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Depth Level Control System using Peripheral Interface Controller for Underwater Vehicle

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ABSTRACT

This research explained on a design and development of an Automatic Depth Control System for underwater vehicle. Definition of underwater vehicle is a robotic sub-sea that is a part of the emerging field of autonomous and unmanned vehicles. This project shows the implementation's development of an Automatic Depth Control System on a test prototyping vehicle especially involved small-scale and low cost sub-sea robots. The Automatic Depth Control System assembled with mechanical system and module of electronic system for development of a controller.

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1. INTRODUCTION

Due to technology developments obtained in the last decades, it is potential to employ robotic vehicles for underwater investigation. Over the past few decades, a range of strategies and techniques has been used to observe the sea. More recently, the role of monitoring has been expanded to include the use of underwater vehicles to perform ocean surveys. The scientist or environmentalist may desire to detect hazardous substances in the ocean such as chemicals from an underwater vent or toxic algae such as red tide. Additionally, the military's detection of mines, biological, chemical or radioactive threats are also very important in the monitoring of the seas. These considerations explain today's development of new types of autonomous underwater vehicles with integrated sampling equipment that is able to perform a wide-range of fully automated monitoring surveys over extended periods of time. These vehicles survey and monitor the sea environment in a cost-effective manner combining survey capabilities, simultaneous water sampling and environmental data gathering capacities.

Sliding Mode Controller (SMC) is a nonlinear feedback control scheme. Yoerger [1] developed SMC methodology for the trajectory control of AUV. Yoerger [2] developed an adaptive SMC for the control of experimental underwater vehicle. Song [3] proposed a Sliding Mode Fuzzy Controller (SMFC). The effectiveness of the control philosophy was tested on Ocean Explorer series AUVs developed by Florida Atlantic University. The problem with SMC is the chattering. J Yuh [4] proposed a neural network for the AUV control, in which the error-back propagation method is used. The development of this scheme was motivated by J Yuh [5] which exhibit that the teaching error signal, the discrepancy between the actual output signal and teaching signal can be approximated by the output error of the control system. J S Wang [6] proposed Neuro-Fuzzy control systems. Proportional Integral Derivative (PID) is used for control over steady state and transient errors. PID has been widely implemented in process industries. It is also used as a benchmark against which any other control scheme is compared [7]. B Jalving [8] proposed three separate PID technique based controllers for steering, diving, and speed control. The concept was tested on Norwegian Defense Research Establishment (NDRE) AUV.

Various types of controllers for AUVs are developed by various institutions or organizations to study the responsiveness or capability of their AUVs in the aspect of position control, tracking given reference position and manner trajectories. With the intension to contribute in underwater vehicle research and developments, the authors have developed a simple automatic depth level control system using Peripheral Interface Controller (PIC) for underwater vehicle through the methodology discussed in the next section.

2. RESEARCH METHOD

The flow chart of the methodology is shown in Figure 1. Methodology of the research project has started with the simplify the process of controller, C language programming designs using MPLAB software, simulation using sofware computer aided called Proteus, selection of microcontroller and sensor, fabrication and assembly, and lastly testing and modification.

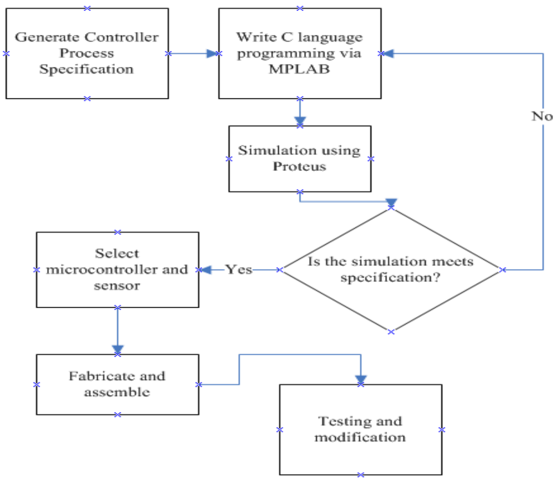

Figure 1. Flow chart of the methodology

The conceptual idea of PIC circuit diagram using PIC16F877A is shown in Figure 2. The diagram consist of power supply, bits display unit using leds, RF receiver module, motor drivers and sensor module.

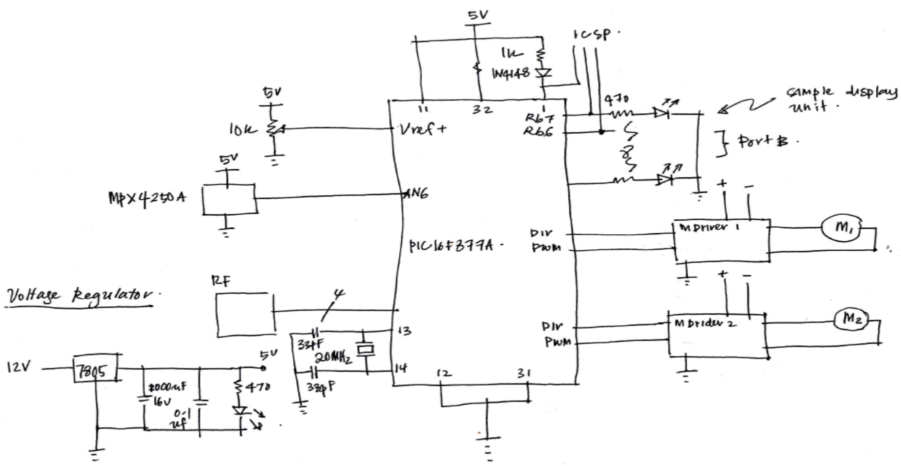

Figure 2. Conceptual Idea of PIC Circuit Diagram

The MPX4250 is designed to sense absolute air pressure. The MPX4250 series piezoresistive transducer is a state of the art monolithic silicon pressure sensor designed for a wide range of applications, particularly those employing a microcontroller or microprocessor with A/D inputs. This transducer combines advanced micromachining techniques, thinfilm metallization and bipolar processing to provide an accurate, high-level analog output signal that is proportional to the applied pressure. The pressure sensor MPX4250 is used to measure the dept which produce small voltage when the depth increases. The MPX4250 needs supply voltage in between 4.85 to 5.35 Volts to operate. The MPX4250 is a low cost and capable to measure maximum pressure of 36.3psi or about 2.47atm. At sea level, pressure due to open air is 14.7psi or 1atm and for every 10meters of depth, the pressure increases about 1atm. The absolute pressure at 10meters underwater is 2atm or 29.4psi.

3. RESULTS AND ANALYSIS

3.1. Flow chart of PIC programming

The PIC programming flow chart for depth control system is shown in Figure 3. The flow chart shows the programming sequence processes to control the ballast tank operation in order to get the require dept.

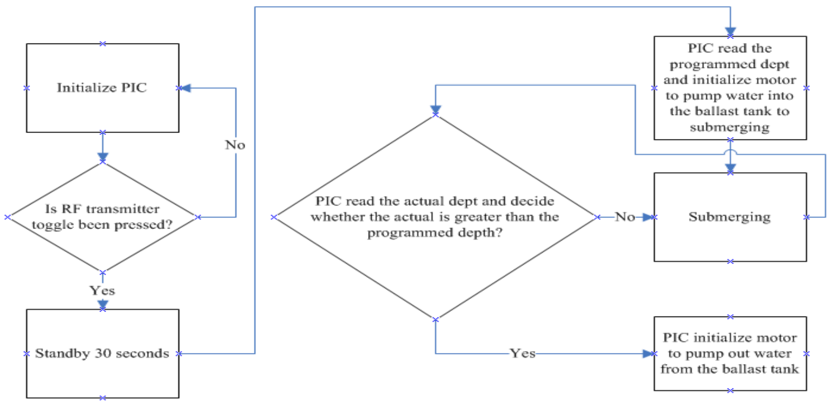

Figure 3. Flow chart of PIC programming

3.2. Sub Section 2

The result of controller fabrication is shown in Figure 4. Figure 4(a) shows the circuit layout for the controller that been design using EAGLE PCB software. Figure 4(b) shows the etching process using suitable chemical. Figure 4(c) show the assembling process of electronic component and Figure 4(d) shows the complete product of the PIC.

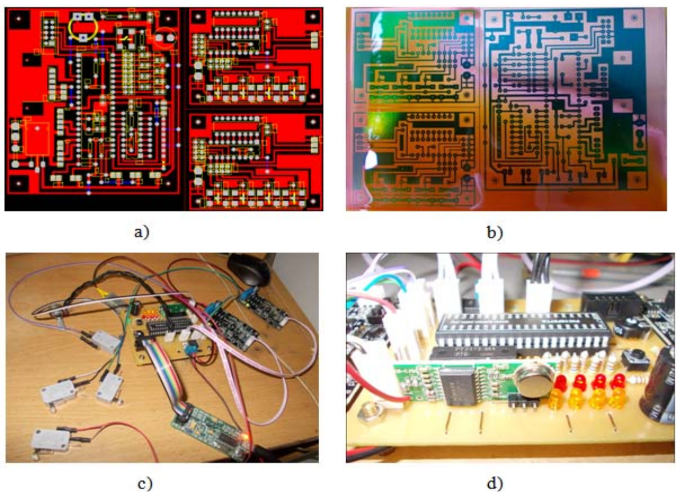

Figure 4. a) Circuit layout, b) Etching Process, c) Assemble Process, d) Complete Controller product

4. CONCLUSION

The automatic depth control system using PIC has been developed as a research tool for conducting research in the underwater robotics applications. Our research aim is to develop a programmable depth control for underwater vehicles system which can execute simple task which control the depth position of underwater vehicle. A module hardware and software of depth control system allowed the researchers to employ the system on their underwater vehicle while testing a new invention. For future efforts, we will consider the cost and other important parameters like the power comsumption, capability and robustness of PIC.

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