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Development of Autonomous Underwater Robot with minimum sensing devices

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***Abstract*— The development of ocean resources increases as ocean is the medium of earning of many people and it communicates between two different regions. Water is the resource of life as well as threat. Many locations in ocean is harmful for human being in such area underwater robot are going for inspection of sea life. Accordingly, autonomous underwater robots for the general inspection of ocean environment resources emerge important subjects of research and development. Navigating the robot through the underwater environment avoiding obstacles is still one of the major tasks for robot. The aim of this project is to develop an underwater robot with minimum sensing devices that avoid obstacles and helps in the inspection of sea life for various underwater applications. The Autonomous underwater vehicle prototype was developed in real time. Python 2.7 is used for the path planning algorithm.**

***Index Terms*— Obstacle Avoidance, Autonomous Underwater Robot, Python 2.7**

I. Introduction

Obstacle avoidance for the autonomous underwater robots is very important subject which has to be considered in order to prevent damages to the autonomous underwater robots due to collision with the hazardous objects, aquatic animals and underwater mountains/rocks. In this project a prototype of AUV is proposed and its algorithm that enables the safe navigation towards the destination without collision to the obstacle in an environment.

Mike Eichhorn et al. (2005) represents a DeepC AUV to avoid obstacles. Sonar sensor is used to avoid obstacles. The reactive obstacle avoidance is based on Gradient lines. The goal is to calculate the gradient lines from start location to final location. This is applicable only on X-Y axis (2D). In this paper, gradient lines are constructed and by the information of speed, sea life were determined from the location of obstacles. Nils Gageik et al. (2015) represents a sonar system is not effective and sufficient for depth information. Far sounder technology is used for finding 3D depth information of sea with the current update. Basically, far sounder must be adequately versatile to become an ingenious autonomous underwater vehicle navigation, as well it aimed for making decisions such as to detect, classify, confine and navigate. S.Cusi et al. (2015) DVL (Doppler velocity log) is used to navigate the path in underwater surface. An AUV 3D is developed by using python 2.7 DVL is used over GPS as GPS failed sometimes. Using DVL, AUV collected the various data in 3D with respect to bottom such as physical data of water masses, exploring sea life. AUV developed in this paper named as Ocean server Iver2 AUV. It is relatively low cost, reliable and ease of operation. Also the noise produced is removed by using Doppler technology measurement. Python 2.7 scripts gives the graphical outputs and explains how the data is filtered and averaged. Yu Zhou et al. (2015) AUV works independently, but to control on it need a controller. STM32 ARM Processor are used for the control system. Various sensors such as waterproof camera, inertial sensors, hydrophone, and pressure sensors are used. AUV travels under the water capture the image and send to the server, for that it is used image processing algorithms, the signals received by the hydrophones to get accurate position of AUV with respective to obstacles. The C++ language is used for programming and UC-OSII operating system. PID algorithm also used for controlling the sensors and thrusters. Taakai et al. (2011) describes an underwater robot called Darya Bird. It is used for various applications in deep sea such as for rescue operation, investigation of sea life and animals etc. It worked on the few subject such as controlling action of robot, fed sensor information obstacle avoidance and navigation self-localization etc. Adaptive controller used for navigation system and underwater end effector system. This technology works in natural disaster environment such as hazardous effect. Specially, “Handy underwater robot” was developed for wide and depth level of sea life. Lei Zhang et al. (2013) describe an underwater robot called “Amogh”. This design of this AUV Amogh consist of two-on board camera which is used to navigate and control the AUV with respective to environment. IMU is used for data orientation (processor called i7-4470). Arduino Mega 2560 used for interfacing between CPU and payloads. Structure consists of six thrusters, pressure sensor, IMU, battery called lithium polymer. It is a multi-disciplinary task to make an AUV which faced a lot of numerous challenges such as static and hydrodynamic stability, water proofing navigation etc. The technologies which are employed in the AUV is image processing, artificial intelligence, embedded system. Matthew.A et al. (2008) represent a waterproof underwater robot with the minimal cost. Various sensors and communication system are used. It moves in 3D and able to avoid obstacle. The design of underwater robotic consist of three thruster vertical and two horizontal. Microcontroller is used to run and control the robot. PICI8F4550 microcontroller is interfaced to program different task. LINMC201 IC is used for internal serial communication. Power supply required is 12V for motors with maximum current 0f 2.5Amp. NiH or LiPoly batteries are used for charging. Few sensors such as depth sensor, collision avoidance sensor are used. For localization GPS is used which gives accuracy. In front a camera is fed to the robot to get the information of underwater sea life. F.Geovani et al. (2014) describes the algorithm called simple linear nearest neighbor used to avoid obstacles. It estimates the route for the robot which is more free-collision. Further it improves the

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SLNN algorithm and apply CIE Lab color code for the detection of obstacles not only but with the help of color also. This method is very simple and efficient systematic way. Another step for the obstacle avoidance consider of present direction and orientation of the robot that can be calculated. This is done by remotely operated vehicle (ROV) for navigation purpose which consist of image error with the help of geometric center of ROI. SLIC super pixel segmentation algorithm is used for rapid and robust segmentation of submarine vehicle. It tested this vehicle successfully for 10 to 18 m and was developing high level patterns in super pixels for navigation. Matthew Dunbabin et al. (2005) describes a truly low-cost AUV for environmental monitoring through navigation, robotics, data harvesting etc. AUV design for a dynamic nature for monitoring, collecting the information of sea life. Also for the improvement by using new technologies such as increase data collection rates, improve collected data etc. In this reef environment navigation becomes even more difficult because of few obstacles such as caverns, overhangs hard and soft corals, rocks etc. The most powerful technique used is vision hardware. It is very cheap and it collects the data which is required. This paper basically develop a low-cost autonomous underwater vehicle uses low cost sensors, hardware required for localization and navigation, without human intervention. The research platform of star bug AUV was successfully developed and is capable of manoeuvring and navigating for reef environment.

II. OBJECTIVE

The objectives of this research includes the following

- To fabricate a prototype of Autonomous underwater robot.
- To design and simulate the different algorithm to get feasible path.
- To test the Autonomous underwater robot in underwater for obstacle avoidance for path planning.

III. SYSTEM ARCHITECTURE

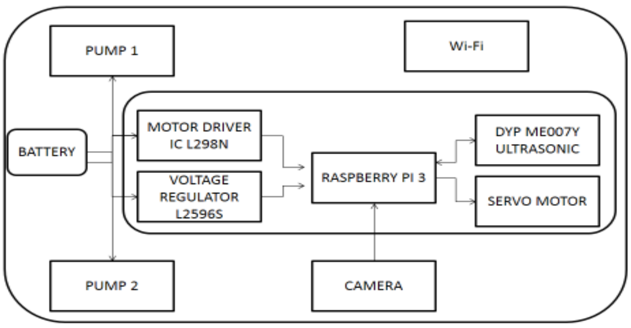

Figure 1 System Architecture

The above figure shows the System Architecture which consists of controller called Raspberry Pi 3, water-proof ultrasonic sensor DYP-ME007Y, motor driver IC L298N, voltage regulator L2956S, servo motor, BLDC Pump, 12V battery and camera. Battery is connected and powered to motor driver and voltage regulator. Camera, sensor and servo motor is directly connected to Raspberry Pi3. Both BLDC pump is controlled by motor driver and powered by it. Voltage regulator is used to convert high voltage to low voltage for controller board.

IV. METHODOLOGY

There are numerous application of autonomous underwater robot such as inspection of sea life, Oil & gas exploration, path planning etc. Autonomous underwater vehicle used in domestic and military field because of its advantages. In this project, obstacle avoidance is foremost approach for feasible path planning. There are different steps that follow the path for obstacle avoidance and check position of the obstacle.

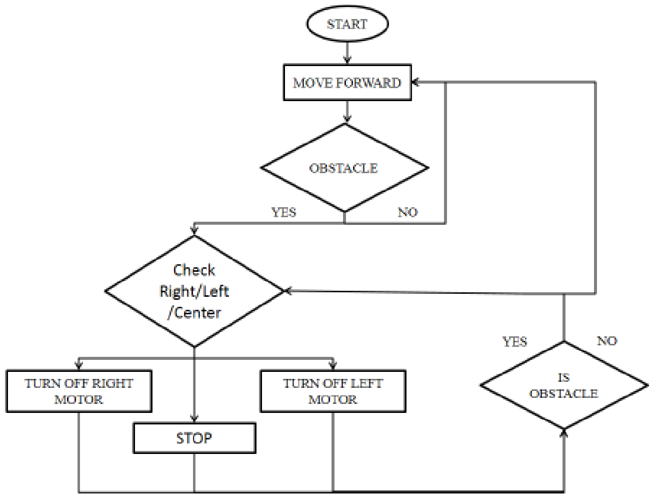

Figure 2 Methodology

- AUV starts moving in forward direction, both motors are running in forward direction.
- AUV checks the obstacle comes into its path.
- If 'Yes' AUV check the obstacle position whether right, left or centre.
- With the help of sensor mounted in servo motor "AUV" check the 180 degree of the beam width divergence.
- If obstacle position is in right side, right BLDC stops and if obstacle position is in left side, left BLDC stops.
- And if the obstacle position is in centre both BLDC stops working check the obstacle and takes the decision to move forward either by right or left.
- After checking the obstacle position again checks another obstacle if it in path than proceed.
- If 'No' obstacle found "AUV" moves forward to reach its goal

V. CAD DESIGN OF AUV

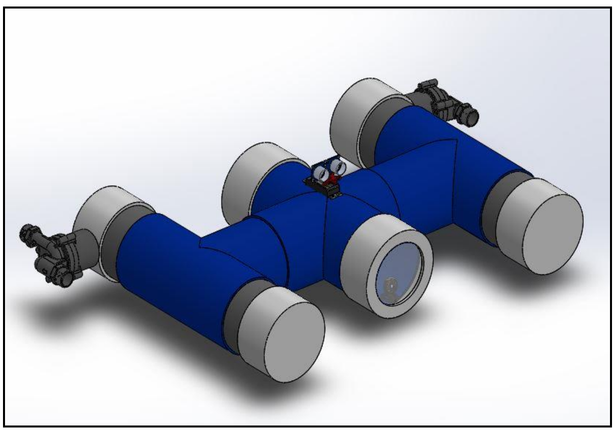

Figure 3 Isometric View of the CAD Design

The CAD design has to been done in SOLIDWORKS. This unique design consider the balancing factor.

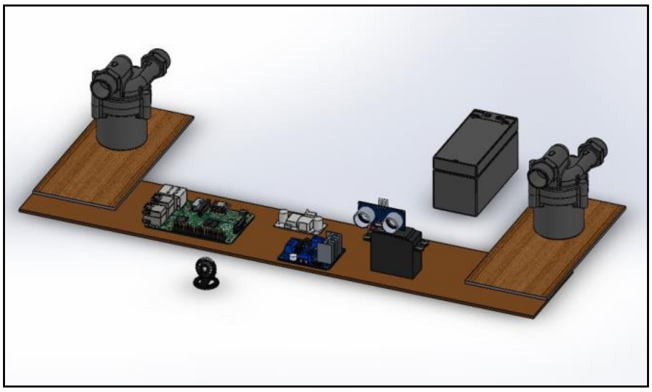

Figure 4 Isometric View of the Components

The above figure 4 shows all the internal unit components modelled in SOLIDWORKS.

VI. EXPERIMENTAL SETUP

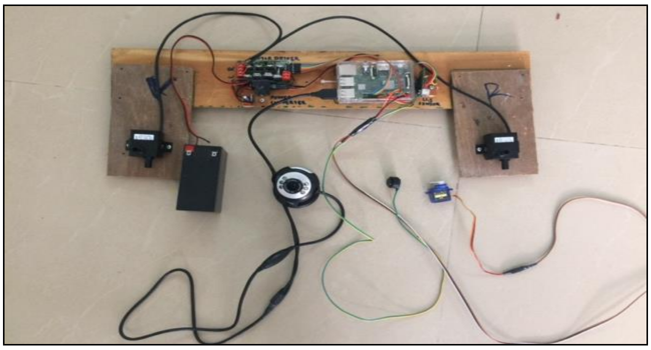

Figure 5 Experimental Setup of hardware components

This is the experimental setup of hardware consist of controller as Raspberry Pi3, Water-proof Ultrasonic Sensor DYP-MEE07Y , Brushless 12V Dc motor, servo motor, camera, Voltage regulator L2596 and Motor Driver L298N. This experiment based on obstacle detection, if sensor detects any obstacle below the range sets pump stop working and with the help of servo motor sensor check 0 to 90 degree. If obstacle detects in right side, right pump stop working only left works and vice versa if obstacle detects in left side, left pump stop working only right pump. Camera captures obstacle picture.

VII. RESULT AND DISCUSSION

AUV PROTOTYPE

Figure 6 AUV Prototype

The above figure shows the prototype of the AUV. The AUV Prototype is made up of PVC pipe which can resist the water. The AUV consists of all hardware components, basically the main circuitry is in the mid of the AUV which consists of Raspberry Pi3. This AUV is tested first on the land to check the output of each components such as sensor, camera and motor. The hardware concept is done for dynamic environment in real time.

Figure 7 Real Time testing of AUV

The figure shows the Real time testing of AUV. This test has been tested in a swimming pool with dynamic environment. The robot detects the obstacle with a distance and take another path for moving forward. Camera vision continuously showing the view after every 2 sec.

VIII. CONCLUSION

The AUV has various application in which the approach of this AUV is to avoid obstacle and get the feasible path. Also the inspection of sea life is to be done. The design of the AUV has been chosen on the basis of stability. This design approaches for 2D view of the sea life. The underwater test has been done in real time in dynamic environment. A low cost underwater robot with single sensor can work well for obstacle avoidance in underwater

REFERENCES

[1]Mike Eichhorn(2005). “A Reactive obstacle avoidance for an autonomous underwater vehicle”, Institute of Automation and Engineering, Germany, 16th Triennial world conference Prague, pp-331-336.

[2] Sumedh Nils Gageik, Paul Benz and Sergio Montenegro(2015). “Obstacle Detection and collision avoidance for a UAV with complementary Low Cost Sensors”, IEEE , Vol 3, pp-559-609.

[3] S.Cusi, P. Rodgrieuz and N. Pujol(2015).“A python tool for AUV-Borne ACDP currents data processing”, Sixth International Workshopn on Maritime Technology,2015, pp- 56-59.

[4]Yu Zhou, Suxia Cui and Youghui Wang(2015). “Design of Autonomous underwater vehicle control unit”, ASSE conference.

[5]Taakai Takemastui, Masayoshi Honda, Masato Ogura(2011).“System design and increment hardware development of an autonomous underwater robot ‘DaryaBird’, Journal Paper, pp-1-8.

[6]Lei Zhang,Da-peng Jiang, Jin-xin Zhao and Shan Ma,“An AUV for Ocean exploring and its motion control system Architecture”, The open Mechanical Engineering Journal, pp- 40-47.

[7]Matthew.A(2008).“Design of a low cost underwater Robotic Research platform”, IEEE.

[8] Dunbabin M, Roberts J, Usher K, Winstanley G, Corke P.(2005). A hybrid AUV design for shallow water reef navigation. InRobotics and Automation, ICRA . (pp. 2105-2110). IEEE.

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