

# Design and Development of SHIPS-ROV

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# Design and Development of SHIPS-ROV

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**Keywords:** Remotely Operated Vehicle, Underwater, Bio-fouling, Performance, Corrosion, Design, Development.

**Abstract:** Ships that are operating can experience damage to the hull during operation, including: damage to deformation, fatigue, corrosion etc. The presence of bio-fouling attached to the hull makes the hull plates thin due to the formation of deposits or deposits on the hull caused by marine life. This will cause the condition of the ship's structural strength to decrease due to the decreasing moment of inertia of the structure due to thinning plates. Therefore, it is necessary to inspect the condition of the ship's hull after a period of operation. The amount of the bio-fouling component will affect the speed of the ship as well because the condition of increasing ship resistance increases if the bio-fouling is not cleaned from the hull. This paper describes a development of SHIPS-ROV (Ships building Institute of Polytechnic Surabaya-ROV) as a device that help to monitor the condition off ship's hull.

## 1 INTRODUCTION

Some of the damage to the hull in operations include deformation, cracks, fatigue, fouling, corrosion, thus requiring an earlier hull investigation process so that more hull damage does not occur. The number of marine transportation accidents, such as ship collisions can result in some parts of the ship being deformed or the condition of the hull breaking which causes a hull leak that causes the ship to sink. The condition of bio-fouling in the hull, a condition where the thickness of the hull plate is reduced due to the presence of marine life attached to the hull, these conditions can be in the form of deposit formation, encrustation, curding, deposition, scaling, scale formation, slugging, and mud formation. Therefore, the Bureau of Classification will always check the thickness of the hull plate every year in terms of issuing the feasibility of the ship in sea operations, but the docking process must be carried out and this requires no small cost. Therefore, SHIPS-ROV technology is urgently needed to directly investigate the condition of the hull submerged in water, both due to fouling and even deformation or crack conditions in the hull. ship hull for low-cost investigation processes with simpler size and function capacity

settings but using reliable technology and materials. In the process of designing SHIPS-ROV, a design method with the latest technology is needed so that optimum product results are obtained with a few rows of wasted material. The latest product design technology can control material requirements, structural strength, and product optimization forms and can more easily carry out the inspection process for the product design process. Some of the SHIPS-ROV product design processes with product design methods can be grouped into three parts, including:

- Computer Aided Design (CAD) is a computer software program for the process of drawing a product or part of a product component. Products that are designed can be represented with lines or symbols that have certain meanings according to applicable standards. In CAD it can be a 2D or 3D drawing.

- Computer Aided Engineering (CAE) which is the use of computer software in product design that assists technical propulsion system, controlled and piloted by an on board analysis tasks. Such as finite element methods (FEA), fluid dynamics (CFD), and optimization.

- Computer Aided Manufacturing (CAM) which is a design process in the form of working drawings and G-code results that can be directly used in the

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production process. In CAM includes the needs of row material, G-code, working drawings, assembly drawings and others.

## 2 SHIPS-ROV DESIGN

Figure 1 shows the step by step process of the design and development of SHIPS-ROV. The first step is to identify the system requirements. Specifications will be owned by SHIP-ROV. This step will determine the design and equipment

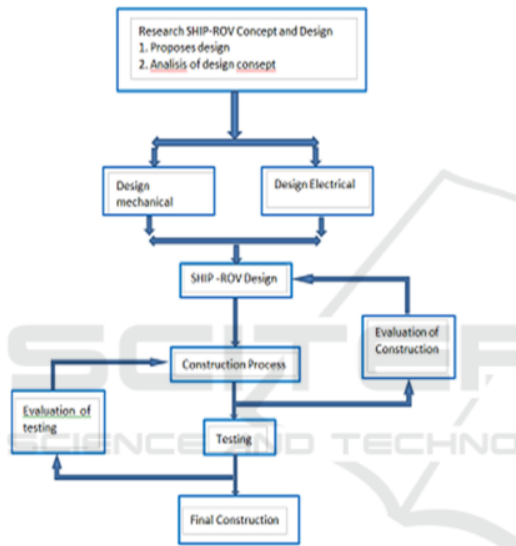


Figure 1: Overall Flow of design of SHIP-ROV.

requirements of the SHIPS-ROV. The later step, determine the mechanical design and electrical design. To develop the mechanical design, Fusion 360 software is used to draw and animate the SHIPS-ROV that are proposed and expected and AutoCAD software is used to electrical design for internal and external. The last step is to test and evaluate the imperfections of the SHIPS-ROV system and the weaknesses of the mechanical design and electrical design of the SHIPS-ROV

## 3 GENERAL DESIGN OF AN SHIPS-ROV

In the development of regulation in Ship-ROV

construction some applicable regulations are such as BKI, ABS, GL, NK, BV and others. Each classification of the regulation has a critical content in performing standard in accordance with the results of research and design.

There are several aspects that need to be considered in mechanical design and electrical design in order to successfully obtain a suitable circuit for SHIP-ROV. In ship design where in determining the main size and line plan includes several designs, including: determining the main size of the ship, determining the design of comparison ships, making CSA and shape control body plans. (Budianto, 2018). Some floating object designs have a fairly high level of difficulty. The amount of weight placed in light weight and death weight should not be more than the planned ship displacement. CAD technology Computer Aided Design (CAD) is a computer software program for the process of drawing a product or part of a product component. Products that are designed can be represented with lines or symbols that have certain meanings according to applicable standards. In CAD it can be a 2D or 3D drawing. Computer Aided Engineering (CAE) which is the use of computer software in product design that assists engineering analysis tasks. Includes for finite element methods (FEA), fluid dynamics (CFD), and optimization. Computer Aided Manufacturing (CAM) it is a design process in the form of working drawings and G-code results that can be directly used in the production process. In CAM can cover the needs of raw material, G-code, working drawings, assembly drawings and others. In designing a SHIP-ROV that operates in water, it is very necessary to have knowledge of ship design, marine use materials and the laws of physics that support the concept of underwater vehicles and their environment. Therefore, the major design aspects that need to be considered are body design, material selection, electric power. Figure 2 shows the SHIP-ROV design using Fusion 360 software.

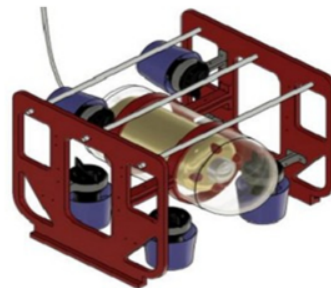


Figure 2 : The Ships-Rov Design.

### 3.1 SHIPS-ROV Structure Design

The SHIPS-ROV is designed to operate at a maximum depth of 200 m. Therefore, it is very important to calculate the strength of the SHIPS-ROV structure. The important thing to note is,

- 1) Cover strength in operation
- 2) Effective Body of Ship-ROV Structure for effective thickness and design applied
- 3) Reduce Resistance
- 4) Reduce Power Consumption
- 5) Low-Cost

SHIPS-ROV must have a hull (enclosure) that is used to place components so that it is always dry and watertight. Components placed in the hull/enclosure are used for hull investigations. The SHIPS-ROV hull/enclosure should allow easy access maintenance of components, and allow for modularity in the event of future changes or additions [1]. In addition to being light and strong, the hull must also be corrosion resistant because it will experience a harsh saltwater environment. The tubular spherical hull offers the best structural integrity; however, its shape precludes efficient use of the available space as most components and systems are rectangular. The cylindrical hull provides the best alternative, consisting of: high structural integrity and a form conducive to housing electronic components. The enclosure or main body or hull is the main component in the MSB component in the SHIPS-ROV, which is very protected from water entering the enclosure. Some of the equipment placed in the enclosure include: thruster, color camera, monochrome camera, lighting, multi beam sonar, Oil Compensated dome, Dual imager and battery. Figure 3 shows the shape of the SHIPS-ROV hull/enclosure.

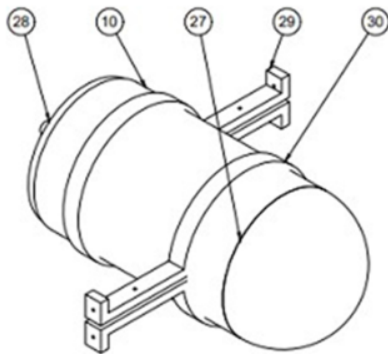


Figure 3: Design of SHIPS-ROV Hull/enclosure.

Legend:

- (10) Body shell
- (27) Body Head
- (28) Body AFT
- (29) Main support
- (30) Main support

### 3.2 Submerging

Because the SHIPS-ROV works under water, for diving the SHIPS-ROV must be able to increase the downward force acting on it to counter the buoyant force. This can be achieved using either an external thruster i.e. a thruster and a propulsion motor for forward, reverse, up and down of the SHIPS-ROV. Details of the SHIPS-RUV enclosure components can be given in the picture above which contains component components including cameras, main circuit boards, capacitors, and others. It is used in the main function in the process of taking data and setting the control of the motor and propeller which is connected to the joystick of the control system. This is a much simpler system, but quite inefficient in terms of power consumption and not very suitable for deep depths. For the diving process, the SHIPS-ROV is designed in such a way that it has residual buoyancy. Thus, the weight of the vehicle is made approximately equal to the buoyant force.

### 3.3 Propulsion

Propulsion is required SHIP-ROV and is one of the main sources of power consumption. SHIPS-ROV uses a motor for propulsion. The location of the motor will affect which degrees of freedom can be controlled. Motor placement can affect noise interference with onboard electronic components, as well as propeller-to-hull and propeller-to-propeller interactions. Propeller-to-hull and propeller-to-propeller interactions can have unintended effects on the dynamics of the SHIP-ROV maneuver. When traveling at a constant speed, the thrust generated by the motor is equal to the friction or resistance of the vehicle, namely:

$$\text{Thrust} = \text{Drag} = 0.5s^2AcD \quad (1)$$

where  $\rho$  is the water density,  $s$  is the speed,  $A$  is the effective surface area and  $CD$  is the drag coefficient. Power consumption for the propulsion system increases dramatically as the vehicle speed increases. This is because the thrust is equal to the product of the thrust and the speed, meaning that the thrust is a function of the cube of the speed,

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 $Thrust\ Power = Thrust \times s = 0.5s^3ACD... (2)$

Therefore, due to the limited energy supply of the SHIPS-ROV, the one is functioned according to its task, namely to investigate the hull of the ship. And try not to travel at a speed that doesn't draw too much power, and in completing the task it doesn't take too long

### 3.4 Electric System

6  
 Electrical power is usually provided via a sealed battery. The ideal battery arrangement is to connect them in parallel with diodes between each battery to allow for even discharge and to prevent current flow between the batteries. Fuses or other protective devices must also be used to prevent excessive current flow in the event of a short circuit or component malfunction. The limited power properties of the SHIP-ROV affect the types of components and equipment that can be used. Components and equipment must be selected to draw as little power as possible so that the battery can provide more than enough time for the vehicle to complete its mission. The arrangement of the electrical diagram is shown in Figure 4

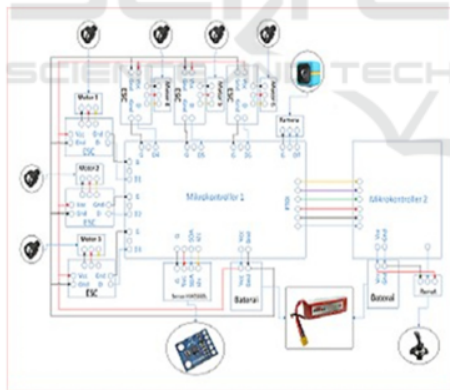


Figure 4: Design of SHIPS-ROV Hull/enclosure.

## 4 RESULT

SHIPS-ROV was designed in 3D using Fusion 360 software. This software allows users to easily design and analyze the strength of the design. The steps in the design process are as follows:

1. CAD and Material Definition

At the beginning of the analysis can be done by making CAD with existing components. Then do the material definition using 5083 marine used aluminum alloy material.

### 2. Meshing

The meshing process is carried out to discuss the object into the Ships-ROV constituent elements which are conditioned in fine mesh conditions.

### 3. Load and constraint

The loading process is placed in the loading area of the structure which is then entered for the value of the force acting. It's as placement is applied at the bottom of the structure.

Buckling Analysis of buckling load is an value - passable condition in maintaining the strength of the structure on the SHIPS-ROV. The buckling load is very risky to the structure which can cause the structure to break or deform. The results of the buckling analysis are shown in Figure 5.



Figure 5: Buckling Analysis.

Mechanical and electrical structures have been developed as described in the previous chapter. SHIPS-ROV is an auxiliary equipment as a substitute for divers to see the condition of the ship's hull. Next will be developed as a test bed platform for various underwater researches, where the prototype developed has a fixed mechanical system, has a modular electronic system for the development of various controllers, recording devices and sensor modules.

Performance test was conducted to determine the performance of SHIPS-ROV. Test 1 refers to the specified technical specifications. Performance testing can be carried out in several ways under complete conditions, including: Progressive speed, Circle rotation, Zigzag, Inertia Stop testing, Crash Stop Ahead and Crash Stop Astern. Progressive speed is a test to determine the speed of the test object, because speed is very important in the characteristics

5 of the test object and this is one of the bargaining abilities in its operation. Zigzag is a motion condition of the test object in 5 form of maneuvering this condition in real operation to determine the characteristics of the test object in avoiding other objects. Inertia stop test is a test to find out how far the test object stops after the driving force is turned off. It can also be used to find out how far the test object is to avoid colliding with other objects. Crash Stop forward and stern are test conditions to position the test object to move forward and backward simultaneously. Due to the limited size of the test object, the performance test is carried out at least into 2 (two) main capabilities of the test object, namely: Progressive Speed and Turning Circle Maneuvering.

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