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DESIGN AND FABRICATION OF UNDERWATER VEHICLE

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ABSTRACT

Remotely Operated Vehicle (ROV's) are remote controlled underwater Drones driven by an individual on the surface. These drones are tethered by a series of wires that send signals between the operator and the ROV. It has the ability to carry the medical aid during emergency in water to the harmed person directly with no wastage of time, early aid will lead to early heal and can save life during critical cases. We need not wait for the person to reach the shore or onboard to get his treatment started, as soon as he his rescued the drone takes the kit directly to the person and he his aided at the earliest with no time delay. Trash in the ocean is affecting the health of humans and wildlife, plastic bags, straws, bottles plastics end up in the ocean. It requires a lot of manpower and energy to clean this up, a person or group of people are asked to swim and clean this up by hand picking or they use high machineries to clean which is costly. With the help of drones, we can clean this with less man power and cost efficient to, the drone has a manipulator arm which can pick carry and move stuffs this will help us pick garbage's collect them and clean the ocean. To clean water weeds in ponds, lakes, agricultural fields and other water bodies. These roots are 1m in height and do not hold tight grip to the water but they multiply in numbers and becomes toxic weeds. They damage the environment having a bad impact on agriculture sector, electricity production, transportation, health, living conditions and social structure. To clean this again require a lot of man power, energy and big machines which is time consuming and costly, with the help of the drones we can clean them up in a swift of time. The multipurpose drones can also be used to clean swimming pools and small water bodies.

Keywords: Drones, Signals, Trash, weeds.

I. INTRODUCTION

Remotely Operated Vehicle (ROV), sometimes known as underwater drones, are any vehicles that are able to operate underwater without a human occupant. Remotely Operated Vehicle (ROVs) is remote controlled underwater Drones driven by an individual on the surface. This is the vehicle which can submerge in water and has no crew member present in it. It is operated by someone who is on surface or on ship with the help of group of cable connected between rov and the ship. Generally rov's are manned with camera, lights and many other sensor to perform variety of different task. the operator can manipulate or do some changes with the robot, so that he can avoid some obstacles, or for any other reason which is suitable to get the work done successfully. In many situation like clearing the minefield which is a hazardous situation and very expensive to send a submarine to clear the minefield, in such situation we can deploy the rov and get the work done efficiently. Two important parts considered in the design of the vehicle to be stable, point of the center of gravity or center of weight and center of the buoyancy force. These determine the stability characteristic of vehicle, in which the vehicle stability means the ability of the vehicle to be on the equilibrium condition even when there is an external force or any external disturbance. Good stability indicates the center of gravity is underneath the center of buoyancy force and the longer distance between center of gravity and center of buoyancy the higher moment stability and stiffness of motion. The Rov uses buoyant tube at the top and weights at the bottom. The propeller was chosen as a ducted one instead of conventional and this propeller had small diameter. It is installed with fixed mounting angles as it is simple in design. The Rov is also designed to be stable under force disturbance. Therefore, we have took proper care in designing Rov so it remains stable in water. The ROV is designed with a propeller system for its movement. The major difference between other

Unmanned Vehicles and this underwater drone is that it uses a Manipulator arm, This Manipulator arm is fixed on to the bottom of the drone which is used to carry, lift, and pick objects, they are also used to move objects from one place to place. With this application we can provide emergency medical kits to people harmed in the sea, like before we may not wait for the person to get on board for treatment, the UUV will get the medical kit wherever u are on waterand provide on spot treatment, the second application is that to collect garbage waste floating on water using its manipulator arm. Apart from these applications the ROV can be used for surveying large ships for cracks, oil leakages in pipelines, ship maintenance, collecting water samples, hydrology, Military uses etc. These drones are tethered by a series of wires that send signals between the operator and the ROV, the drone is driven by 3 propellers and a camera with high resolution and high sensitivity to darkness and a torch light.

II. METHODOLOGY

Design Alternative 1

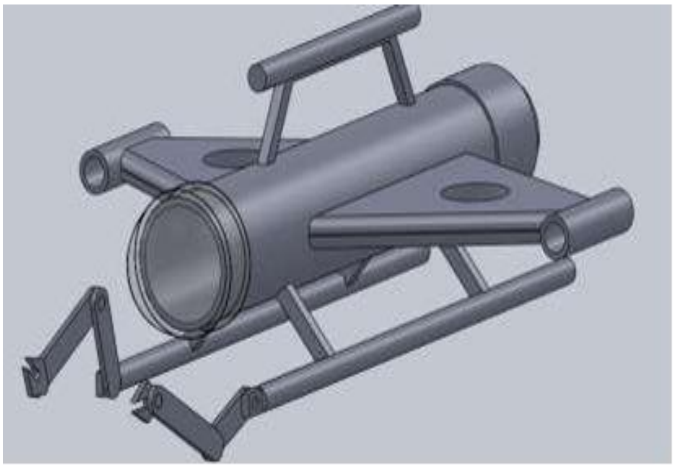

Figure 1: Design Alternative 1 model

The first design that was observed is shown above in Figure 1. This setup use two legs at the bottom of the remotely operated vehicle that is useful for many purpose. Thus the vehicle exerts a buoyant force and it moves upwards. The propeller used to propel the vehicle increases the efficiency and has lower diameter compare to non- ducted propeller. Ducted propeller is being installed on the on the main structure.

Apart from it rotatable propeller can be used to decrease the no of propeller installed for application in multidirectional movement. Thus considering all aspects vehicle is designed according to and the byounacy of every part is designed properly so as to improve the vehicle stability.

Design Alternative 2

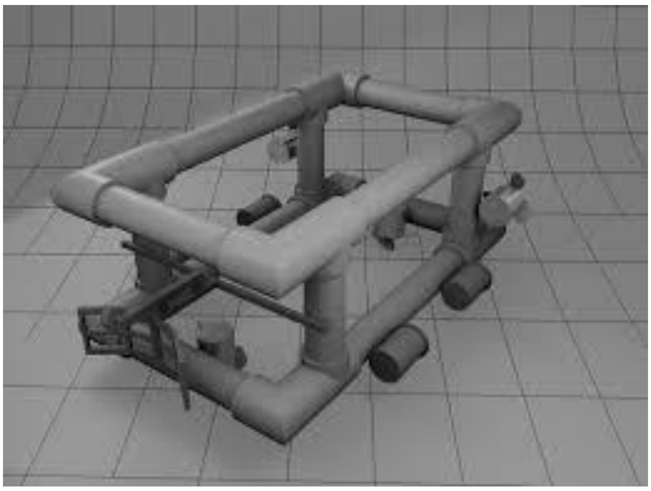

Figure 2: Design Alternative 2 Model

The second alternative of the design was to make it in the shape of a box. This setup follows the traditional design of ROVs. The complete setup is like it is fully closed just like a cage with weight on the downside and foam on the upside and all the electronic system is in the middle of the ROV such as figure 2. Having a box setup allows the components to properly get fit on the cage, which makes it easier to construct and increases stability.

To achieve the desired buoyancy the manipulator arm and the weight would be placed underside of the cage followed by manning the foam into four section at the upper side of rov in specific location while camera and four thrusters would be implanted around the outside of the cage so that they balance each other. All electrical components would beat the center, and properly placed in a cylindrical body for their protection. The materials considered to this design are the same as Design Alternative1.

This rov is bigger in size as compared to the other rov's who is not having a cage like structure. and it is designed in such a way that it is less hydrodynamic than the design alternative 1. the advantage of the cage like structure is that it can be implanted and carry additional instrument even after the rov has been built while in the uncaged setup it is not possible to implant any other additional instrument, the uncaged rov can only carry the instrument for which it is designed.

Proposed Design

Figure 3: Proposed Design

As the proposed design shown above, we decided to unite the design alternative 1 and design alternative 2, as our aim was that we have to built this rov as hydrodynamic as possible while keeping the balance of the system as well as the capability to add more instruments. This design would be compact meaning almost every possible component would be placed as close as possible while leaving space for specific additions. A smaller ROV increases the maneuverability of the system under water.

This model will have a foam on top and every other thing will be enclosed around the cage. The four thrusters will be placed accordingly for the proper movement of the rov. The robotic arm will be detachable so we can remove it when not needed.

For this design, the team plans to try the same type materials as the alternatives but would like to experiment also with a fiberglass body.

Actual Design

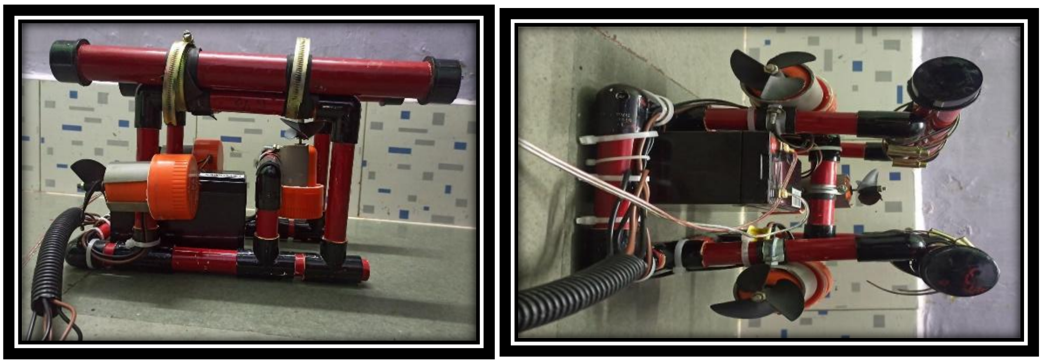

Figure 4: Actual Design Outcome

The actual design is a culmination of the first design alternative and the proposed design. The main difference was that there was no cage-like structure. The ROV uses two EDF's for forward and reverse thrust, a brushless motor for lift.

III. DESIGN CALCULATON

Determination of Forces

When the ROV is submerged, the magnitude of forces acting on it change drastically. These changes occur due to change in pressure of water caused by variation in depth . The relation can be obtained using the equation(1).

$P = \rho \times g \times h$ …………(1)

Where:

P = Pressure change [Pa]

ρg = specific weight of the liquid [N/m3]

h = Elevation change [m]

Substituting the values in equation (1), the specific weight of the water is 9805 N/m3 (at 15 C) and depth is 20 m, the water column exert the pressure of 0.196 MPa was obtained. Due to the force acting the hollow cylinder. The stresses developed, to find the failure condition of the structure, we need the value of strains and their direction. The total pressure equal to the difference between atmospheric pressure in cylinder and the pressure exerted on the cylinder. In equation (2) substituting the value of the pressure exerted and the value of internal pressure of the remotely operated vehicle. In equation (2) the total pressure of 0.0925 MPa was obtained.

$P_r = P_{wat} - P_{atm}$ ……………………(2)

Where:

P_r = Net Pressure [Pa]

$P_{water(abs)}$ = Water pressure at 20 m [Pa]

P_{atm} = Atmospheric pressure [Pa]

The critical pressure of a material refers to the pressure it can withstand before failure. The value was found by using equation (3).

$$P_{cr} = \frac{2E}{1-\mu^2}\left(\frac{e}{D-e}\right)^3$$

Where:

P_{cr} = Critical pressure (failure condition) [Pa]

E = Modulus of elasticity of the material [GPa]

e = Pipe thickness [m]

D = External diameter of the pipe [m]

μ = Poisson's ratio

Substituting the values in equation (3), elasticity for PVC as 2.89 GPa, the Poisson's ratio as 0.410, the thicknessof the pipe by 0.003912m, and the outside diameter of the pipe as 0.06032 m, a critical pressure of 2.317 MPa was obtained. The critical pressure is greater than the total pressure acting on the ROV the casing would be safe under the working condition.

Design of Immersion System

When an object is immersed in a liquid, the force is generated to push the object towards the surface, this is known as force B.

$B = \rho \times g \times V$ (4)

Where:

B = Buoyant force [N]

ρ = Fluid density [kg/m^3]

g = Gravitational acceleration [m/s^2]

V = Volume of displaced fluid [m^3]

The immersion system facilitates the vertical motion of ROV in water. There are two ways for executing the immersion system viz. a) Mechanical method by using propellers b) Hydraulic method by using ballast tank. For the sake of simplicity, the mechanical means of immersion is used. Substituting in (4), density of water is 1000 kg/m^3, gravitational acceleration of 9.81 m/s^2 and the volume of displaced fluid as 0.0048921289 m^3, the force was determined to be 47.99 N.

From the above result, we can obtain the force required for immersion and vertical downnward motion of rov. To calculate the power required by the propeller to overcome this buoyant force, following assumption were made:

- Dimension of ROV : L = 35 Cm, B = 15 Cm, T= 20 cm
- The Condition of ROV operation is sea water.
- Force of drag is calculated at the maximum speed of ROV is 0.51444 m/s
- Drag coefficient is 0.8.
- We have used CAT-5 cable which has 20 m length and diameter is 5 mm. drag coefficient is 0.4 .

As the equation of drag did not include the added mass effect, we should add 10% correction into the final result. Equation of drag force ,

$F_d = (0.5\,\rho V^2 C_d A)_{ROV} + (0.5\rho V^2 C_d A)_{cable}$ (5)

$= 49.3916$ N

Where:

P = Fluid Density

V=Unit Velocity

C_d = Drag Coefficient

A = Frontal Area

A marginal correction due to effect of added mass is added to the final result as mentioned above;

$Fd' = 49.3916 + 0.10 \times 49.3916 = 54.33$ N

Power required,

$P = Fd \times V = 54.33 \times 0.5144$ ……………(5)

$= 27.9499$ Watt

Where:

P = Power [W]

F = Force [N]

v = Linear velocity [m/s]

Using above equation, P = 27.9499 W. A commercial motor of power 36 W was chosen. To achieve perfect vertical motion and dive, the propeller was located in the centre of ROV and weights were added to the front to balance the weight of the rear thrust motors.

IV. RESULTS AND DISCUSSION

After the ROV was designed and modelled it was moved on to the next stage that is testing, we found a tank for our tests so that the water would be still and stagnant water was very useful for our primary tests.

Figure 5: Float Test

The most primary and important aspect of the design and model was insulation, as all the avionics components are present inside the fuselage it was mandatory for water not to enter it and the insulation to be high. The insulation test was done and there was no water leakage and no water affected the internal components during the test.

Silicone Gel, PVC solvent and M seal an Epoxy Compound was used to insulate the model, Utmost care was taken near places which were drilled and components were mounted, the end caps of the ROV was silicon gelled so that there was no excuse of water entry even through the end capos of the fuselage.

After finishing the Insulation test the Float test was followed, the aim was not to have excess weight as theROV would sink so the weight of the components used was always checked, the ROV was left free for some time in the water without any disturbance and the ROV failed to sink and stood stable which was a success.

As the fuselage pipe was filled with air and was hallow the Buoyancy force was more which kept the ROVfloating and rather sinking though it weighed around 2.5 kg. The Centre of Gravity of the ROV is around 0.55meter from the Rudder which is almost away from the Centre of Buoyancy making it more stable and still.

After all the tests were done the ROV was again rechecked for any water leakages and was seen that no water entered it in, the battery was always in backup in case we ran out of battery during testing, extra insulationwas in hand and the working was recorded for future references and studies.

And we also did the submergible test of this rov and it work perfectly nice.

V. CONCLUSION

Remotely operated vehicles can help us to analyze and examine the sea or ocean without actually going into the sea. These rovs are very easy to use and can be used by a person who is on surface or on ship. these rov can be controlled easily and it just feel like playing a video game in joystick. Sending and receiving of electrical signals back and forth between the operator and vehicle is done by group of cables which is connected between rov and the ship. Most of the time remotely operated vehicles are at least readied with a camera and light so that the rov can record, capture or show live video back to the ship or the person who is operating rov. Many other equipment can be fitted in rov depending upon our need, such as manipulator arm, cutting arm, water samplers and other instrument to measure the water clarity, temperature or dissolved chemicals etc. There are many applications of rov in oil and gas company, in science research, in military application etc. As the technology being better day by day, the rov will perhaps one day will be capable of travelling into the deepest depth of the sea.

VI. REFERENCES

[1] Yannick Allard, Elisa Shahbazian, "Unmanned Underwater Vehicle (UUV) Information Study OODA Technologies Inc.4891 Grosvenor Montr´eal (Qc), H3W 2M2 514.476.4773.

[2] Ottar L. Oseny, Rolf-Inge Sandvikz, Jørgen Berge Trygstady, Vegard Rogney, and Houxiang Zhangz. "A Novel Low Cost ROV for Aquaculture Application" Software and Intelligent Control Engineering Laboratory.

[3] Gabriel Martos, Ashley Abreu, Sahivy Gonzalez, "Remotely Operated Underwater Vehicle" EML 4905 Senior Design Project, A B.S. THESIS, September 21, 2013.

[4] Bharat Kungwani1, Noopoor Misal, "Design and Fabrication of A Low Cost Submersible ROV forSurvey of Lakes". International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056

[5] Abishini A, Priyanka Bas, Raque Bertilla , Haston Amit Kumar, " Design And static Structural Analysis Of An Aerial And Underwater drone" International Research Journal of Engineering and Technology (IRJET) e-ISSN:2395-0056.