Land And Underwater Rover Using Raspberry Pi

Dr. S. Nithya[1], Kanishk Yashvardhan[2], Suryansh Pravin Katiyar[3], Subham Kumar Singh [4]

[1] Assistant Professor Department of Electrical and Electronics Engineering, SRM Institute of Science and Technology Ramapuram, Chennai
[2]Student of Electrical and Electronics Engineering, SRM Institute of Science and Technology Ramapuram, Chennai
[3]Student of Electrical and Electronics Engineering, SRM Institute of Science and Technology Ramapuram, Chennai
[4] Student of Electrical and Electronics Engineering SRM Institute of Science and Technology Ramapuram, Chennai

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Abstract - *In this present scenario, the world is focusing on automation to increase Efficiency, Accuracy and Consistency in operations by reducing human error. Since we are heading towards development we need to maintain everything in which we invest. For example Underwater HVDC lines, Bridges over sea etc. So here we have focused on underwater ROV instead of AOV. AOV is an autonomous rover that works automatically without any remote control. There is a disadvantage of AOV controlled rover which is, a user does not have enough control over the rover once it is designed and programmed. So our main purpose of choosing Underwater ROV is to give humans more command over the machine for error rectifying purpose.*

So in our multipurpose proposed rover, we can use this rover on both land and water. In water, our rover will be controlled by the host ship or from land by a human. Control of moving front, reverse, left and right will be handled by the operator, rest of the data like water quality, water pressure, depth of the sea, the temperature of the water and we can get live feed from our rover on our computer. It will reduce the time and cost which sea divers take to give this data also our project will save them from life-threatening animals that live inside the water. Our rover can be used to check fault in the Underwater HVDC transmission lines, it can be used by Oil ships to check if the hull is doing good or not if there is any oil leakage or not. It can be used by the Ministry of Railways and NHAI to inspect their bridges for and damages to the structure and also to study the water quality of the area where they are making bridges. We can study marine life from our rover instead of spending money on divers and risking their life. Our rover can also be used on land by the army in remote areas as a decoy to detect land mines which can save many lives. Our rover will be affordable and low maintenance as its structure will be made of PVC pipes inside it there will be steel rods for strength. All the sensors will be connected with the Raspberry pi model 3B.

1. INTRODUCTION

In the current scenario, the demand for accuracy has been increasing at a distressing rate. So each person cannot have to a different or more different machine for a different purpose. As it is hectic for a person or a company to purchase and maintain different machine for different purpose as it is costly it occupies space and it requires attention to keep that machine working. So we have combined two rovers land and underwater rover to make both task easy and with one machine. We have also attached many sensors to it so it will give more data. That data can be seen on the computer screen near to host that data will be sent by the sensor to Raspberry Pi and Raspberry Pi will send that data to user. For example, Depth of the ocean or sea, the temperature of the water so we can study the marine life and also decide that if the structure which will be made there will be safe or not to sustain that temperature. There will be a pressure sensor which will be used to detect the pressure of sea and air, also there will be an ultrasonic sensor which will be used to detect the distance of the object near our rover so it can be used in low visibility.

2. LITERATURE SURVEY

A. Balasubramaniam Esakki and team have developed a robotic amphibious vehicle that was inspired by animals to navigate underwater with payload of 7 Kg. The paper's main consideration was the development of an unmanned land and water vehicle that can coordinate the highlights of a multi-rotor UAV and an air cushion vehicle. The land and water-capable vehicle's parts and subsystems were designed with consideration for streamlined, auxiliary, and natural angles. For distinct wind circumstances and points of attack (AOA), a computational liquid dynamic (CFD) examination is carried out to examine the impact of drag and necessary plan adjustment is proposed. The developed vehicle is expected to meet the functional requirements of catastrophic water quality monitoring missions large bodies of water.

B. Liin Meng and team has developed the drone technology in which they try to recognize fish species in natural lake with the help of camera. These drones are primarily utilised by unmanned aerial vehicles, though. We predict that in the near future, underwater drones will attract a lot of research attention and develop a business. We created an underwater drone with a 360-degree camera serving as the craft's "eye." The designs are built on open-source hardware and will be distributed as an open source to support industrial innovation, including drone manufacturing. The two fisheye lenses used to take the photos for the 360-degree panoramic camera are then combined to create the final image. The frame for the underwater drone was created using OpenSCAD, and the printed parts were made by extending the Raspberry Pi compute module.

C. Arnab Kumar Saha and team have designed underwater rover to track precious materials underwater with the help of Raspberry Pi. They suggested that a human controller would operate an underwater ROV rover using a Raspberry Pi-mounted RC transmitter and RC receiver from the host ship. By clicking on the image of the enemy submarine, the armed forces can utilise it to locate any underwater training drills, allowing the men to prepare for the assault. They focused on a ROV submerged meanderer instep of an AOV controlled Independent Meanderer, which operates automatically without the need for any external controls.

D. Leo V Steenson and team have designed underwater submarine which is used to check depth and study the marine life. It is an autonomous vehicle.

3. COMPONENTS REQUIRED:

Table -1: Component Used

Sr.No.	NAME OF THE COMPONENT	NUMBER REQUIRED
1	Raspberry Pi	1
2	Raspberry Pi Camera	1
3	Temperature Sensor	1
4	Pressure Sensor	1
5	Ultrasonic Sensor	1
6	BLDC Motor	4
7	Electronic Speed Controller	4
8	Servo Tester	3
9	Li-ion Battery	1

3.1. Raspberry Pi 3 Model B

Here we are using Raspberry Pi model 3b for connecting the sensors in our rover. As we get 40 GPIO pins to connect our sensors in the raspberry so we took Raspberry Pi for our rover. As we get 4 USB ports, 1 Ethernet port, 1-3.5mm audio jack, 1 HDMI port, 1 CSI Camera output, 1 DSI Display connector, 1 Vin which is Micro USB, 1 SD card slot for boot purpose and it has 1.2 GHz 65-bit quad-core Arm Cortex-A53 processor also it has inbuilt 80.11n wireless LAN and Bluetooth 4.1 so we get many things in raspberry pi 3b so it reduces the space occupied by the rover and reduces its weight and also cost-saving.

Fig 1. Raspberry Pi Model 3 B

3.2. Pressure Sensor

This is an instrument consisting of a pressure-sensitive element to determine the actual pressure applied to the senor and some components to convert this information into an output signal. MPL115A1 is an absolute pressure sensor with digital SPI output targeting low-cost application. It has low current consumption during the working condition of 5uA. The sensor will be connected with the Raspberry Pi which will then be put underwater to measure the pressure in the region where the rover will be passing from and according to that the data will be measured, collected and will be displayed on the host ship. This will gather the data about underwater physical conditions.

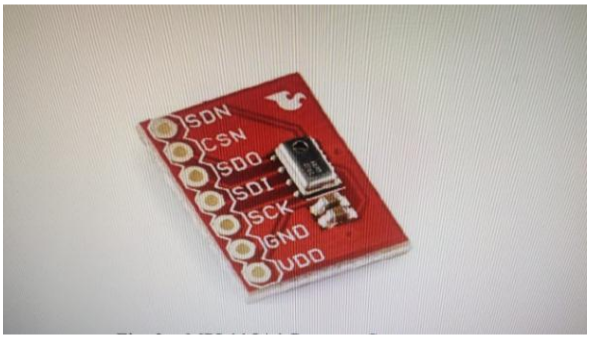

Fig 2. Pressure Sensor

3.3. Temperature Sensor

This sensor comes with a special NTC to measure temperature and an 8-bit microcontroller to o/p the values of temperature and humidity as serial data. The sensor is factory calibrated and so it is easy to interface with other microcontrollers. This sensor can measure temperature from 0 degree Celsius to 50 degree Celsius and it has an accuracy of + - of 1 degree Celsius.

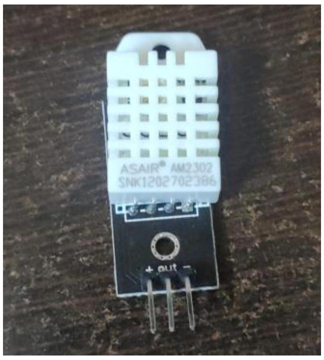

Fig 3. DTH11 Temperature Sensor

Table -2: Connection of pins

NO.	PIN NAME	DESCRIPTION
1	Vcc	Power supply 3.5V to 5.5V
2	Data	The output of Temperature and Humidity through serial Data
3	NC	No connection and Hence not used
4	Ground	Connected to the ground of the circuit

DTH11 Specification-

Operating Voltage: 3.5V to 5.5V

Operating Current: 0.3mA (measuring) 60uA (standby).

Output: Serial Data.

Temperature range: 0 degree Celsius to 50 degree Celsius.

Humidity range: 20% to 90%.

Resolution: Temperature and Humidity both are 16-bit.

3.4. Ultrasonic Sensor

It is an electronic device that we will use to measure the distance of a target object by emitting ultrasonic sound waves, and it converts that reflected sound waves into an electric signal. The ultrasonic wave travels faster than the speed of sound which humans can hear. Ultrasonic sensors mainly consist of two components which are Transmitter and Receiver. The transmitter emits the sound using Piezoelectric crystals and to calculate the total distance between the sensor and the object, the sensor measure the time taken by sound waves to return to the receiver. The formula for time calculation is D=1/2 T x C. We are using this technology to detect the object underwater. We will use an ultrasonic sensor for detecting any crack in structures or on the hull of the ship by sending the waves and if that wave returns then everything is good but if we don't get the waves back then we will know that there is some crack from which the waves crossed and didn't come back.

Fig 4. HC-SR04 Ultrasonic Sensor

3.4. Electronic Speed Controller

An electronic speed controller is used to control the speed of the BLDC motor. ESC is an electronic circuit. It also provides reversing of the motor and dynamic braking.

Fig 5. Electronic Speed Controller

3.5. Servo Tester

Servo tester is used to control the speed of BLDC motor as servo tester allows two digital or analogue servos without using transmitter or receiver, by just plug in our battery to start testing.

Fig 6. Servo Tester

3.6. BLDC Motor

It is a brushless DC electric motor, also known as electronically commutated motor and synchronous DC motor. These motors are powered by direct current (DC) electricity via an inverter or switching power supply which produces electricity in the form of alternation current to drive each phase of the motor via a closed-loop controller. The controller provides pulses of current to the motor windings that control the speed and torque of the motor. This control system replaces the commutator (brushes) used in many conventional electric motors. As we can easily use it in water so we took BLDC motor in our project.

4. METHODOLOGY

Here we will explain to you the working process of our rover.

Here we have taken PVC pipes for our foundation. As PVC can handle water very well and it is corrosion resistant so we have assembled all our main component of PVC foundation. Now we have four BLDC motors in which two motors will move in forward and reverse direction for moving rover in the forward and backward direction. Same motors will be used for turning the rover left and right by using the motor in different directions. For example, if we want to turn left then the motor on the left side will work in the reverse direction and the motor on the right side will work in the forward direction then the rover will turn left. Now the third motor will be attached to the centre of the rover which will help it to go up and down, so when our work will over we can use that motor to reduce the depth and bring the rover on the surface and if we want to dive in the with the help of weight and motor we can dive in. Now the last BLDC motor will be used to navigate on the ground as it will be connected to the centre wheel and the rest 2 wheels will be for support.

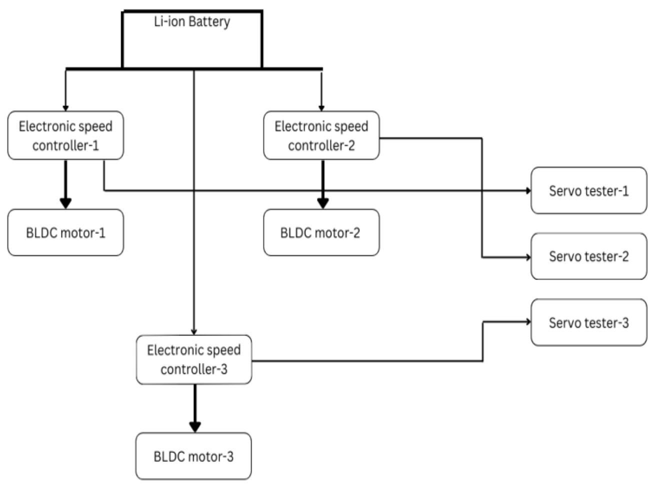

Fig 7. Block Diagram

Now comes the sensor part. All the sensor will be connected to Raspberry Pi Model 3B and that Raspberry Pi will be powered by micro USB i/p. The pressure sensor will collect the data and transfer it to Raspberry Pi and that data we will get on a computer monitor by HDMI cable. For the temperature sensor, the data will be collected by the sensor and that data will be shown on the screen the same as the pressure sensor. For the Ultrasonic sensor, the data will be collected from the sensor it will be shown on Raspberry Pi display output which is connected by HDMI.

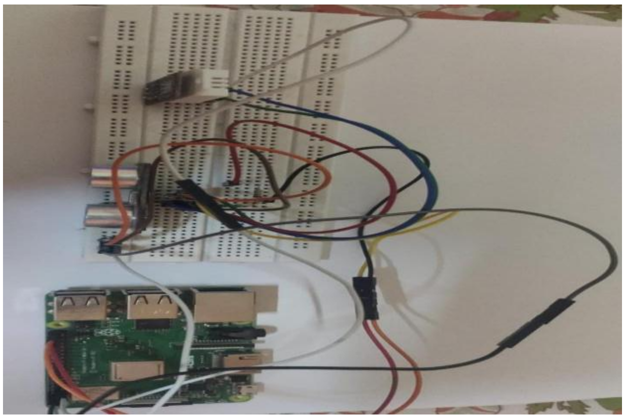

Fig 8. Wiring Connection

The camera will be an individual device because by chance if the sensor fails so our camera will be still working so it will be easy to navigate the rover out of the sea and also we will get live feed from the camera and the camera has a separate inbuilt battery so if we run out of battery on rover we can still see the live feed. And for the wiring, we have used the normal electric wire which is covered by a plastic sleeve over it and heated so it is sealed and waterproof and the wiring is run under PVC pipes so the chance of entering water is very less.

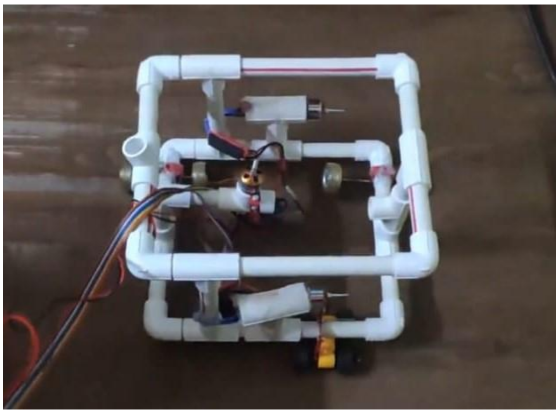

Fig.9: Final Prototype

5. CONCLUSIONS AND FUTURE WORK

In this report, we have proposed a remotely operated vehicle that not only gives insight into aquatic habitats but also helps to locate faults and cracks in the structures. It provides promises by checking deep altitudes whether it is comfortable or not. Other than that or rover will dive deep into the sea or pond to study coral life and will help to find new species. So our main point in designing this rover is to reduce the threat to human life and reduce the cost of maintenance work. That's the main conclusion of the whole project Land and Underwater Rover using Raspberry Pi. This project was successfully carried out at a low cost and is durable. In future, we can install more sensors and can make it useful in the sky by adding drone features by adding some more motors and propeller to make it useful for surveillance in the sky and it can calculate the parameters in the air so it can detect life hazard on the structures of skyscraper-like cracks and wetness in the structure so or rove can be used in land, sea and air. In future, we will also work on making the whole system wireless.

6. ADVANTAGES CONTRIBUTION TOWARDS SOCIETY

In the current situation, the need for advanced technology, infrastructure, and automation has been rising at an alarming rate, and there are less efficient or cost-effective ways to manage it. Our goal in this instance is to protect human life from harm by building a machine to monitor the parameters. By developing this project, we not only increase the accuracy of the data that is acquired underwater and save money overall on the operation, but also the lives of sea divers.

ADVANTAGES TO THE SOCIETY

1. Our rover will work on electricity which will not do any pollution underwater.
2. Cost-efficient
3. Low maintenance
4. No use and throw materials like an oxygen mask, etc.
5. It can be used on both land and sea so no Hassel of keeping two devices for different purposes.
6. Accurate data.

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