Design and Development an Underwater Glider Using Remote Control

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Abstract— **This project is about developing an underwater glider. It's driven depending on buoyancy adjustment of itself and move horizontally wing. Underwater glider becomes more important especially in oceanographic and this project is concerned with the design and development an underwater glider using remote control (RC). This glider is designed by using a buoyancy control to make the glider become float and using a hydrodynamic concept. The main part of this an underwater glider consist of wings, tail, receiver and transmitter board, DC motor, fan and remote control. This glider is controlled by using radio frequency (RF) with 4 channels. The RC will control the movement of a glider and the DC motor will be used to rotate the fan. However, DC motor spins too fast and has too little torque to drive the loads. Thus, gear reduction is required to slow down the rotational speed and increase the torque of the motors.**

***Keywords*— an underwater glider; Remote control;** DC Motor

I. INTRODUCTION

The main purpose of this project is to design and developed and underwater glider using remote control (RC). Since nowadays there are many new kind of underwater glider have been developed till an advanced state. The development of the Underwater Gilder is presented as an example of the implementation process for a mechatronic product.

An Underwater Glider is a underwater vehicle that is driven through the water by a propulsion system and control by a remote control (RC). Radio frequency will be used as a signal between a remote control (RC) and the glider body. There have a receiver and transmitter board to transmit the signal. Motor and fan function as a thruster which being a main part for movement purpose. There have 4 channels in the remote control.

An Underwater Glider has been designed by using SOLIDWORK software before convert to the actual vehicle. The basic information about the remote control, hydrodynamic concept, buoyancy adjustment and motor will be implementing in this project.

To build this project, it requires the knowledge that not readily offhand. There are three main parts need to be investigated in order this project will be successful, design of the glider body for mechanical part , motor and remote control for controller purpose and underwater glider concept such as a hydrodynamic shape and buoyancy adjustment. An underwater glider is a type of Autonomous Underwater Vehicle (AUV) that uses small changes in its buoyancy in conjunction with wings to convert vertical motion to horizontal, and thereby propel itself forward with very low power consumption [1]. It also drives through the water by a propulsion system, controlled and piloted by an onboard computer or remote control. In order to design any underwater glider it is essential to have strong background knowledge and fundamental concepts and theory about the processes and physical laws governing the underwater vehicle in its environment.

II. DESIGN METHODOLOGY

The design methodology of the project is introduced in this section. Methodology is a process or procedure that need to follow and done in designing and developing project. There are two phase of Underwater Glider. It is mechanical design and electronic circuit. The design procedure of Underwater Glider must be carefully followed step by step and the entire design factor must be taken into consideration. To design an Underwater Glider, the project process should be identified first as shown in Figure 1. It can be classified into several stages. The first stage concentrates on the design concept of the Underwater Glider. The later stages can be described the development of the mechanical structure and development of the electronic design of the Underwater Glider. Thus, the SolidWorks software is used to draw and animate the Underwater Glider that are proposed and expected. Another section is the final stage is concluded with its testing, appraisal and minor adjustment. The design flows of the design and development of Underwater Glider is shown in Figure 1 .

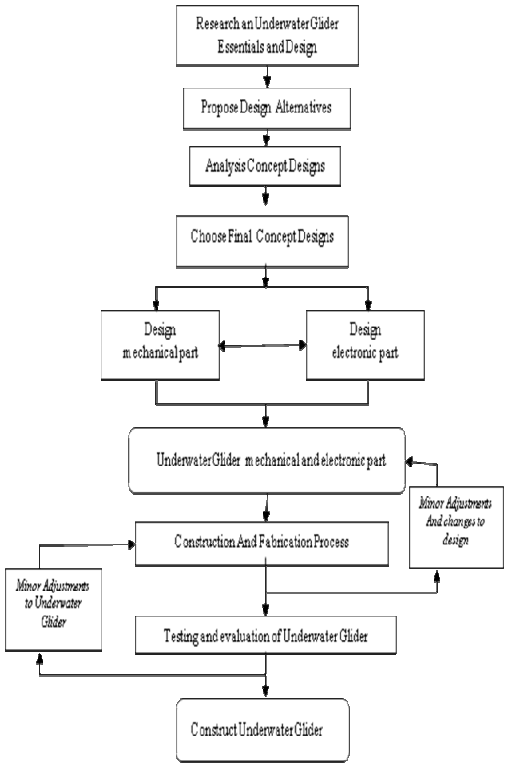

Figure 1. The Design Flows of the Design and Development of Underwater Glider

III. THEORY

The knowledge and fundamental concepts are very essential before designing any vehicle. These include the processes and physical laws governing the vehicle in its environment. With regard to an Underwater Glider, factors such as buoyancy, stability, hydrodynamic concept and controller have to be taken into consideration.

A. Buoyancy

In physics, buoyancy is the upward force that keeps things afloat. The net upward buoyancy force is equal to the magnitude of the weight of fluid displaced by the body. This force enables the object to float or at least seem lighter.[8]. The Figure 2 shows the force work in buoyancy.

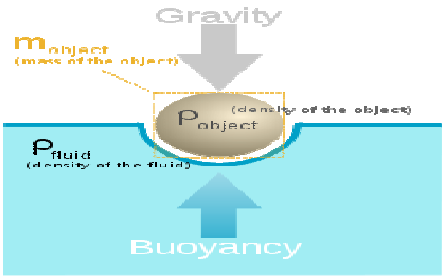

Figure 2. The Force Work in Buoyancy

B. Hydrodynamic Damping

When a body is moving through the water, the main forces acting in the opposite direction to the motion of the body are hydrodynamic damping forces. These damping forces are mainly due to drag and lifting forces, as well as lineal skin friction .Damping forces have a significant effect on the dynamics of an underwater vehicle which leads to nonlinearity. Lineal skin friction can be considered negligible when compared to drag forces, and therefore, it is usually sufficient to only take into account the latter when calculating damping forces. [6]

C. Stability

A floating object is stable if it tends to restore itself to an equilibrium position after a small displacement. For example, floating objects will generally have vertical stability, as if the object is pushed down slightly, this will create a greater buoyant force, which, unbalanced against the weight force will push the object back up. [8]

Assuming no water movement, the stability of a static body underwater is predominantly affected by the positions of the centres of mass, C_M, and buoyancy, C_B. The centre of buoyancy is the centroid of the volumetric displacement of the body .If C_M and C_B are not aligned vertically with each other in either the longitudinal or lateral directions.[6] then stable and instability configuration have been shown in Figure 3.

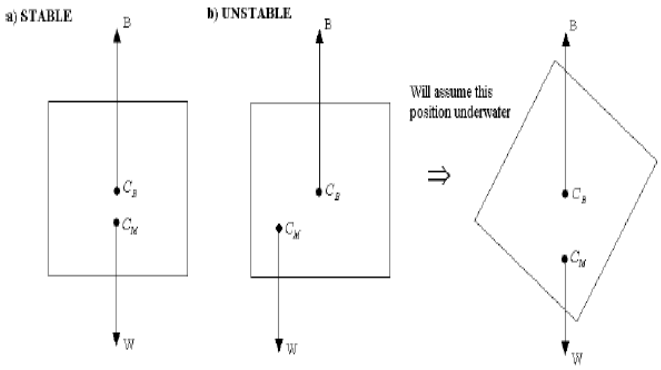

Figure 3. Stable and Unstable Configuration

IV. RESULT

In every research and project, the main point need to focus is the results and findings. This section discussed about the result for design and for an Underwater Glider. At the end of this project, this underwater glider can be floats on surface of the water by using buoyancy concept. This underwater glider also can moves forward, reverse, turn right and turn left by using remote control (RC) through radio frequency signal. The result is a drawing of Underwater Glider which draws by using SolidWorks

software. This design considers the design and dimension of the Underwater Glider body from the literature review but the dimension maybe will be changed after construct the actual vehicle. The design of Underwater Glider has been shown on Figure 4 (isometric view) and Figure 5 (four views).

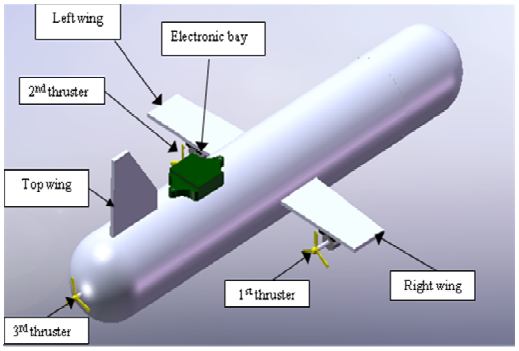

Figure 4. Design of Underwater Glider (Isometric View)

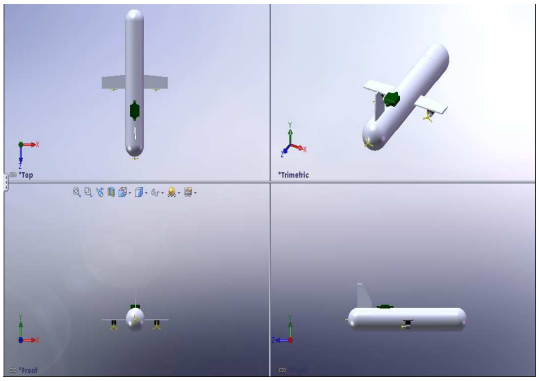

Figure 5. Design of Underwater Glider (Four View)

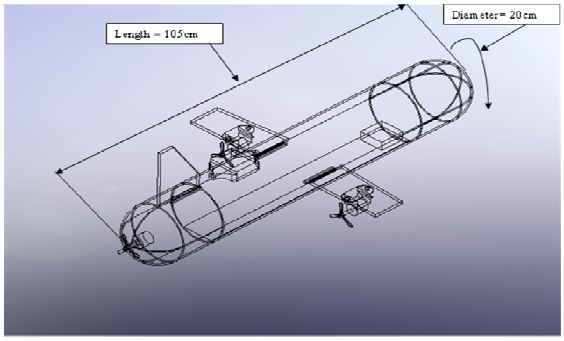

Figure 6. Dimension for the Length and Diameter of the Glider

The Figure 7 shows the Thruster at left and right side in SOLIDWORK drawing and actual thruster. Thruster is combination of motor and fan which acts as actuator at left, right and back side. This Thruster is design with water resist on the motor to avoid the motor risk caused by water.

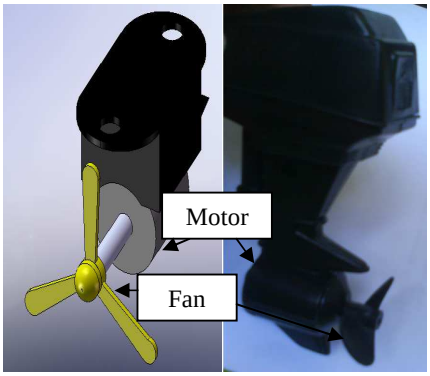

Figure 7. Thruster

V. CONCLUSION

As a conclusion, the expected and preliminary result has been described. Based on the previous section, the project planning is very important before starting the project. Project planning plays important role in any projects that have been made to ensure the project well-oiled and successful. Besides that, literature review can helps to understand the background and concept of the

project before starting the project. In addition, methodology is important thing which can ensure the project will be done systematically and follows the rules.

From study were made for this project, An Underwater Glider is a type of underwater vehicle. Underwater gliders are autonomous vehicles that profile vertically by controlling buoyancy and move horizontally on wings. This vehicle are valued for both their expand ability and replace ability. They can be deployed in hazardous environments without risking human divers. In addition, the Underwater Glider have a potential for cheap scalability makes Underwater Glider ideal for large scale and long term data collection tasks. This research aims to design and develop an Underwater Glider control by Remote Control (RC) which can float and moves on water surface with long time. The prototype that will be developed will have a fixed mechanical system and having an electronic part that allows development of various controllers.

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REFERENCES

[1] Rutgers , 2005, The State University of New Jersey, Available at http://marine.rutgers.edu/cool/glider
[2] Jefrie Sherman, 2009, University of California, Available at http://spray.ucsd.edu/.
[3] Sam Arden, Jason Borman, Christian Flemming, Jern Valcin, 2007,The Powered AUV-Glider2007 Senior Design Project. Available at my.fit.edu/~swood/2007 AUV Final Report.pdf.
[4] Todd Allen, Joseph Caldwell, Sean Kuhn, Seth Noyes, 2007, Autonomous Underwater Vehicle:Powered Glider Florida Institute. Available at http://my.fit.edu/~swood/AUV%20Final%20Report.PDF.
[5] Chunzhao, Naomi Kato, 2007, Mini Underwater Glider (MUG) for Education, Osaka University.Available at naoe.eng.osaka-u.ac.jp/naoe/naoe7/MUG/.
[6] Mohd Shahrieel, Hyreil Anuar, Muhammad Herman, Mohd Farriz, 2009, Design And Development Of An Autonomous Underwater Vehicle, Universiti Teknikal Malaysia Melaka, Faculty of Electrical Engineering.
[7] General Theory on Motor, 2009. Available at www.mecatronics.mech.northwestern.edu.
[8] Buoyancy,2005, Wikimedia Foundation Inc.Available at http://wikipedia.org/wiki/Buoyancy
[9] Daniel L. Rudnick,Russ E. Davis, Charles C. Eriksen, David M. Fratantoni, Mary Jane Perry "Underwater Glider For Ocean Research", Vol. 38, 2004.
[10] Joshua Grady Graver ,"Underwater Gliders: Dynamics, Control And Design", May, 2005.
[11] Jeff Sherman, Russ E. Davis, W. B. Owens, and J. Valdes, "The Autonomous Underwater Glider "Spray" ", IEEE.J Of Oceanic Engineering, Vol. 26, No. 4, Oct, 2001.
[12] Masahiko Nakamura, Wataru Koterayama, Masaru Inada, Kenji Marubayashi, "Disk Type Underwater Glider for Virtual Mooring and Field Experiment" ISBN 978-1-880653-70-8 (Set); ISBN 1-880653-68-0 (Set), July , 2008.
[13] Paul G. Fernandes, Pete Stevenson, Andrew S. Brierley, Frederick Armstrong, and E. John Simmonds "Autonomous underwater vehicles: future platforms for fisheries acoustics", ICES Journal of Marine Science, 60: 684–691. 2003.
[14] Jeff Keljik (1995). "Electric Motors and Motor Control." 1st ed. USA: Delmar Publishers.
[15] A Guide For Preparation Fianl Year Project, 2009, Universiti Teknikal Malaysia Melaka, Faculty of Electrical Engineering.