VIVA-TECH IJRI
ANNUAL RESEARCH JOURNAL
VIVA-TECH INTERNATIONAL JOURNAL FOR RESEARCH AND INNOVATION
ANNUAL RESEARCH JOURNAL
ISSN(ONLINE): 2581-7280

Remotely Operated Vehicle for Underwater Inspection

Sreetish Mundayat[1], Amaan Saiyed[2], Raj Shinde[3], Bhushan Save[4]
[1]((Electrical, VIVA Institute of Technology/ Mumbai University, India)
[2]((Electrical, VIVA Institute of Technology/ Mumbai University, India)
[3]((Electrical, VIVA Institute of Technology/ Mumbai University, India)
[4]((Electrical, VIVA Institute of Technology/ Mumbai University, India)

Abstract : *The remotely operated underwater vehicle also known as ROVs are like underwater robots designed to explore different depths of water for industrial and research purposes. There has been an increased risk to human life during underwater explorations, different types of observational and work-class ROV are used to reduce such problems. The Mini observational class ROV proposed in this paper is equipped with different sensors like BME280 and MPU6050 to collect temperature, pressure, humidity as well 6-axis digital motion track of the vehicle respectively during its operation, since it is an observation class ROV it also has an onboard camera, all the data from the sensors and the video feed from camera are sent to the ground by Raspberry pi 4 a microcomputer connected to the internet through Ethernet protocol. The motion control of the mini ROV in different directions is initiated by a transmitter and receiver, dc brushless motors are used as thrusters which are attached to a cylindrical PVC pipe. The DC brushless motors provide the required translational, ascent, or descent movements of the vehicle. The design of the mini ROV provides good stability, portability, it is cost-effective and it can be operated in deep-water and for shallow water applications.*

Keywords - *Brushless Motor, Camera, Internet, PVC pipe, Raspberry Pi 4, Underwater Exploration*

I. INTRODUCTION

Remotely operated vehicles also known as ROVs are tethered underwater vehicles which are used for underwater exploration. Remotely operated vehicles were first used and funded by the US navy in the 1960-80s for deep-sea exploration and to recover submerged objects from the ocean floor. These vehicles were adequate to help deep-sea exploration, later advancements in technologies helped the ROVs to work upon in different industries. Remotely operated vehicles in today's world, are in great trend for oceanic research and other underwater activities. The technology used in some years ago did not meet the needs of the industries due to the loss of advancement in technology. Nowadays many ROVs are far more advanced and can be used for small, medium class ROV that has the power of around 50 hp and large size can handle more pressure as compared to others and are used for oceanic trench research. Many Industries especially operating on water like Oil and Gas, hydroelectric etc. specifically require divers or underwater crew for maintenance and repair work. Since pressure is immense, human intervention in underwater is dangerous [1]. Communication from the surface to the increasing depth is also tedious and quite difficult. According to industry survey divers' fatality rate has increased drastically which is thousand times risky than working as a law-officer. This project is an observation class unmanned mini underwater vehicle whose priority is to collect real-time data elementary between the vehicle and the operator for a successful mission. Most of the observational class ROVs has the operator who monitors and investigates the target of interest, similarly the ROV proposed here has the same operation as the traditional ones [2]. The ROV system in this project is based on a definite choice for covering a certain task categorized by its own size, depth, capability and as well as proper stability.

II. METHODOLOGY

2.1 Block Diagram:

The figure below shows the block diagram of the remotely operated vehicle (ROV),

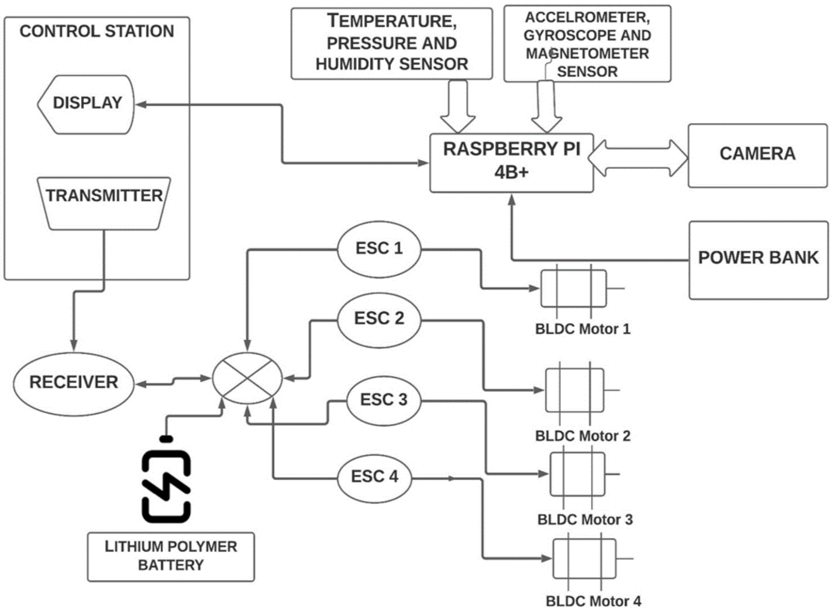

Fig 1. Block diagram of remotely operated vehicle (ROV)

2.2 Circuit Diagram:

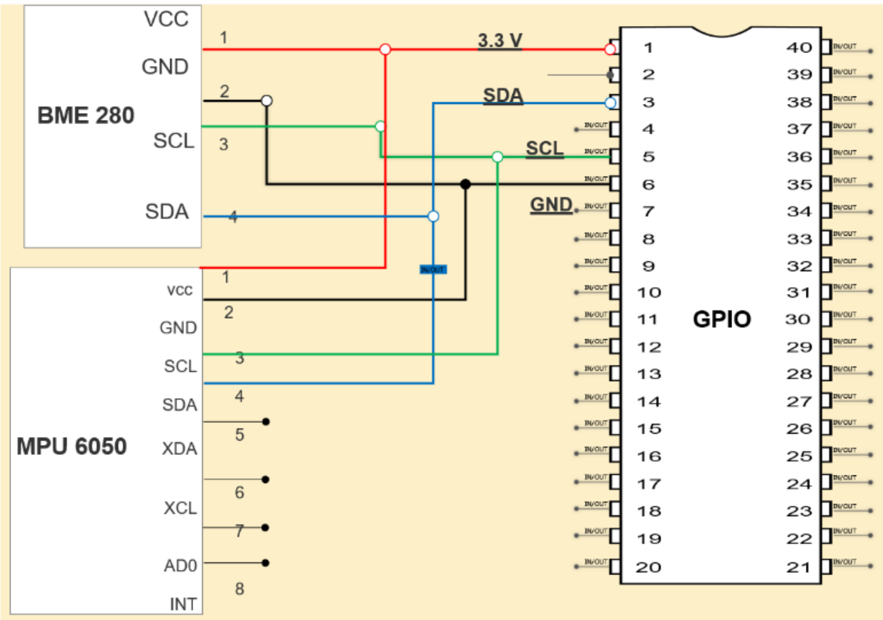

Fig 2. Circuit Diagram of Raspberry Pi 4B+ GPIO with BME280 and MPU6050 sensor

2.3 Electronic System:

This section explains the electrical components and sensors used in the ROV for data collection and monitoring. The Pi camera module is used to capture images/stream video, the live video feed is sent to the user over the internet. The ROV consist of a microcomputer (Raspberry Pi 4B+) to which different sensors, Pi cam and ethernet are being connected. Raspberry Pi 4B+ has 40 GPIO ports and has a RAM option of 2GB, 4GB or 8GB. It has Broadcom NCM2711, quad-core-A72(ARMVB) 64-bit processor at 1.5GHz. To power, the Raspberry Pi4 model a 5V 3A power bank is used. Figure (BME280) is a temperature + pressure + Humidity Sensor called the BME280, it sends the temperature and humidity values in C to the raspberry Pi and MPU6050 is a 6-axis motion tracking device that combines the 3-axis gyroscope, 3-axis accelerometer and a Digital motion processor in a single chip. It collects the angular momentum, static acceleration due to gravity as well as dynamic acceleration data of ROV during its operation and sends it to Raspberry Pi. All these raw data sent to the Raspberry Pi is later displayed on the computer at the control station. This is basically done with the help of an ethernet cable connected to the Raspberry Pi and the Hub. To get the live video streaming and data from the sensors the IP address of the Raspberry Pi and the User should same so that the transfer of files or data can be done through Ethernet. The thruster used is mainly brushless DC motors connected with an electronic speed controller (ESC). The transmitter and Receiver help in controlling the translational, ascent and descent motions of the vehicle.

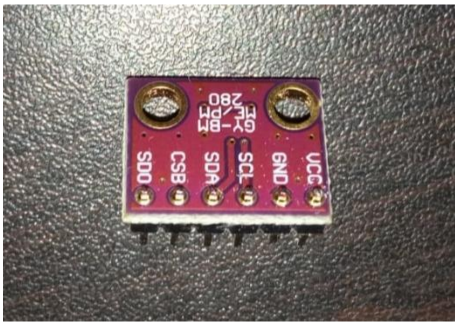

Fig 3. BME280 temperature, pressure and humidity sensor

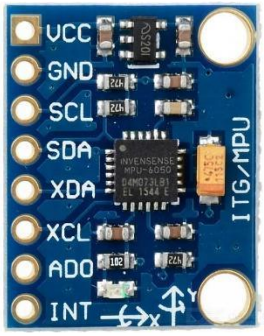

Fig 4. MPU6050 sensor

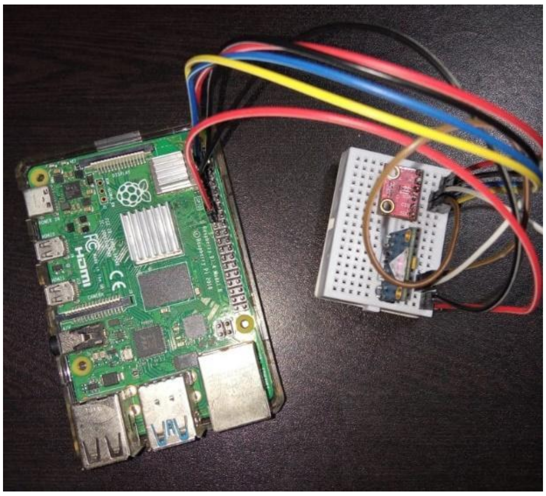

Fig 5. Raspberry Pi 4B+ Microcomputer

2.4. Mechanical System

The deployment of ROV is aimed to give provide neutral buoyancy so that controlling of ROV becomes ease to the operator. When working underwater ROV faces many challenges that include weight, drag symmetry and depth control etc. [3]. The design of the min- ROV consist of PVC pipes which is the best material at low-cost since it is less corrosive and can width stand underwater pressure easily. The central cylindrical pipe is 6inch in diameter and has a length of 62cm, this central pipe has all the electronics and the camera being located and are waterproofed efficiently in order to prevent any damage to the circuits. There are 2 motors attach 9cm right from the Centre of the central pipe and other remaining motors 9cm left from the Centre. Four holes of 1 inch are made on the central pipe to attach the DC brushless motors for the movement of the vehicle. The front of the central pipe is enclosed by an acrylic transparent dome which enables the camera to get a clear 170-degree view of the surrounding's. The extreme right motors are used for the front movement of the vehicle and the later extreme left motors are used to submerse the vehicle during its operation.

Fig 6. Back view of the PVC structure

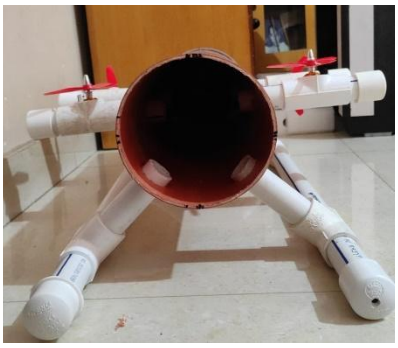

Fig 7. Front view of the PVC structure

III. CONCLUSION

The Remotely Operated Underwater Vehicle proposed in this paper has the ability to reduce the efforts of human underwater interventions. The ROV performs all the required tasks during its deployment and also sends the required data for different research and surveillance activities. In addition to a flexible and portable low-cost design, the vehicle provides adequate stability and offers higher depths in water during its operation. With advancements in the technological features, this ROV can also be used as an autonomous underwater vehicle.

Acknowledgements

We express our sincere gratitude to Dr. Arun Kumar, Principal, Viva Institute of Technology, who has always been playing a great role in all round development of the Institute. Our deep gratitude to Prof. Bhushan Save, The Head of Electrical Department who is also our project guide and our project coordinator Prof. Mukeshkumar Mishra, for their valuable guidance, advice and constant motivation inspired us to do our best.

REFERENCES

Journal Paper:

[1] Aguirre-Castro, O.A.; Inzunza-González, E.; García-Guerrero, E.E.; Tlelo-Cuautle, E.; LópezBonilla, O.R.; Olguín-Tiznado, J.E.; Cárdenas-Valdez, "Design and Construction of an ROV for Underwater Exploration*" J. Sensors* December 2019, 19 ,5387.

Papers:

[2] A. F. Ali and M. R. Arshad, "Design and development remotely operated vehicle for anode ship hull inspection," 2017 IEEE *7th International Conference on Underwater System Technology*: Theory and Applications (USYS), 2017, pp. 1-5.

[3.] N. S. Pinjare, S. Chaitra, S. Shraavan, Harshita and I. G. Naveen, "Underwater remotely operated vehicle for surveillance and marine study," 2017 *International Conference on Electrical, Electronics, Communication, Computer, and Optimization Technique*s (ICEECCOT), 2017, pp. 330-334.

[4] H. Sugimoto, Y. Moriya and T. Ogasawara, "Underwater survey system of dam embankment by remotely operated vehicle," 2017 *IEEE Underwater Technology (UT)*, 2017, pp. 1-6

[5] Allotta B, Brandani L, Casagli N, "Development of Nemo remotely operated underwater vehicle for the inspection of the Costa Concordia wreck". Proceedings of the Institution of Mechanical Engineers, Part M*: Journal of Engineering for the Maritime Environment*. 2017;231(1):3-18

[6] Allotta B, Brandani L, Casagli N, "Development of Nemo remotely operated underwater vehicle for the inspection of the Costa Concordia wreck". Proceedings of the Institution of Mechanical Engineers, Part M: *Journal of Engineering for the Maritime Environment. 2017*;231(1):3-18.

[7] Z. M. Zain, M. M. Noh, K. A. Ab Rahim and N. Harun, "Design and development of an X4-ROV," *2016 IEEE International Conference on Underwater System Technology: Theory and Applications* (USYS), 2016, pp. 207-211.

[8] G. Divya Priya, Mr.I.Harish, “Raspberry PI Based Underwater Vehicle for Monitoring Aquatic Ecosystem”, *IJETA 2015*, ISSN-2393-9516.

[9] C. Joochim, R. Phadungthin and S. Srikitsuwan, "Design and development of a Remotely Operated Underwater Vehicle," *2015 16th International Conference on Research and Education in Mechatronics (REM), 2015*, pp. 148-153.

[10] M.Saranya, K.Sumitha, S.Suganthi, M.Parkavi, “Underwater Vehicle Monitoring using Raspberry Pi”, *IJIRSET September 2015*, vol 14, 2319-8753.

[11] B. M. M. Anwar, M. A. Ajim and S. Alam, "Remotely operated underwater vehicle with surveillance system," *2015 International Conference on Advances in Electrical Engineering (ICAEE), 2015*, pp. 255-258.

[12] García-Valdovinos LG, Salgado-Jiménez T, Bandala-Sánchez M, Nava-Balanzar L, Hernández-Alvarado R, Cruz-Ledesma JA, “Modelling, Design and Robust Control of a Remotely Operated Underwater Vehicle. *International Journal of Advanced Robotic Systems”, January 2014*.

[13] A. Molero, R. Dunia, J. Cappelletto and G. Fernandez, "Model predictive control of remotely operated underwater vehicles," *2011 50th IEEE Conference on Decision and Control and European Control Conference*, 2011, pp. 2058-2063.

[14] N. Harsamizadeh Tehrani, M. Heidari, Y. Zakeri and J. Ghaisari, "Development, depth control and stability analysis of an underwater Remotely Operated Vehicle (ROV)," *IEEE ICCA 2010*, 2010, pp. 814-819.

[15] David Smallwood1, Ralf Bachmayer, and Louis Whitcomb, “A New Remotely Operated Underwater Vehicle for Dynamics and Control Research”, *International Symposium on Unmanned Untethered Submersible Technology 1999*, pp.370-377.