control the robot accordingly. [2]

Search and Rescue Robots: The Civil Protection Teams of the Future:

This paper discusses the creation of a robot that can be used to rescue people in case of a disaster. Two robots have been used for this purpose, one aerial and one land robot. These robots work together to ensure that the rescue operation is successful. The aerial robot obtains the map of the site and the land robot uses GPS to navigate towards the goal. We will be using a Pi camera to get live feed from the same robot to the user's phone. This will not only allow us to optimize the use of resources but also ensure a speedy process. [3]

A Water Walking Robot Inspired by Water Strider:

This paper discusses the creation of a water robot has been designed to mimic a water strider. This robot can be used for many useful applications like water quality monitoring and aquatic exploration. The robot has four supporting legs and a miniature DC motor has been used in the making of this robot. The weight of the robot is about 10 g. Compared to a water strider, this robot has lower performances in many aspects, such as speed and stability. Our robot will be designed to float on water and carry out the rescue operation. Moreover, we will ensure that it is fast and has more stability to successfully carry out its mission. [4]

Water Monitoring Robot with Double Layer Structure Design:

This research paper proposes a surface patrol robot that has an upper and a lower structure along with a lifesaving throwing equipment device. The robot can operate in two modes, automatic and remote-control mode. The collected data is displayed on a monitor screen installed on the robot. The robot will navigate according to the scheduled route in automatic mode. In emergency situations, the operator can disable the automatic navigation mode and rescue the person manually. At the front end of the robot, a pneumatic throwing device is installed, which will only open in an emergency. Our project is in many ways similar to this robot, but the main flaw in this robot is that it is only designed for conscious people, as it will only throw the life buoy to the rescue target without checking the state of the person, if the person is unconscious then he will be unable to hold the life buoy, but we are developing a robot that will also rescue unconscious people. If the operator detects that the person is unconscious, then he will press a button that will release a protective belt around the person and bring him safely back to land. [5]

1.4 Report Outline

This report is further divided into multiple chapters as listed below.

In chapter 2, proposed solution is discussed in detail. It includes details of block diagram, flow chart of the process and interfacing of the sensors.

Experimental results are explained in chapter 3. The project budget, milestones achieved and progress are discussed here as well.

Chapter 2 Solution Design & Implementation

This chapter discusses the complete design and implementation of the proposed product. Section 2.1 discusses the block diagram and module specifications. The details of flow chart are presented in section 2.2. Section 2.3 discusses the software implementation while the hardware implementation is presented in Section 2.5.

2.1 Block Diagram

Figure 2.1 shows the complete block diagram of the project. The details of each block with related technical specifications are discussed below.

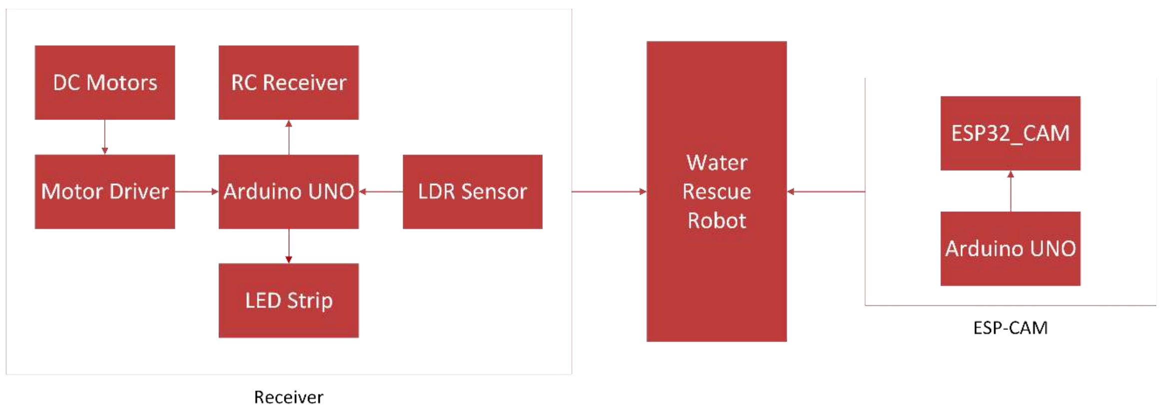


Figure 2.1 Block diagram of the project.

The block diagram shows the interfacing of various components with the robot body. The RC receiver has been interfaced with the Arduino UNO in the body of the robot. The 4 DC motors have been interfaced with Arduino using Zk-5AD motor drivers. An LDR sensor has been used for the development of smart LED for night vision whereas an ESP32-CAM has been used to get the live feed.

Sensor Specifications

We have used an LDR sensor to control the refraction light strip, which will be on if the LDR sensor detects the light intensity and off if it doesn't detect the light intensity. LDR sensors have a resistance range that can vary from several kilo-ohms to several mega-ohms. The resistance decreases with increasing light intensity and increases in darkness. The sensor has been controlled by setting this resistance value to a certain threshold. This will ensure that instead of being stuck in water at night or under bad weather, these people can be rescued in a more effective and faster way.

Arduino UNO

Arduino UNO has been used as the main microcontroller in this case. All programming has been done on it along with the interfacing of all the components. Similarly, the ESP32-CAM has been programmed using Arduino. All these components have then been fixed to the body of the robot.

RC Controller

An RC (Remote Control) controller has been used to remotely control the movement of the robot. It consists of the following features and components:

- **Transmitter:** The transmitter is the handheld unit that is used to send commands to the RC receiver. The RC joystick has been used to control the movement of our robot.
- **Receiver:** The receiver has been interfaced with Arduino inside the robot body. It will receive signals from the transmitter and will enable the robot move according to those received signals.
- **Channels:** RC controllers operate at a specific frequency and have multiple channels to operate the device without any interference.

Motor Driver Specifications

A Zk-5AD motor driver has been used to drive the motors. We have interfaced each of our four motors with a separate driver in order to not exceed the current under load. Each motor requires a voltage of 12 V and a current of 1.5 A while a single Zk-5AD driver is capable of bearing a current of up to 5 A. This would make sure the motors are able to smoothly work in water without burning out the driver.

ESP32-CAM

An ESP32 camera module has been used to obtain the live feed and display it on any browser by simply entering the IP address. Our own Wi-Fi credentials have been provided and an IP address is obtained on the serial monitor. This IP address is then used to view the live video stream.

2.2 Flow Chart

Figure 2.2 shows the complete flow chart of the project. The details are discussed below.

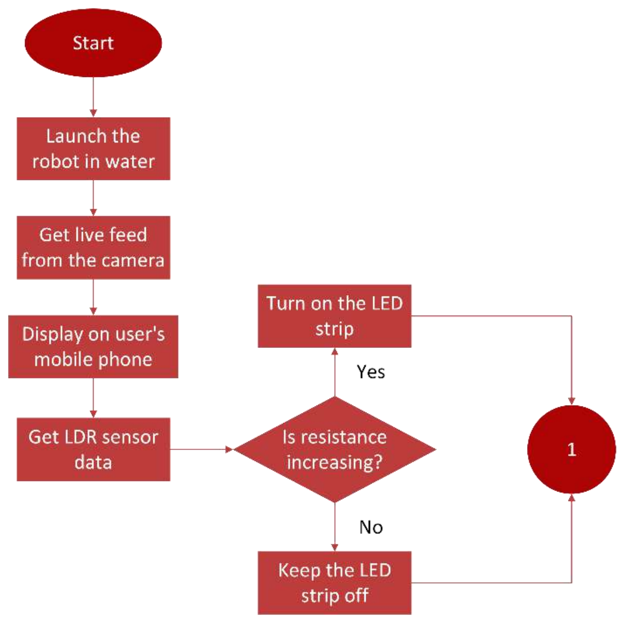


Figure 2.2-a Flow chart of the robot's body

Initialization Stage

In this flowchart, the initialization stage of the robot has been shown. The robot will be turned on and launched in water. The camera will start displaying the live feed on the controller's mobile phone. Meanwhile, the LDR sensor will check whether the LED strip needs to be turned on or not.

Figure 2.2-b shows the complete flow chart of the controller. The details are discussed below.

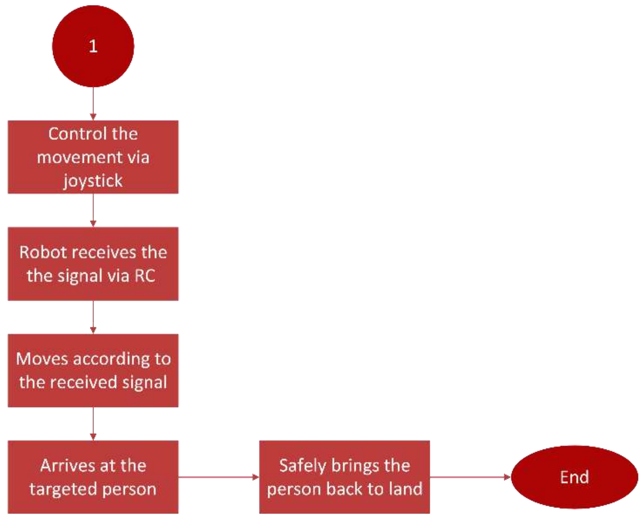


Figure 2.3-b Flow chart of controller

Joystick Controller

This flow chart depicts the working of the joystick controller. The user will control the whole movement of the robot using this RC controller, since it is manually operated. It will act as the transmitter while the receiver will be in the robot's body. The robot will move according to the received signal. It can be moved in all four directions; forward, backward, left and right.

Arriving at the targeted person

The user will move the robot towards the drowning person or any individual that needs help in any water body. Once it arrives at the targeted person, it will be able to safely bring that person back to land. The structure has been designed in a way that will allow the individual to easily hold onto the robot and reach the land without any fear of falling off. This will save humans from such repetitive tasks.

2.3 Software Implementation

Designing the Robot on AutoCAD

The body of the robot was first designed by us using AutoCAD. This was done to ensure a smooth manufacturing process and to enable us to get a clear idea of the design. The size of the robot was kept around 60*40*14 cm. This size would be large enough for the person to hold onto it while being bought back to land. The design has been made by keeping all the specifications under consideration.

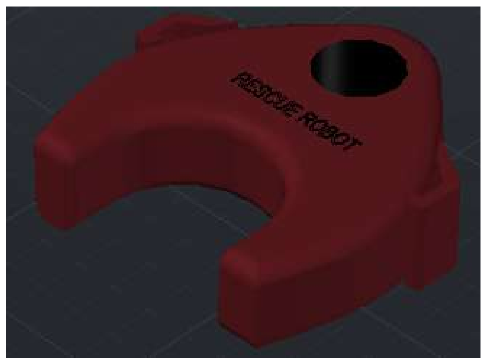


Figure 2.3-a AutoCAD Design

A hollow space of about 15*10 cm has been kept in the middle of the robot. This is where all circuit will be kept. This design will enable us to have a clear picture of the model while working on the hardware.

ESP32 Camera

ESP32 camera module has been used to watch the obtained live stream on the user's mobile phone as it has built-in Wi-Fi and Bluetooth. The ESP32-CAM can also save the feed on an SD card as it supports micro-SD cards. The camera module has been powered up using Arduino UNO. The coding for the camera has been done on Arduino IDE using the ESP32 Wrover Module, operating at a flash frequency of 80 MHz.

To interface the camera with Arduino, our own Wi-Fi credentials have been provided. This returns an IP address that can be displayed on the serial monitor once the code is uploaded. The live stream can be viewed on any device which is connected to the same Wi-Fi network as the ESP-CAM by entering the IP address in any web browser. This enables the user to easily control the movement of the robot regardless of the distance travelled.

Figure 2.3-b ESP32-CAM Module

2.4 Hardware Implementation

Manufacturing of the Robot's Body

After the completion of the AutoCAD design, the robot's body was manufactured according to those provided specifications. The body was designed in a way that enabled it to easily float on water. The robot's body was made out of wood sue to its several advantages which are listed below:

- Wood is naturally buoyant which helps the robot stay afloat and maintain stability while in water.
- Wood is lightweight compared to some other materials. This allowed for easier mobility and maneuverability of the robot.
- Wood can withstand prolonged exposure to water without significant degradation, reducing the risk of damage to the robot's structure over time.

Apart from this, the robot was then adorned with several coatings of paint to further reduce the risk of any leakage.

We then tested the floating ability of our robot on water with and without any load. Our circuit and batteries, which weighed around 6 kg, were added as load. In both conditions, the robot was easily able to stay afloat. This structure also allowed us to easily navigate our robot in water as it was not much heavy and could withstand the water level.

Figure 2.4-a Robot Floating on Water

Integration of Motors with Arduino and Driver

We have used 4 waterproof DC motors in order to control the movement of the robot. These motors were integrated with the Zk-5AD driver and Arduino UNO. Since each of our motor requires a current of 1.5 A, this driver was the most suitable fit for us since a single Zk-5AD driver has the ability to bear up to 5 A of current. The current under load increases, which is why our driver should be such that it is able to bear any extra current under load.

Figure 2.4-b Zk-5AD Driver

The motor terminals and the Arduino pins are connected to the appropriate pins of the motor driver. The Zk-5AD driver has 4 digital pins are connected with Arduino for direction and speed control. The driver was provided a suitable power supply using a LiPo battery which is capable of providing a voltage of 12 V.

RC Transmitter and Receiver

RC has been used to establish communication between the RC controller and the receiver connected with the motors. It uses SPI (Serial Peripheral Interface) for communication between the transmitter and the receiver. The transmitter acts as the master device while the receiver acts as the slave device. The transmitter and receiver were first paired with each other, after which it became possible to send and receive signals.

PWM (Pulse Width Modulation) was used in our code to control the motors. In this, the transmitter sends control signals as varying pulse widths, typically between 1ms and 2ms, representing different positions or commands. The receiver interprets these pulse widths and translates them into corresponding motor control signals.

The relationship between the transmitter and receiver is as follows:

i. Forward: all four motors move forward
ii. Right: the right two motors move towards the right
iii. Backward: all four motors move backward
iv. Left: the left two motors move towards the left

- **RC Transmitter**
  RC transmitter has multiple channels for simultaneous operation of RC devices. However, we only require two channels in our case. We have used channel 3 and channel 4 for the movement of motors. The transmitter operates at a specific radio frequency which is 2.4 GHz in our case. The transmitter is powered by batteries to provide continuous power during operations.

Figure 2.4-c RC Transmitter

- **RC Receiver**
  The receiver is placed inside the body of the robot and is responsible for receiving the signals transmitted by the robot. The receiver corresponds to the number of control channels supported by the transmitter. The receiver is powered by the Arduino since it only requires a voltage of 5 V.

Figure 2.4-d RC Receiver

- Pin 1 is the signal pin which is connected to the analog pin of Arduino. Since we have used channels 3 and 4 in this case, our signal pins of the respective channels were connected to Arduino pins A0 and A1.
- Pin 2 is the Vcc pin which is connected to the 5 v of Arduino.
- Pin 3 is the ground pin which is connected to the GND pin of Arduino UNO.

LED Strip for Night Vision

An LED strip is used to allow the user to see during night. An LDR (Light Dependent Resistor) sensor, interfaced with Arduino UNO, has been used to control the strip. During the day, the LED strip will remain off but once the resistance of the LDR sensor starts decreasing (as soon as it starts getting dark) the LED strip will turn on.

The LDR will measure the intensity of light from the surroundings. If the intensity of light is low, the resistance of LDR will increase which will turn on the LED automatically. When the intensity of light is high the LDR resistance will decrease and the LED will be turned off. This has been implemented to ensure that the rescue operations do not stop at night and people can be rescued at any time.

Figure 2.4-e LDR Sensor

- The D0 pin of the LDR sensor is connected to any digital pin on Arduino UNO
- Vcc of the sensor is connected to the 5 V of Arduino
- The ground pin of the sensor is connected to the GND pin of Arduino.

2.5 Design Calculations

- **Density**

  Our robot's density must be determined in order to determine whether it can float on water. Mass per unit volume is measured using density. First, we take into account water's density, which is generally accepted to be 1 g/cm3. The mass of water contained in each cubic centimeter is represented by this number.

  Next, using the robot's parameters of length (l), width (w), and height (h), we calculate its volume. Volume is calculated using the formula V = l x w x h, where l stands for length, w for width, and h for height. The dimensions in this instance are 98 cm long, 78 cm wide, and 26 cm high. These quantities are entered into the calculation, and the result reveals that the robot's volume is 198,744 cm3.

  Next, we need to figure out the robot's mass. The robot's weight, 15,100 g m/s2, is given as a representation of the force of gravity acting on it. We divide the weight by the gravitational acceleration (g), which is roughly 9.8 m/s2, to get the mass. Thus, 1540 g is determined to be the robot's mass.

  Finally, by dividing the robot's mass by its volume, we can determine its density. The density is calculated as 0.0077 g/cm3 when the mass is 1540 g and the volume is 198,744 cm3.

  These calculations lead us to the conclusion that the robot has a density of 0.0077 g/cm3. This density meets the requirement for the robot to float on water because it is much lower than the density of water (1g/cm3). As a result, it is proven that the robot will float on water.

  Density of water = ρ_{water} = 1g / cm3.
  Density = ρ = mass / volume
  Length = l = 98 cm
  Width = w = 78cm
  Height = h = 26cm
  Volume = l x w x h
  = 98 cm x 78 cm x 26 cm
  = 198744 cm3.
  Weight = 15100 g m/s2
  Mass = m = Weight / Acceleration of Gravity

= 15100 g m / s2 / 9.8 m/s2
= 1540 g
Density of robot = ρ_{robot} = 1540 g / 198744 cm3
= 0.0077 g / cm3

Floating Condition:
Density of robot ρ_{water} < Density of water ρ_{robot}
0.0077 g / cm3 < 1 g / cm3

As the density of the robot ρ_{robot} is less than the density of water ρ_{water}, the robot will float on water.

- **Torque**

1 gallon = 3.78541 liters
1 hour = 3600 seconds
1 foot = 0.3048 meters

So, the flow rate in SI units would be:

500 GPH x 3.78541 L/gal ÷ 3600 sec/hour = 0.5227 L/s
And the discharge head in SI units would be:
1 meter x 1 ft/meter = 1 ftH2O
1 ftH2O x 0.3048 m/ft = 0.3048 m

Now, we can use the formula:

Torque = (Flow rate x Head) / (3,960 x Pump efficiency)
Assuming a pump efficiency of 0.8, we have:
Torque = (0.5227 L/s x 0.3048 m) / (3,960 x 0.8)
Torque = 0.0045 Nm or 45.41 Ncm

Therefore, the required torque for this pump in SI units is approximately 0.0045 Newton meters or 45.41 Newton centimeters.

The calculated torque of the water pumps (i.e. motors) can help us determine the robot's ability to stay afloat and move easily under loaded conditions. By calculating the required torque, we were able to ensure that the motors being used are powerful enough to handle the necessary load and perform the rescue tasks effectively.

- **Speed**

The speed of Rule 500 GPH motor has a speed of 3600 RPM. We are using four motors in our project so the average RPM will be:

Average RPM: (3600 RPM + 3600 RPM + 3600 RPM + 3600 RPM) / 4 = 3600 RPM

This calculation determines the average RPM by summing up the individual RPM values of the four motors and dividing by the total count of motors (4 in this case). The result is an average RPM of 3600.

Total RPM: 3600 RPM + 3600 RPM + 3600 RPM + 3600 RPM = 14,400 RPM

This calculation determines the total RPM by summing up the individual RPM values of the four motors.

In this case, the sum of 3600 RPM for each motor results in a total RPM of 14,400.

- **Velocity**

  We can calculate the linear velocity based on the average RPM of the four Rule 500GPH motors.

  Average RPM: 3600 RPM
  Wheel Diameter: 10 cm
  Circumference = π * Diameter
  Circumference = 3.14 * 10 cm = 31.4 cm

  Next, we can calculate the linear velocity using the formula:

  Linear Velocity = (Circumference * Average RPM) / 60
  Linear Velocity = (31.4 cm * 3600 RPM) / 60 = 1884 cm/min
  Linear Velocity in m/s = (Linear Velocity in cm/min) / 6000

  Using the previously calculated linear velocity of 1884 cm/min, we can now convert it to meters per second:

  Linear Velocity = 1884 cm/min / 6000 = 0.314 m/s

  Therefore, the linear velocity of the system, assuming a wheel diameter of 10 cm and an average RPM of 3600, is approximately 0.314 meters per second.

Chapter 3 Result and Recommendations

We tested the various components of our project in several stages to ensure we were meeting our milestones with reliable results. Each individual module was tested separately prior to integration. Based on the results of testing we made improvements and changes to our design and approach as well. We have also discussed the budget of the project, its impact on society and milestones achieved in this chapter.

3.1 Project Results

LDR Values Monitoring Results

An LDR (Light Dependent Resistor) is being utilized in this instance to measure light intensity. The amount of light an LDR receives has an inverse relationship with its resistance. This implies that as light intensity falls, the LDR's resistance rises. On the other hand, as light intensity rises, the LDR's resistance falls.

An LED is attached to the Arduino board in order to automate the procedure dependent on the light intensity. When light levels are low and it becomes dark outside, the goal is to automatically turn on the LED. Monitoring the resistance of the LDR allows for this.

The Arduino board is configured to read the LDR's resistance value and display it on the serial monitor of the IDE (Integrated Development Environment) for Arduino. You can see the data being exchanged between the Arduino board and the PC by using the serial monitor.

The LDR is tested in various lighting circumstances, both in the presence of light and in the absence of light, in order to identify the threshold value for turning on the LED. Based on these experiments, it is shown that in well-lit settings, the LDR's resistance value stays below 600, whereas in dark conditions, it begins to rise above 600.

As a result, a threshold value of 600 is established as the need for lighting the LEDs. The Arduino board causes the LED to switch on automatically if the resistance value of the LDR rises over this threshold value (600), which denotes that the light intensity is low (it is dark).

In conclusion, when the light intensity is low, the LDR's resistance rises, and the Arduino board tracks the resistance values by showing them on the serial monitor. Based on the collected data, a threshold value of 600 is established, and when the resistance value rises above it, the LED automatically turns on to signal that it is getting dark. On the other hand, the LED remains off while the resistance value remains below 600, which denotes a well-lit state.

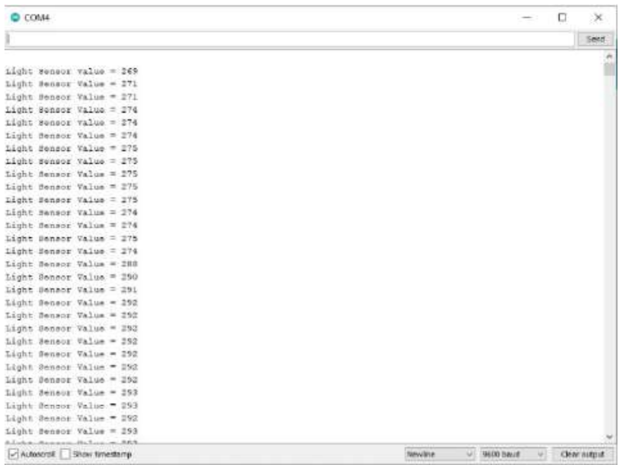


Figure 3.1-a LDR Sensor Output on Serial Monitor

The above values helped us determine our threshold value for the implementation of smart LED.

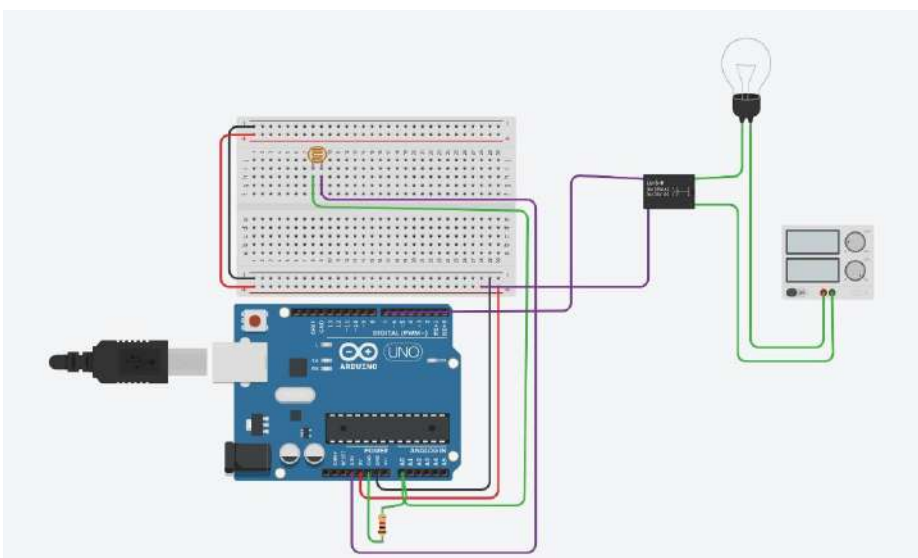


Figure 3.1-b Schematic Diagram of LDR

The above is the schematic diagram of our LDR Sensor which shows how our LDR sensor is integrated with Arduino which is our main microcontroller used to control the LED after reading the values from the LDR sensor.

RC Transmitter and Receiver

To transmit signals wirelessly to a receiver, a user uses an RC transmitter, a handheld device having a variety of controls including joysticks, switches, and buttons. It is frequently utilized in remotely controlled applications, including as piloting cars, drones, robots and airplanes.

The RC transmitter is employed in this scenario to direct the motion of a robot. By using the controls on the transmitter, the user can issue input commands such as forward, backward, left, and right motions.

Sending modulated radio waves at a certain frequency powers the RC transmitter. These signals convey details about the intended directives, including the strength and direction of movements. The RC receiver, which is attached to an Arduino board, then records the signals.

In this situation, an RC transmitter's low-latency transmission is one of its main benefits. Real-time control of the robot's motions is possible thanks to the receiver's near-instantaneous reception of signals from the transmitter. For applications like robotics that demand precise and quick responses, this is essential.

The RC transmitter has a shorter delay than other communication modules like NRF (Nordic Semiconductor's NRF series). This can be especially useful in circumstances when prompt and precise control of the robot's motion is essential.

The user can wirelessly control the robot's movement from a distance by using the RC transmitter, which increases flexibility and convenience. The knobs on the transmitter may be easily used to provide different commands, giving the robot a flexible selection of motion options.

In this situation, the RC transmitter is crucial because it offers real-time control, reduced delay, and user-friendly command manipulation, allowing precise and quick control over the robot's movement.

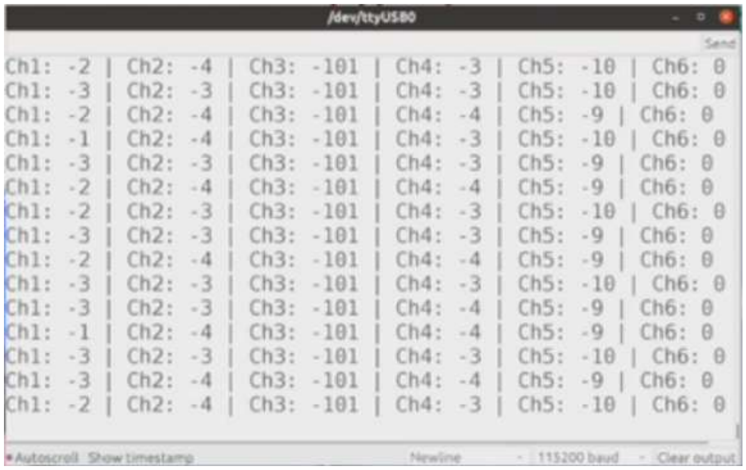


Figure 3.1-c RC Output on Serial Monitor

The above figure shows the RC output values on the serial monitor of all channels respectively.

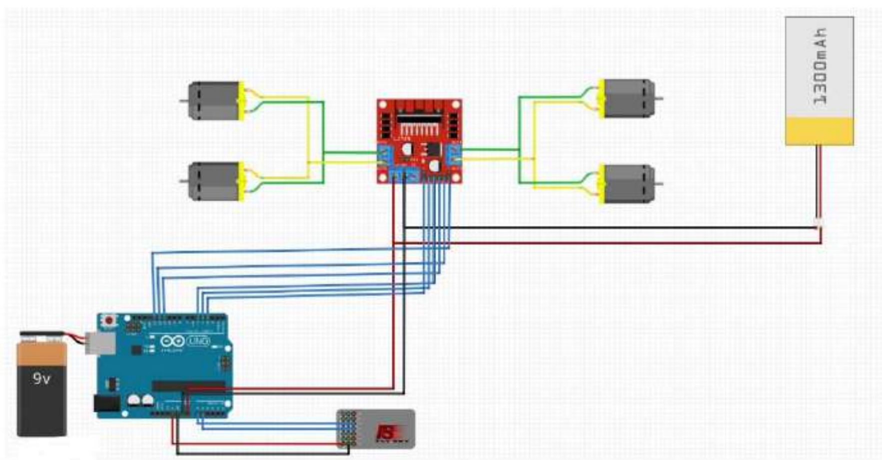


Figure 3.1-d RC Schematic Digram

The above is the schematic diagram of our RC circuit. It shows how the RC receiver is integrated with the arduino and the drivers (ZK-5AD) to control the motion of the motors.

ESP32-CAM Module

The IP address obtained by the camera was also displayed on the serial monitor. This IP address allowed us to obtain the live feed by entering it on any browser. The IP address is essential and without it the live feed cannot be viewed. Moreover, the camera connectivity was also ensured by printing out various statements. In case of packet issue or faulty camera, the camera failed to connect and printed an error message on the serial monitor. This enabled us to easily detect any errors and overcome them for the successful viewing of the live feed.

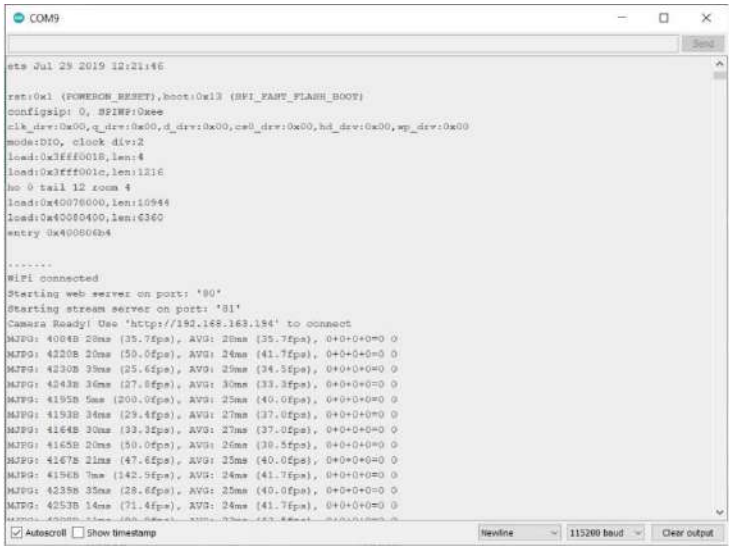


Figure 3.1-e Camera Output on Serial Monitor

In this case our IP address came out to be **192.168.163.194** as can be seen on the serial monitor output displayed above. This IP address was then entered on any browser and the live video feed was obtained by starting the stream.

3.2 Impact on Society

Our project 'Water Rescue Robot' will lead to great technological advancement in the country. Pakistan does not have much resourceful and effective means of rescue. Our project will enable people to get rid of the old ways and move towards a better solution for rescuing drowning people.

Our proposed solution will be a cost effective one as the ones already available in the global market are quite expensive and not affordable by all. We plan on providing a solution that is accessible to all and is locally available as well.

In the past (and even now in most countries), people still have to rely on lifeguards and rescue teams to save them from drowning. This can be quite time consuming and challenging sometimes. Our robot will efficiently rescue the drowning people thus saving other humans from carrying out such tasks.

Societal and Environmental Impact

1. **Industry, Innovation and Infrastructure:**
   This goal focuses on fostering a more innovative approach to industrial development. It's basically thinking of innovative new ways to repurpose old material. In the past, there was no concept of robots but now technology has made some great advancements.

Because of this we now have better and more effective ways of performing day-to-day tasks. Our project will enable people to let go of the traditional modes of rescue and switch to a better and more efficient one.

Our project contributes directly to this goal by promoting technological innovation and the development of infrastructure for rescue operations. This water rescue robot can access remote or hazardous locations where human access is limited or risky. This capability enhances the resilience of infrastructure by ensuring that rescue operations can be conducted in a wide range of environments and conditions.

2. **Sustainable Cities and Communities:**
   This goal focuses on addressing issues like transportation, disaster preparedness, and preservation of the world's cultural and natural heritage. Our robot will rescue people from drowning in any water body and in case of a flood. It will significantly reduce the drowning mortality rate and give hope to people in such disasters.

   The presence of water rescue robots in communities raises public awareness about water safety and emergency preparedness. These robots can serve as educational tools, demonstrating the importance of water safety practices, the risks associated with water bodies, and the role of emergency response systems. By promoting awareness and knowledge, water rescue robots contribute to building a culture of safety and resilience among community members.

3. **Responsible Consumption and Production:**
   The target for this goal includes improving corporate sustainability practices. Our project water rescue robot will be made by keeping in mind sustainable consumption and production patterns. The development and deployment of this robot can adhere to principles of waste reduction. Through sustainable design practices, manufacturers can minimize the generation of waste during the production process.

   Choosing wood as our main material demonstrates a commitment to using sustainable resources and reducing reliance on non-renewable or environmentally harmful materials. It is also generally considered to have a lower environmental impact compared to materials like plastics or metals.

3.3 Lifelong Learning

This project will contribute to our lifelong learning of the following:

- **Understanding the working of RC transmitter and receiver and ESP32-CAM**

Learning about RC transmitters and receivers, as well as the ESP32-CAM module, provides a foundation in wireless communication technologies and microcontroller systems. This technical knowledge can be applied to various projects and areas of interest, such as robotics and automation.

Understanding how RC transmitters, receivers and the ESP32-CAM work opens up opportunities for practical application. This knowledge can be used to build our own remote control systems, create wireless projects and develop surveillance systems with video streaming capabilities.

- **Learning the Fritzing and EasyEDA softwares**
  Fritzing and EasyEDA are both widely used software tools for designing electronic circuits and creating schematic diagrams. Learning these tools helped enhance our understanding of electronics and circuit design principles.

  Learning to use the simulation features of these softwares enables one to identify potential issues, troubleshoot circuit problems, and refine designs without the need for physical prototyping. This saves time and resources during the iterative design process.

3.4 Budget

Following is the budget of our project. It includes all the purchased items.

S. No	Items	Price/Unit	Unit	Price
1	Arduino UNO	1250	3	3750
2	ESP32-CAM with OV2640	1350	1	1350
3	RC Transmitter and Receiver	6000	1	6000
4	9 V Battery	220	4	880
5	Mini Breadboard	60	3	180
6	Zk-5AD Motor Driver	2000	4	8000
7	12V Adapter	385	1	385
8	9V Battery	220	2	440
9	Labor Charges	25000	1	25000
	Total cost of Project			45,985

3.5 Gantt Chart and Milestones Achieved

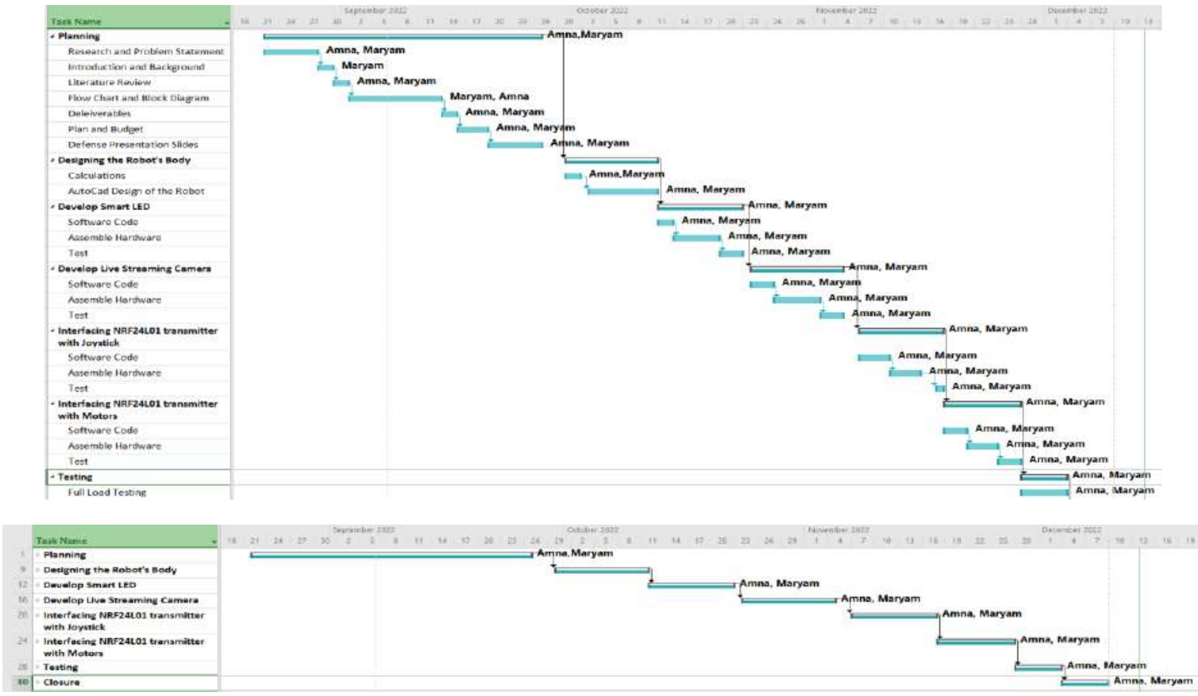
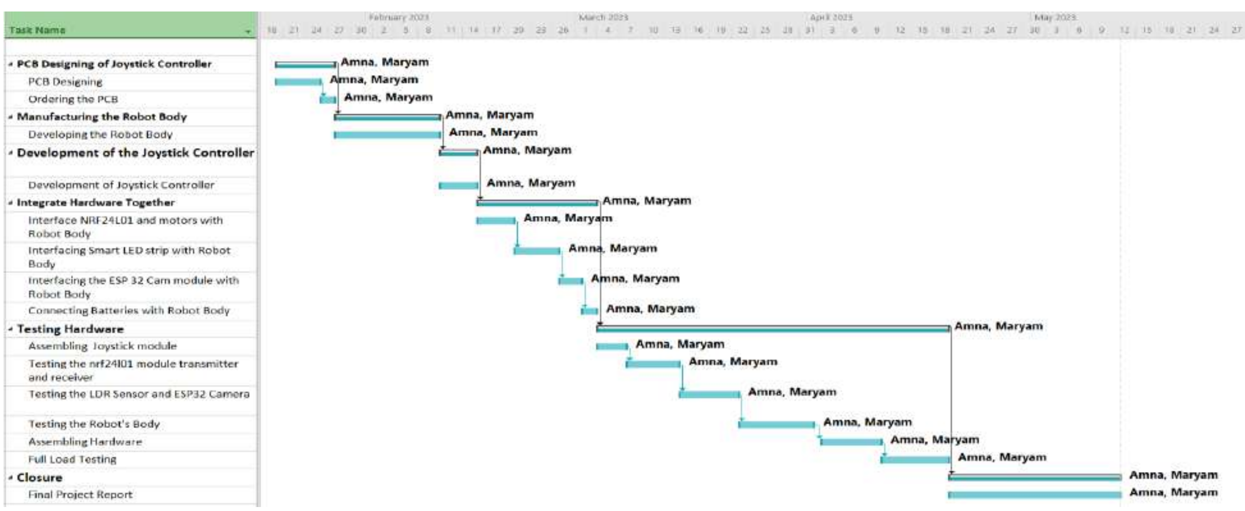


Figure 3.5-a FYP I Gantt Chart



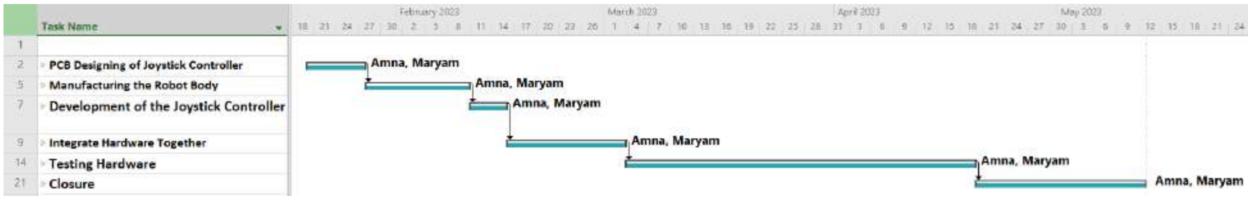


Figure 3.5-b FYP II Gantt Chart

3.6 Conclusion

This robot will not only save more lives in a short span of time but also optimize resources. Finding people faster can save lives and produce better outcomes for serious injuries. A water rescue robot can be easily deployed in places that might be dangerous for any human, thus making it a more convenient mode of rescue.

3.7 Recommendations / Future Work

In this project we mainly focused on developing a prototype that is able to float and move on water even under a certain load. Due to time constraints many improvements in the project are left for future work.

The robot has been designed without introducing any weight lifting limit and without any factors that would ensure its weight bearing ability. However, for a working product that is to be deployed to potential clients, such factors are quite essential and need to be taken into consideration.

Moreover, having an autonomous mode of rescue along with the manual one would be more beneficial since it would reduce human involvement and make sure the robot makes its own smart decisions.

Appendix-A: Project Codes

A-1 RC Transmitter and Receiver

```
// All the pins here used are PWM enabled pins and for such pins ~ is
// printed beside them
const int D0=9;
const int D1=6;
const int D2=5;
const int D3=3;


// Defining the Channel Pins
// The Ao and A1 analog pins will be used to read the receiver values.
// Rc3 is the  channel 3 which will be used to control the Forward and
// backward motion
// Rc4 is the channel 4 which will be used to control the left and right
// motion of the robot
#define rc3 A0
#define rc4 A1


// Defining the direction of the motors globally
// CW is for the clockwise direction
// CCW is for the counter clockwise direction
bool CW = true;
bool CCW = false;


bool debug = false;

void setup() {
  Serial.begin(9600);
  Serial.println("Water Rescue Robot");
 pinMode(D0, OUTPUT);
 pinMode(D1, OUTPUT);
 pinMode(D2, OUTPUT);
 pinMode(D3, OUTPUT);
 pinMode(rc3,INPUT);
 pinMode(rc4, INPUT);
```

```
}

void loop() {
// Reading the values from the channels using the analog pins and then
// controlling the motion by using conditions
ch3 = pulseIn(rc3, HIGH);
ch4 = pulseIn(rc4, HIGH);
  if (ch3 > 1700){
      M1(CW, 100);
      M2(CW, 100);
}
else if (ch3  <= 1400)
{
    M1(CCW, 100);
    M2(CCw, 100);

}
  else if (ch4 > 1700)
  {

   M1(CW,100);
   brake(2);
  }
else if(ch4 <= 1400)
{
   M2(CW,100);
   brake(1);
}
Else{


brake(1);
brake(2);
}

}//loop ends




void M1(bool direction,int speed)
{
  int pwm=map(speed, 0, 100, 0, 255);
  if(direction == CW)
```

```
  {
   analogWrite(D0,pwm);
   analogWrite(D1,LOW);
  }else{
   analogWrite(D1,pwm);
   analogWrite(D0,LOW);
  }
  debugPrint(1, direction, speed, false);
}//M1 end







void M2(bool direction,int speed)
{
  int pwm=map(speed, 0, 100, 0, 255);
  if(direction == CW)
  {
   analogWrite(D2,pwm);
   analogWrite(D3,LOW);
  }else{
   analogWrite(D3,pwm);
   analogWrite(D2,LOW);
  }
  debugPrint(2, direction, speed, false);
}//M2 ends



void brake(int motor)
{
   if(motor == 1)
  {
   analogWrite(D0,HIGH);
   analogWrite(D1,HIGH);
  }else{
   analogWrite(D2,HIGH);
   analogWrite(D3,HIGH);
  }
  debugPrint(motor, true,  0, true);
}//brake ends
```

Appendix

```
void debugPrint(int motor, bool direction, int speed, bool stop)
{
  if(debug)
  {
      Serial.print("Motor: ");
      Serial.print(motor);
    if(stop && motor>0)
    {
      Serial.println(" Stopped");
    }else{
      if(direction)
      {
      Serial.print(" CW at ");
      }else{
       Serial.print(" CCW at ");
      }
      Serial.print(speed);
      Serial.println(" %");
    }
  }//debug

}


void Brake()
{
 brake(1);
 brake(2);

}
```

A-2 LDR Sensor

```
// Initializing the Pins of the Arduino
int LDR_Pin = A0;
int LED = 7;
int threshold_value = 600;

// Setup Loop
void setup()
{
  // Setting Up the Serial Monitor
  Serial.begin(9600);
  // Setting the LED as Output
  pinMode(LED, OUTPUT);
}

// Main Loop
void loop()
{
  // Reading the LDR resistance value
  int data = analogRead(LDR_Pin);
  // Displaying the Resistance on the Serial Monitor
  Serial.println("");
  Serial.print("Light"
  Serial.print("Sensor ");
  Serial.print("Value = ");
  Serial.print(data);
  // if loop to check if the resistance is less than the threshold value
  // The threshold value is 600
  if(data <= threshold_value)
  {
    // The LED will be turned on if resistance is less than the threshold value
    digitalWrite(LED, HIGH);
  }
  // if the resistance is greater than the threshold value it will go to else loop
  else
  {
    // The LED will be turned off if resistance is greater than the threshold value
    digitalWrite(LED, LOW);
  }

}
```

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