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A COST-EFFECTIVE AND RELIABLE TEST-BED BODY STRUCTURE OF A REMOTELY OPERATED UNDERWATER VEHICLE

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Abstract

A Remotely Operated Underwater Vehicle (ROV) is a robot which works underwater for certain purposes, such as the need for inspection of a ship's hull for maintenance, damage or security is becoming increasingly prevalent. The jobs are presently being performed by divers. This may include a series of dive teams or appropriate deck gear to lift and deploy the divers. A simple, lightweight and easy to control vehicle for rapid response prior to ship hull inspection requirements would be an important asset for the shipyard and also related field. Hence, this project is done to design and fabricate a cost-effective and reliable test-bed body structure of a remotely operated underwater vehicle.

Keywords*:* cost-effective, reliable test-bed body, lightweight, remotely operated underwater vehicle

1. Introduction

The exploration of underwater environment is quite challenging due to the limitation of the deep sea, safety of divers and cost. High quality wet suit and diving equipment set do not comply with the underwater surrounding on line with the increasing of the depth. The unmanned underwater vehicle, (UUV) is introduced BY the high technology attached to overcome the limitation of underwater work in person. The UUV carries instrument and equipment regarding to their application for instance, commercial underwater vehicles sector, underwater surveying, underwater rescue, underwater inspection and others. The UUV consist of different type, shape, size depending on the application of deep sea scientific research (Chadwick, 2002). The UUV outfitted with the lighting system, broadcast quality camera and sensors state that the experimental components have been configured to the work in the extreme environment.

Nowadays, maritime industries, especially in underwater activities need underwater vehicles due to high cost, high risk of security and time lagging for underwater inspection by human or divers (Mcmillan et. al, 1995). Some researchers believe that underwater vehicles one of the most important equipment for ease people to explore and expose marine environment due to the limitations of human subsea divers.

2. Review of Previous Design and Fabrication of ROV Structure

The ROV was designed as Close Frame which that it was hull in designing and different parts of the robot such as thrusters, electrical boards, and waterproof cameras and mounted in different places in an aluminium structure. These waterproof units are connected together by means of special connectors also known as Wet Connectors and sealed Hoses (Nima Harsamizadeh et. al, 2010). The hull shape of the AUV is similar to the general ROV structure which is suitable for mounting loads and the efficient use of space. The frame made of stainless steel to prevent rusting which is a rectangular piped shape (Byun et al, 2007). The frame was constructed of Polyvinyl chloride (PVC) piping held together by PVC connectors. In order to compensate for the battery containers, the size of the frame was dramatically increased. The ROV PVC primer and cement were used to hold the piping together whereby PVC cement made the frame watertight and end of PVC, two caps were integrated into the frame to fill with water if needed. Furthermore, there are about contradicting requirements which is interfaced between the frame and performance is dependent on the dynamics of the vehicle. The frame design represented a critical step in setting the requirements for both modules. A design was developed by considering the requirement that the modules are easy to attach and remove from the frame was maintained (Sinha et al., 2007).

The ROVs were best suited to work operating in slow speeds and it required as the body design is asymmetrical and sensors were attached to its inherent open frame structure (Chin et al, 2012). Moreover, waterproof motor necessary and Filho said that an aluminium housing-shield was built because it resists the corrosion caused by seawater, besides being cheap, light and easy to handle (de Carvalho et al, 2000). Besides that, there are two types of motor compartments constructed from PVC piping, one for the vertically aligned motors and one for the horizontally aligned motors. The frame is rectangular configurations consist of two internal vertical members and three horizontal members. The internal members are used for frame stiffness and hardware support and made of foam filled pultruded fiberglass square tubing and channel. The frame is fabricated with miter joints and butt joints on all members (Nicinski, 1983). The main structural components of the ROV are two buoyancy devices or pontoons, which provide buoyancy and help achieve the required tasks and were designed using SolidWorks.

A vertical thruster in the centre of each pontoon separates each pontoon into two independent chambers. On the outside of each pontoon, a horizontal thruster is mounted using High density polyethylene (HDPE) brackets and joint with one forward and one aft of the thruster, so that one pontoon is ported and the other starboard (Howse, 2009). In the marine environment, the material used for underwater manned vehicles and remotely operated unmanned vehicles does not contribute significantly to the weight of the structures. One of such materials is acrylic or polymethyl methacrylate that is transparent, which has it allowed the occupants of the submersible or underwater observatories to observe and study of hydrospace.

3. Result and Discussion

Through SolidWorks, the design by step had been developed. Began with the designed part of the structure, assembled until the structure was simulated for the density of the ROV. Design by part consisted of their measurement and material of that structure to find the perfect ‘mate’. SolidWorks Part Document was used in (.SLDPRT) format. The structure was drawn the part before assembles each part of a solid structure as shown in Figure 1. Each part must draw by the view of the structure such as front view, top view and right view to get the perfect match of assembly which is consisted of 41 parts. The part A, B, C, D is the several components of the structure. Part A is the motor of the ROV. The part B which is pipe for assembling between part C (tee) and part D (elbow).

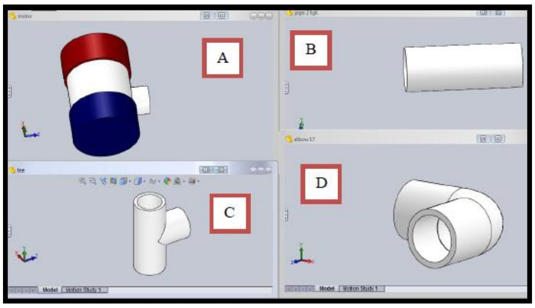

Figure 1: The several parts of the structure

During the assembly process, the part was 'mate' using the SolidWorks Assembly Document (.SLDASM) file. This design was shown about the basic structure of an ROV for moving purposes. According to Figure 2, the ROV was viewed from front, left, top and trimetric was shows the motor placement which is used to produce four degrees of freedom movement. The motor attached are using thrust force which is a water jet system that push the water out of the input water as blue part. In the vertical placement, the motor used for lift ROV up and down while the horizontal placement was used for turning forward, port and starboard. If the ROV makes a turning to the starboard, the speed of the motor on the left was increased than the motor on the right. Otherwise, the vehicle was turning to the port side, it's vice versa to the turning process to the starboard side. Moreover, with the constant speed of both motors arrows B and C, the ROV is moving forward towards arrow A.

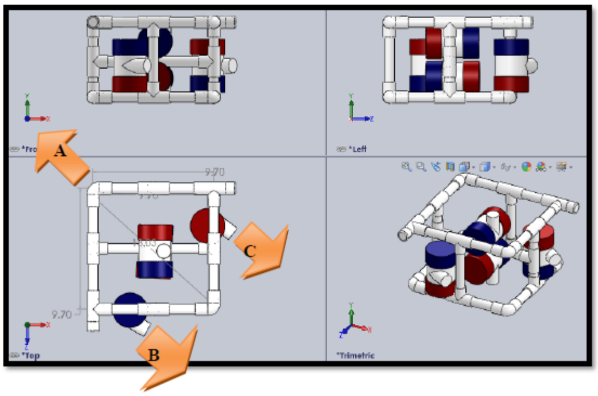

Figure 2: Assembly component as the ROV structure

Simulation of the ROV structure is done to identify the density of the ROV where is the density of the PVC is higher than the density of fresh water and sea water as shows in Table 1. Means that the ROV sinks in both water conditions (fresh water and seawater). Due to this reason, during the fabrication, modification was made to ROV is positive buoyancy.

Table 1: Density of ROV structure

Volume of ROV structure	**Density of ROV structure**	**Density Fresh Water, ρ**	**Density Seawater, ρ**
1.97x10-03 m3	1300kgm-3	1000kgm-3	1025kgm-3
Buoyancy = ρV		**1.97N**	**2.02N**

The development of the project consists of assembling the structure. The ROV was developed by using the UPVC and attached by three types of camera which is shown in Figure 3 (E, F and G) as vision systems. The 4 placements of the same type of motor, (B) for horizontal movement and (C1 and C2) for vertical movement which has been already been explained previously. Moreover, the ROV structure was equipped with the floating equipment (A and D) in Figure 28 to get the natural buoyancy of the ROV, UPVC pipe as the main material used.

To increase withstand of pressure to the UPVC pipe, another PVC connector will put and seal with PVC cement for making sure the ROV is waterproof. From the ROV frame, the buoyancy of the structure is carried out so that the ROV can be easily submerge. The weight will be used to encounter the buoyancy problem by playing around some buoyancy experiment such as using the buoy.

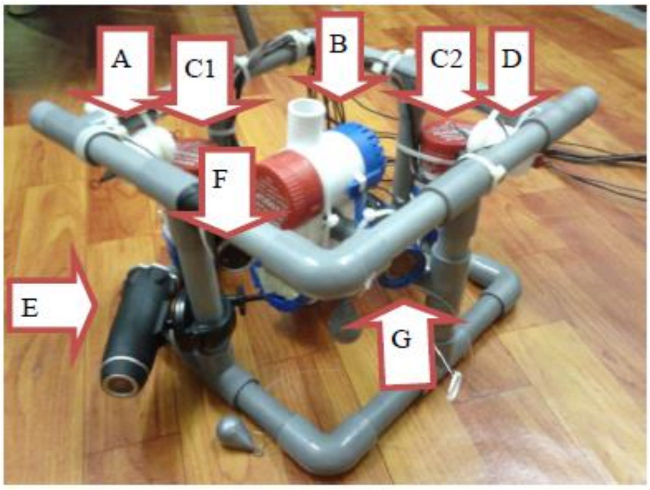

Figure 3: The implementation of the design

4. Conclusion

The vehicle's design is an important process before implemented to fabrication stage. The design should be able to be more stable underwater, this can be achieved by understanding the manoeuvring concept, the Archimedes principle, and the aerodynamic concept even better. These concepts and principle can produce an integrated results to sophisticated design with the proper material and last longer. The beneficial of this project, a design of ROV is to be produced with the buoyancy system for ROV will be tested and implemented. The ROV can be used for underwater inspection and ground mapping.

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