Underwater Technology Research Group (UTeRG) Glider for Monitoring and Surveillances Applications

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Abstract

This paper describes a design and development of Underwater Glider for Monitoring and surveillances applications. An Underwater Glider is a type of Autonomous Underwater Vehicle (AUV). Underwater gliders are buoyancy-driven device. It can alternately reduce and expand displaced volume to dive or climb through the ocean. It has wings to control its motion from vertical to horizontal at very low power consumption. The motivation of this underwater glider is at its long range and high endurance for certain types of mission. Gliders are designed to slip through the ocean a fraction of meter per second to cover hundreds of meters for weeks. It can be used in commercial and military purpose. The design and development of this underwater glider have hydrodynamic characteristic, stability and buoyancy. The simple Microprocessor PIC is used to control the movement of the glider. There are three major phase in developing this glider which are mechanical design, programming and fabrication. The speed and power consumption of the glider in pool and lake are then measured and analyzed. This glider was tested on three types of differences testing area such as lake, swimming pool and laboratory pool. This paper also shows the performances of glider in term of speed and power consumption of three conditions. This glider is proven suitable for monitoring and surveillances application.

Keywords: Underwater Glider, PIC, Weight, Speed, Power Consumption

1. INTRODUCTION

Underwater glider is another type of Autonomous Underwater Vehicle (AUV) that deals with buoyancy changes which coincides with wings to move in upward or downward position. With its low power consumption and quiet characteristic, it is ideal for scientist, environmentalist or military to use for collecting data or surveillance. Therefore, this underwater glider can be small, smart and inexpensive with a longer operating time when compared to conventional AUV's [1]. These conventional AUV's differs from its propulsion mechanism [2]. Thus with this notion, an underwater glider is developed through this project. This project is under Underwater Technology Research Group.

The basic function of underwater glider is it expels and extracts the water inside the nose of the glider. Inside the nose there is a hole and a plunger that plugs up the hole and the motor. When the plunger pulls up, the water would fill the hole and it will points down with the help from wings to keep forward. Then the motor will be activated while the plunger pushes out the water from the nose. The nose becomes light again and glides up to the surface. For this development of underwater glider, this glider will have a hydrodynamic characteristic, stability and dynamic buoyancy. This underwater glider propels itself by an electrical motor-driven propeller. The glider was designed, developed and controlled by the PIC. To explore and sampling the ocean for its biological, chemical and physical data are very difficult and dangerous. To gain more insight on the oceans' process, they used ship based measurement and mooring which is complex, inaccurate and expensive. Thus an underwater glider is built to fulfill these constraints. Underwater glider made it possible for scientist to make complicated studies on effect of metals, nutrients of fish abundance and reproductive success or contamination of chemical or biological toxins and detect hazardous substances. Military also gain from the development of this underwater glider because it is cost effective, has the ability to glide for a long time and distance without compromising its power and also is quiet which is great for military purpose like observing. Furthermore, underwater glider is a vehicle that combines survey capabilities, simultaneous water sampling and environmental data gathering capabilities which is great for scientist to determine the condition of ocean's ecosystem and document its parameter. For this development of underwater glider project, the objectives are stated below:

i) To design and develop an underwater glider and controller for monitoring application such as underwater activities.
ii) To study the performance of the underwater glider for monitoring applications in term of speed and power consumption.

Based on the objectives, this project will have a few scopes and constraints are set in developing and designing this underwater glider. First, this design is strictly for underwater use only and uses a PIC to drive the glider. Secondly, this underwater glider will be tested on three types of water conditions which are laboratory pool, swimming pool and lake to gather and analyze the data received.

2. METHODOLOGY

Throughout this project, the research and learning process will be continued as any problem that might surface we need to learn how to overcome it. Designing the prototype of the glider using CAD will be discussed details. SolidWork software is used because it is easy to implement. Next, the movement of the DC motor is controlled by the PIC. C language program is used to process the data and a C compiler will execute the hex file that will be downloaded into the PIC ship. Then fabrication process will be focus. At this stage the body of the glider and PIC was assembled together to produce a completed glider. The troubleshooting and testing was conducted to get the desired result. There are three categories of designing and project development which are electronic design, mechanical design and software design. Fig. 1 shows the three designs that will be discussed in this paper.

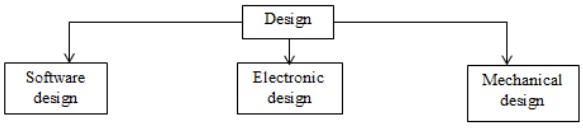

Fig. 1: Project Design

2.1 Software Design

This section explains mainly about the development of a program to control the DC motor. In order to control the movement of the motor, a program was developed. The program is written in C language. The software used for this project is mikro C software. Mikro C is a powerful, feature rich development tool and provides the easiest possible solution to develop applications using embedded system without compromising its performance. To develop the program, the first thing to do is to identify which function to use. In this project, the process in which to move the glider is determined and the algorithm is generated through flowchart. The flowchart is shown in the Fig. 2. To make sure the program source code is well functioning, the codes must be run in the Proteus. Proteus is software for microprocessor simulation, schematic capture and PCB design. Before testing it on the real hardware, the programming must be run in simulation mode to prevent the PIC from damage. It will also avoid the PIC from being burned numerous times because of some small error.

Fig. 2: Flow chart of programming

2.2 Electronic Design

This project, PIC microcontroller, SK40B Microcontroller Start-Up Kit, MD10B motor driver and DC motor are used. All functions and specifications for these components have been analyze and considered the best components for optimized result. The PIC microcontroller that was used in this project was PIC16F877A. This PIC was chosen for its low cost, wide availability and serial programming with reprogramming with flash memory capability. To control the speed of DC motor and movement of the glider, PWM is used. PWM stands for Pulse Width Modulation is a technique used to control power for inertial electrical devices. PWM is used mainly because its power loss in the switching device is very low. SK40B Microcontroller Start-Up Kit functions as a start board for PIC. It is very compact, flexible and powerful with robust start-up platform. It has 40 pins for 16F and 18F PIC with 33 I/O pins. This board is developed with RS232 Serial hardware as an alternative method to load program easily other than burning the PIC with USB PIC programmer

MD10B motor is used because of its capability to drive high current brush motor since the motor that is used in this project is DC geared motor. It also can support up to 10A and has a PWM up to 12 kHz speed control. Also it has a bi-directional control for 1 motor. Meaning it can move in two

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