

REMOTELY OPERATED UNDERWATER VEHICLE (ROV)

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**BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II**

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ABSTRACT

This report will state in detail the design of remotely operated underwater vehicle (ROV). Basically remotely operated underwater vehicle is control by a user on the boat and the ROV is used for research in undersea location where human cannot be able to reached. Remotely Operated Underwater Vehicle is designed base on low cost material and low electricity consumption. The application of the remotely operated underwater vehicle widely used in industry. Due to feature like camera, robotic arm and etc that can be add on, it very famous in underwater field. Beside this, the ROV is remotely control, so it can ensure the operator's safety from the unknown condition under sea. Thrusters on the ROV enable it to move left, right, forward, backward, up and down. And the movement of the ROV can be control by using programmable logic control (PLC).

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LIST OF ABBREVIATIONS

ROV	-	Remotely Operated Vehicle
PVC	-	Polyvinyl Chloride
PLC	-	Programmable Logic Controller

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CHAPTER I

INTRODUCTION

In this chapter, contains introduction, objective of the project, problem statement, and scopes of work, brief methodology, and report structure.

1.1 Introduction

ROV has several sizes from small vehicles equipped with a tiny water proof camera which is used for observation, and mechanical tools like robotic arm for complex job requirement. Generally they are the freest flying in underwater. The ROV vehicle class includes the majority of low-cost vehicles, mostly are electrical controlled and operates above 984 feet (300 meters) water depth. The next step in advancing the technology is performed by commercial firms that saw the future in ROV support of offshore oil operations and the transition from military use to the commercial world was rather rapid. ROV had gained popularity with the military, oil and gas operations, and science markets due primarily to their quiet operation. In the case of ROV technology the answer is quite simple. There is no other practical, safe and economically feasible way to perform deep underwater intervention.

Due to its potential contributions and high benefit in many fields, a lot of researcher does research on ROV, but most of them are not design for small scale of inspection or recreational needs. Most of the ROV are large size, high deployment weigh

and expensive ownership. The idea of this ROV project is small, low cost, and underwater research vessel that capable of performing in deep depths of the ocean [1].

1.2 Objective

There are three objectives for doing this project:

1. To design a robotic device which can travel through water, controlled by programmable logic circuit.
2. To create movement of the vehicle by controlling the polarity of motor.
3. To create low cost ROV compare to conventional ROV.

1.3 Problem Statement

Under water world are so mystic, especially in the ocean. A lot of scientist and researcher interest in exploring the mystic of underwater world. But there is some problem that researcher will face. The major problem is cost, mostly under water equipment are costly. Due to the programming cost, instrument cost and human resource cost, the ROV are very expensive. Besides this, water proofing also play an important role, electric device will short circuit when expose to water, and that is not easy to water proof a device, because under water there is not water proofing problem, we must not neglected water pressure. Water pressure will cause water proofing failure. Other than this, high water pressure will increase the amp of motor which used as thruster of the ROV, the higher of amp, will break down the voltage regulator. Balance of ROV also is another problem that I face. When a ROV locate under water, the ROV's balance will be affected, that ROV might face problem like head of the ROV is face down, or the ROV is fall to left or right. Last but not least, by using programmable logic control, I not able to control motor speed, because programmable logic control unlike micro controller can generate PWM which can control motor speed.

1.4 Scope of Work

The scopes of work for this project are:

1. Using programmable logic control and interactive program GX-Developer FX to control the movement of ROV. Switches are defines as input of the programmable logic control, and the output of the programmable logic control are connect to relay to create movement of ROV.
2. PVC and silicon will be main material for waterproofing thruster of ROV, the connection between DC motor and cable must well water proofing, besides that the motor also must been water proofed, because water will cause short circuit.

1.5 Explanation of Project Flow

First is discussing idea and direction of my project with supervisor. After discuss, a proposal of a project title is proposed to supervisor and seek for the approval. After decide use PLC as based project, planning and time table is created for this project, after that literature review is done first for this project, the documentation is searched from internet, references book and also seek for supervisor help. Due to lack of PLC knowledge, so study the PLC programming language is needed, than reviewing other part of project is needed also. The next stage is study the movement of the ROV. After all this, fabrication of the real project is proceed, than do testing on it, if the ROV are fulfill the objective of this project, than the project can consider as successful. But if it is not fulfill the project objective, than analyzing why it will not fulfill the project objective is needed, and start troubleshoot it.

1.6 Report Structure

This report is to deliver the ideas generated, concepts applied, activities done, and finally the product of project itself. It consists of five chapters. Following is a chapter-by-chapter description of information in this report.

Chapter 1 gives reader a basic introduction to how the idea of this project generated. The chapter contains introduction, objective of the project, problem statement, scopes of work, brief methodology, and report structure.

Chapter 2 is a literature review on theoretical concepts applied in this project. The chapter concludes the background study of ROVs. Besides that, this chapter also explains how the ROVs work, what is PLC, what is waterproofing dc motor, and application of others component.

Chapter 3 introduces the methodology of the project. The chapter contains the flow chart which explains the overall method taken along the project carry out. Besides that, this chapter also introduces the construction of the project, which involves hardware development and software development. Basically, the hardware development for the project concludes with circuit design, prototype and body design. On the other side, the software development of project will discuss what programming is used, how to use the PLC, and how to implement it on this project.

Chapter 4 will be covered all the result from designing process. It will also include a discussion about the project. The chapter concludes with discussion on ROVs and control circuit for the system.

Chapter 5 will be conclusion of the PSM project. The chapter concludes with some recommendation that can be implemented in the future.

CHAPTER II

LITERATURE REVIEW

This chapter will describe details about the ROV, literature review on the parts and systems used in the project. It includes the explanation of individual component characteristic and also the advantages of using the particular component chosen for the project. The chapter will explain ROV, PLC, motor thrusters, battery supply, and serial communication method used in the ROV project.

2.1 Introduction

This chapter is review about ROV. Remotely operated vehicle is a tethered underwater robot. My project is implemented to produce the low cost ROV. Literature reviews are based in information obtained from valid sources such as books, articles of relevance, published paper or any other source deemed appropriate. One of the more famous sources for literature reviews from IEEE, denoting the Institute of Electrical and Electronics Engineers which is based in New York, USA. The forms of literature include standards of practice, proceeding paper or conference papers such as those from the Power Engineering Conference.

2.2 Background Study

Before any instruments had been made for working on water, underwater task has to be carried out by divers, this was a big problem because the natural conditions could be a restriction for any work for example in deep water is restricted the use of diver for high deep inspection was necessary to build some kind of instruments that can do the inspection work like maintenance and research work. They can be divided in three groups, machines that are controlled and manned by humans (like submarines), Remotely operated vehicles (ROV's) and Autonomous vehicles (AV), first ones are generally used works of inspection and recognition of great areas or as warlike element, in other hand other ROV's was developed unmanned because in some cases despite of being protected by the submarine, the conditions for the work wasn't safe for humans like space, and duration of operation, for this kind of problem the ROV's was used they are remotely operated far away for the place of the operation, maintaining safe of the operator for the risk conditions.

At the beginning the ROV was only implemented for high deeps inspections, because the state of the art was not improved enough to leave a man until there, for this reason, rustic vehicles was implemented, they only carry one camera and the umbilical cable in order to keep the system working and normally it carries communication and power wire, to manipulate the ROV, the operator has to be careful and try to control this new ROV without any help, also while the ROV do the travel for the deep surface to the work area, sometimes it was the most difficult task for the operator. Nowadays the ROV carry out many tasks as new kinds of work are invented for the humans, inspection of sea resources or maintenance work, the actual ROV are adapted to work in high pressure environments and the operators has many helpful tools to guide his robot, extending the scenario or work, for this reasons new kind of these device will be proposed to be able to work in all kind of conditions [2].

2.3 Programmable Logic Control (PLC)



Figure 2.1: Mitsubishi FX1S PLC

A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or lighting fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.

2.3.1 Advantage of using PLC

PLCs are well-adapted to a range of automation tasks and these are typically industrial processes in manufacturing where the cost of developing the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life. Little electrical design is required, and the design problem centers on expressing the desired sequence of operations. PLC applications are typically highly customized systems so the cost of a packaged PLC is

low compared to the cost of a specific custom-built controller design. On the other hand, in the case of mass-produced goods, customized control systems are economic due to the lower cost of the components, which can be chosen instead of a smart solution, and where the non-recurring engineering charges are spread over thousands or millions of units [3].

A microcontroller-based design would be appropriate where hundreds or thousands of units will be produced and so the development cost can be spread over many sales, and where the end-user would not need to alter the command. Automotive applications are an example; millions of units are built each year, and very few end-users alter the programming of these controllers. However, some specialty vehicles such as transit busses economically use PLCs instead of custom-designed controls, because the volumes are low and the development cost would be uneconomic. Very complex process control, such as used in the chemical industry, may require algorithms and performance beyond the capability of even high-performance PLCs. Very high-speed or precision controls may also require customized solutions [4].

Programmable controllers are widely used in motion control, positioning control and torque control. Some manufacturers produce motion control units to be integrated with PLC so that G-code (CNC machine) can be used to instruct machine movements.

Processor plays a main role in most of the electronic circuit that manages the input and implements the output. It will take the signal input from switches, processes the signal and then to produce the logic output in order to control the rotation of the motor. In this project, the PLC CJ1G is chosen as the controlling unit. The PLC actually is a digital electronics system which uses a programmable memory for implementing specific functions like logic, sequencing, timing, counting and arithmetic to control through analog or digital input/output modules and other necessary types of machines or processes.

Based on the control architecture of the PLC, the compact modular CJ1G PLC offers the highest performance per volume in its class. A wide range of CPU capacities and I/O units could make user configure a just-right combination for any application and

also allowing user to scale the system without having to change to another PLC family. The internal features built in this controller like normally open (NO), normally close (NC), timer, counter could make the ROV becomes one of the flexible underwater vehicles.

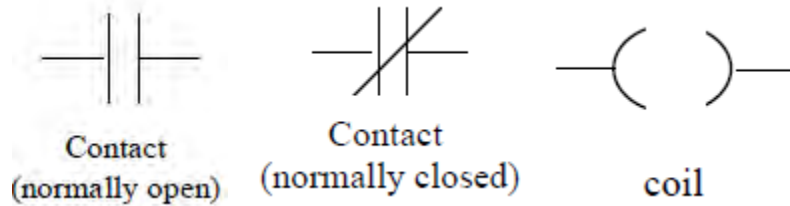
Other than that, the CJ1G units CPUs range from very small CPUs for simple sequence control to powerful and fast models that offer flexible control circuit which can handle up to 16 I/O points for future add-on purpose. This enables to modularize the machine into logical sections without changing PLC series. Then, CJ1G Power Supplies systems can operate on 24 V DC power supply, or on 100 - 240 V AC mains. Besides, the CJ1G digital I/O units serve as the PLC's interface to achieve fast, reliable sequence control. A full range of units, from high-speed DC inputs to relay outputs, let user adapt CJ1G to someone needs. Lastly, the CJ1G communication unit also provides both standardized open networks interfaces, and cost-efficient high-speed proprietary network links [5].

2.3.2 PLC programming language

Early PLCs, up to the mid-1980s, were programmed using proprietary programming panels or special-purpose programming terminals, which often had dedicated function keys representing the various logical elements of PLC programs. Programs were stored on cassette tape cartridges. Facilities for printing and documentation were very minimal due to lack of memory capacity. The very oldest PLCs used non-volatile magnetic core memory. More recently, PLCs are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer

to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM [6].

There are three elements that commonly use in PLC ladder diagram:



The symbol of contact (normally close and normally open) is use for input. And the symbol of coil is use for output. While using this model of PLC, we need the software which use for this PLC – GX-developer-FX.

2.3.2.1 GX-Developer-FX

It is a cost-effective cut-down version of GX Developer, specifically designed for micro FX PLCs. Like the full version of GX Developer, it includes many of the features and functions along with a choice of three programming methods; MELSEC Instruction List, Ladder Diagram and Stepladder.