

Design and Fabrication of an Underwater Robot Boat Propeller Blade Algae Detection and Cleaning

Submitted in fulfillment of the requirements for the award of
Bachelor of Engineering degree in Mechatronics

by

Melvin Anderson P (39090023)

Ruban K (39090045)



**DEPARTMENT OF MECHATRONICS
SCHOOL OF MECHANICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC | 12B Status by UGC | Approved by AICTE
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119**

MAY - 2023

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Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119
www.sathyabama.ac.in

DEPARTMENT OF MECHATRONICS

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **Melvin Anderson. P (39090023), Ruban.K (39090045)** who have done the project work entitled **"Design And Fabrication Of An Underwater Robot Boat Propeller Blade Algae Detection And Cleaning"** under our supervision from June 2022 to May 2023.

Internal Guide

Mr. S. Venkatesh, M.E., (Ph.D.)

Head of the Department

Dr. S. Prakash M.E., Ph.D.

Submitted for Viva Voce examination held on ____ May 2023

Internal Examiner

External Examiner

DECLARATION

We **Melvin Anderson.P (39090023)** and **Ruban.K (39090045)** hereby declare that the Project Report entitled “**Design And Fabrication Of An Underwater Robot Boat Propeller Blade Algae Detection And Cleaning**” done by us under the guidance of **Mr.S. Venkatesh, M.E.,(Ph.D.)** is submitted in fulfillment of the requirements for the award of Bachelor of Engineering degree in Mechatronics.

1. 

2. 

DATE: ____ May 2023

PLACE: Chennai, Tamil Nadu

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Maintaining the cleanliness of the boat is important for its proper operation, avoiding difficulties or repairs. A propeller, a mechanical device consisting of angled blades attached to a shaft, is a vital component of a boat. During underwater maintenance, it is important to inspect the propeller thoroughly to ensure that it is in good working order. Any damage to the propeller can affect boat's performance, resulting in reduced speed, higher fuel consumption and other problems. In such cases it is preferable to seek the help of a professional repair service. To maximize its performance you need to use the appropriate propellers for the specific demands of the boat. Choosing the wrong propeller can harm to the boat while affecting efficiency and performance. Also, algae growth on propeller blades can harm to the boat's performance by reducing the efficiency of the propeller. To solve this problem, we are developing a multi-functional unmanned surface vehicle capable of detecting and cleaning algae from boat propeller blades. We use sensor fusion technology to create a complex system that can perform obstacle avoidance, water-quality monitoring and water surface cleaning. The vessel is equipped with a water surface treatment system that uses a robot to monitor the propeller shaft and remove any existing algae. To facilitate operation and control, it includes a communication module, a power module and a remote human-machine interface. Overall, the development of a water surface cleaning system is a big step forward in the field of underwater maintenance and boat cleaning. This technology, which can identify and remove algae on boat propeller blades, may considerably increase boat performance and efficiency, as well as assist prevent possible problems and repairs.

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LIST OF ABBREVIATIONS

AUV	Autonomous Underwater Vehicle
HSS	Hollow Cross Section
CHS	Circular Hollow Section
RHS	Rectangular Hollow Section
SHS	Square Hollow Section
RPCS	Rudder and Propeller Cleaning System
USV	Unmanned Surface Vehicles

CHAPTER 1

INTRODUCTION

Underwater robots have recently received much attention from researchers who are designing, building, and developing various types of robots that can operate on land and underwater. To ensure longevity and performance of such robots, all components, including boat propeller blades, must be waterproof and regularly serviced. The goal of this research is to review the current status of underwater autonomous and efficient operational robots with emphasis on environmental sensing, vehicle handling system modeling, integrated control, target non-injury capture and control mechanisms. Because of their unique ability to walk on land and swim underwater, bionic amphibious robots are of great interest to the public and military sectors. Building a bionic amphibious robot requires a variety of underwater and land movement modes, and the control system is a critical component to guarantee a seamless transition from air to water. An autonomous underwater robot has been designed and tested for early detection of oil and gas pipelines, therefore increasing industrial safety and efficiency. Furthermore, this technology helps reduce GHG emissions and achieve climate change objectives while cleaning up shipping and making the sector safer and more sustainable. The condition of a vessel's skin is critical to its overall efficiency and effectiveness. A clean hull consumes less fuel and emits fewer GHG emissions, resulting in significant savings for ship owners. On the other hand, traditional techniques for underwater hull cleaning face various obstacles, including safety issues, antifouling coating degradation, and limitations due to environmental regulations. As a result, in shipping circles, hull cleaning is sometimes underestimated and underestimated, with some individuals suggesting that barnacles on the propeller may increase efficiency. Underwater robotic technology will be a game changer in this environment as it will help overcome these issues, increase productivity and provide a cleaner and safer marine environment. Underwater robots have recently received a lot of attention from researchers who design, build, and develop various types of robots that can operate both on land and underwater. Oceanography, marine biology, environmental monitoring, offshore oil and gas development,

underwater archeology and naval operations are some of the applications for these robots. Due to the harsh and unpredictable conditions of the marine environment, such as high pressures, low visibility, powerful currents and corrosive seawater, the design and construction of underwater robots present major challenges. All components, including boat propeller blades, must be watertight and serviced frequently to guarantee longevity and performance. Furthermore, underwater robots require complex sensors and sensing mechanisms to navigate and interact with the environment, as well as robust control systems to ensure stability and safety. One of the primary areas of underwater robotics research is developing autonomous and efficient operating robots that can perform complex tasks in real-world situations. Manipulators, sensors and propulsion systems enable such robots to travel, manipulate objects and interact with their surroundings. This requires the integration of many technologies, including computer vision, machine learning, control theory, and material science. Underwater robotics is developing rapidly, with significant advances being made in various fields. The following parts will go over some of the current developments and applications of underwater robots.

1.1 ENVIRONMENTAL PERCEPTION

One of the most challenging tasks in underwater robotics is environmental sensing, which involves sensing and understanding underwater surroundings. Cameras, sonars and lasers, as well as advanced mechanisms for collecting and interpreting sensor data are required. Underwater robots can move freely, avoid obstacles, and find interesting objects. Recent research in this area has focused on improving mechanisms for underwater object recognition and authentication. For example, researchers at the University of Porto have developed a system that uses deep learning to detect and classify underwater fish species. The gadget also exhibits remarkable accuracy in low-light conditions and can be used for environmental monitoring and fish population estimation. Another example is the development of sonar-based navigation systems that enable underwater robots to operate when GPS is unavailable. Underwater robotics has emerged as a powerful tool for exploring the ocean depths and conducting research in marine environments. These robots have proven to be invaluable in a wide range of applications, from monitoring the

health of marine ecosystems to exploring shipwrecks and underwater caves. However, one of the most challenging tasks for underwater robots is environmental sensing, which involves sensing and understanding underwater surroundings. Cameras, sonars, and lasers are among the most commonly used sensors for underwater robots. Cameras can capture high-resolution images of the underwater environment, providing valuable information about the location and behavior of marine animals and other objects. However, cameras are limited by their range and sensitivity to low-light conditions, which can make it difficult to capture clear images in deep water. Sonars are an essential tool for underwater robotics, allowing robots to "see" their surroundings using sound waves. Sonars work by emitting sound waves and measuring the time it takes for the sound waves to bounce back from objects in the environment. This information is then used to create a 3D map of the underwater environment, enabling the robot to navigate and avoid obstacles. Laser sensors are also used in underwater robotics, providing accurate measurements of distance and depth. These sensors work by emitting a laser beam and measuring the time it takes for the light to bounce back from objects in the environment. Laser sensors are particularly useful for mapping underwater structures such as coral reefs and shipwrecks. Despite the availability of these sensors, interpreting sensor data remains a significant challenge for underwater robots. Recent advances in deep learning have made it possible to develop sophisticated algorithms that can automatically detect and classify objects in underwater environments. Researchers at the University of Porto have developed a system that uses deep learning to detect and classify underwater fish species. This system achieves remarkable accuracy even in low-light conditions and can be used for environmental monitoring and fish population estimation. Another significant challenge for underwater robotics is navigation. GPS is not available underwater, making it difficult for robots to navigate in complex underwater environments. However, recent advances in sonar-based navigation systems have made it possible to develop robots that can navigate autonomously in underwater environments. These navigation systems work by using sonar to create a 3D map of the environment and then using that map to plan and execute navigation paths. In conclusion, environmental sensing is one of the most challenging tasks in underwater robotics, requiring sophisticated sensors

and algorithms to interpret sensor data. Recent advances in deep learning and sonar-based navigation systems have made it possible to develop robots that can navigate autonomously and detect and classify objects in underwater environments. These advances have opened up new opportunities for exploration and research in marine environments, providing valuable insights into the health and dynamics of these ecosystems.

1.2 VEHICLE-MANIPULATOR SYSTEM MODELING

Underwater robots with manipulators can perform a variety of tasks, including picking up objects, handling tools, and completing maintenance tasks. However, the design and control of a vehicle handling system is complex because it involves the integration of various subsystems and the synchronization of their functions. Recent research in this field has focused on developing simulation and control models of the vehicle-manipulator system. For example, MIT researchers have developed a model-based control algorithm for underwater robots capable of performing complex manipulative tasks such as grasping and moving objects. The method simulates environmental conditions by using a physics-based model of the robot's dynamics and the controlled object. Underwater robots with manipulators have become an essential tool for various industries such as offshore oil and gas exploration, marine biology, and oceanography. These robots can perform a wide range of tasks, including underwater maintenance, inspection, and repairs. The integration of a manipulator system into an underwater vehicle poses a significant challenge, as it requires the synchronization of various subsystems, including sensors, actuators, and controllers. Recent research in this field has focused on developing simulation and control models of the vehicle-manipulator system. These models can be used to predict the behavior of the system under different environmental conditions and to design and optimize control algorithms for improved performance. One notable example of such research is the work done by researchers at MIT. They developed a model-based control algorithm for underwater robots capable of performing complex manipulative tasks such as grasping and moving objects. The method simulates environmental conditions by using a physics-based model of the robot's dynamics and the controlled object. The researchers used a modular control approach to simplify the control

design process. The control system consists of three modules: a trajectory generation module, a force controller module, and a position controller module. The trajectory generation module is responsible for generating the desired motion of the robot's end effector. The force controller module regulates the forces applied by the robot's manipulator, while the position controller module regulates the position of the end effector. The researchers also developed a feedback control algorithm that uses sensory feedback to adjust the control system's parameters in real-time. This feedback control algorithm ensures that the system can adapt to changes in the environment and disturbances in the system. In addition to the control system design, the researchers also developed a simulator to test the control system's performance under different environmental conditions. The simulator uses a physics-based model of the vehicle-manipulator system to simulate the behavior of the system in different underwater environments. This simulation environment allows researchers to evaluate the performance of the control system and optimize its design before deploying the system in the field. In conclusion, the development of simulation and control models for underwater robots with manipulators has enabled researchers to design and optimize complex control algorithms that can perform a wide range of tasks. The use of physics-based models and feedback control algorithms allows the system to adapt to changes in the environment and disturbances in the system, making it a powerful tool for underwater exploration and maintenance.

1.3 COORDINATED CONTROL

Another important area of research in underwater robotics is coordinated control, which allows multiple robots to cooperate to achieve a shared goal. It will help in underwater search and rescue, environmental monitoring and offshore oil and gas exploration. Recent research in this field has focused on developing mechanisms for cooperative control of underwater robots. For example, researchers at the University of California, Santa Barbara have developed a distributed control algorithm for a group of underwater gliders that can perform environmental monitoring duties. The program uses a decentralized method in which each robot coordinates its activities and communicates with its neighbors to complete the mission. Coordinated control

of underwater robots has become a crucial research area due to its potential applications in several fields. By enabling multiple robots to work together, researchers hope to improve the efficiency and effectiveness of tasks such as underwater search and rescue, environmental monitoring, and offshore oil and gas exploration. Coordinated control of underwater robots also has several challenges, such as communication constraints, limited energy supply, and the unpredictable underwater environment. To address these challenges, researchers have developed several mechanisms for cooperative control of underwater robots. For example, the distributed control algorithm developed by researchers at the University of California, Santa Barbara (UCSB) enables a group of underwater gliders to perform environmental monitoring duties. The algorithm uses a decentralized method, in which each robot coordinates its activities and communicates with its neighbors to complete the mission. The distributed control algorithm developed by UCSB researchers involves a set of rules that each glider follows. The rules include keeping a certain distance from its neighbors, maintaining a specific depth, and periodically surfacing to communicate with the surface control station. The gliders also have the ability to change their behavior based on the sensed environment. For example, if one glider detects a strong current, it can adjust its behavior to conserve energy. To ensure that the gliders can effectively communicate with each other, researchers use a communication protocol that is robust to underwater noise and can handle intermittent connectivity. The gliders are also equipped with low-power sensors that allow them to sense their surroundings without using too much energy. The benefits of the distributed control algorithm developed by UCSB researchers are numerous. For example, it allows the gliders to operate for long periods without intervention from humans, reducing the risk of human error. It also enables the gliders to operate in a coordinated manner, allowing them to cover a larger area and perform more complex tasks than would be possible with a single robot. Coordinated control of underwater robots has the potential to revolutionize several industries, including environmental monitoring, offshore oil and gas exploration, and underwater search and rescue. As the technology continues to develop, we can expect to see even more sophisticated algorithms and mechanisms for cooperative control of underwater robots. These

advancements will help to further unlock the potential of underwater robotics and enable us to explore and protect our oceans like never before.

1.4 REMOTE HUMAN-MACHINE INTERFACE

Due to the background, the image has a medium range and is compounded by low contrast and geometric distortion. During operation, the vehicles will encounter disturbances from ocean currents, as well as combine and recover forces from the manipulators. A review of manipulator technology for subsea intervention and exploration operations examined both systems. Bionic amphibian robots utilize bionic structures, materials, and other cutting-edge research to demonstrate exceptional performance and wide application potential. Cross-domain motion control algorithms should be implemented on a rigid platform of a multi-mode amphibious vehicle for experimental validation under realistic settings. an autonomous underwater robot, was developed using oceanographic data and water to track and monitor subsea borers following oil spills and gas leaks. Mamba, a bio-inspired underwater snake robot, was utilized to compare its performance with and without a passive caudal fin. Underwater cleaning approaches and various cleaning equipment were compared and analysed . The primary control unit, locomotion module, positioning module, obstacle avoidance module, water quality monitoring system, water surface cleaning system, communication module, and power module are all part of the proposed architecture of the multipurpose unmanned surface vehicle. Brush-based cleaning technology is the most widely used for submersible surface cleaning, with excellent productivity (from 200 m²/h to 1000 m²/h), although these systems are not capable of completely removing bio-waste from the surface. Environmental friendliness of the plant. Accomplished by using recycled water as a functional cleaning agent. Underwater exploration and intervention operations are challenging due to the extreme environmental conditions encountered in the subsea environment. These conditions include high pressure, low light, and cold temperatures, among others. Additionally, subsea exploration and intervention operations require sophisticated technologies that can withstand the harsh environment and operate autonomously or remotely. One critical aspect of subsea intervention and exploration operations is the use of manipulators. A review of

manipulator technology for subsea intervention and exploration operations revealed that bionic amphibian robots utilizing bionic structures, materials, and cutting-edge research demonstrate exceptional performance and wide application potential. The review also highlighted the importance of cross-domain motion control algorithms for a multi-mode amphibious vehicle's rigid platform for experimental validation under realistic settings. The vehicles used in subsea exploration and intervention operations also encounter disturbances from ocean currents and combine and recover forces from the manipulators. As a result, the vehicles' imaging capabilities are often affected by geometric distortion, low contrast, and medium-range imaging. To address this challenge, advanced imaging technologies that can capture high-resolution images and videos in real-time under extreme subsea conditions have been developed. These technologies include underwater cameras and imaging sensors that can withstand the high pressure and low light conditions. Another critical aspect of subsea exploration and intervention operations is the development of autonomous underwater robots. These robots are designed to track and monitor subsea borers following oil spills and gas leaks. For instance, an autonomous underwater robot was developed using oceanographic data and water to track and monitor subsea borers following oil spills and gas leaks. These robots are critical for early detection and monitoring of subsea leaks, thereby mitigating environmental disasters. Bio-inspired underwater robots, such as Mamba, have also been utilized to compare their performance with and without a passive caudal fin. These robots mimic the locomotion and behavior of marine animals, such as snakes and fish, to navigate and explore the subsea environment. Furthermore, underwater cleaning approaches and various cleaning equipment have been compared and analyzed to address the problem of subsea bio-waste. Brush-based cleaning technology is the most widely used for submersible surface cleaning, with excellent productivity (from 200 m²/h to 1000 m²/h). However, these systems are not capable of completely removing bio-waste from the surface. To address this challenge, the use of recycled water as a functional cleaning agent has been proposed, enhancing the environmental friendliness of the plant. In conclusion, subsea exploration and intervention operations are challenging due to the extreme environmental conditions encountered in the subsea environment. However, advances in manipulator

technology, imaging technologies, autonomous underwater robots, and bio-inspired underwater robots have improved the accuracy and efficiency of subsea exploration and intervention operations. Furthermore, the use of recycled water as a functional cleaning agent enhances the environmental friendliness of subsea cleaning operations. These advancements are crucial for ensuring sustainable and environmentally friendly subsea exploration and intervention operations.



Fig :1.1 : Underwater image

CHAPTER 2

LITERATURE SURVEY

2.1 HAI HUANG,QIRONG TANG,JIYONG LI,RTL NOV,2019, REVIEW OF AUTONOMOUS UNDERWATER ENVIRONMENTAL PERCEPTION

Robotic capture and study of aquatic organisms has long been an area of research. Recently, the advent of autonomous underwater vehicles (AUVs) and other robotic tools has improved the success and efficiency of species capture. Advances in automated target capture and environmental sensing technologies have been prioritized in the development of robotic species capture systems. This paper examines the current state of autonomous underwater environmental sensing and target capture research and challenges in capturing robotic species. Autonomous underwater environmental sensing allows robots to identify and recognize underwater objects (4). This technology typically uses sensors such as sonar, video cameras, or lidar. After detecting the object, the robot can use its target grab capabilities to capture the creature. Manipulators such as grippers or suction cups are typically used to hold the target. One of the most difficult aspects of capturing robotic creatures is accurately identifying the creature and its size.

2.2 SANTHOSHA K,P.S ROBI,2019 JUN-ADVANCEMENTS IN THE FIELD OF AUTONOMOUS UNDERWATER VEHICLE

Autonomous underwater vehicle (AUV) technology has expanded these vehicles' capabilities and prospective uses in the realm of ocean exploration. Autonomous underwater vehicles enable distant exploration of the ocean, allowing access to locations that would otherwise be inaccessible due to depth or distance from shore. They are outfitted with a variety of sensors, cameras, and other gear that collect data about the ocean environment and perform other duties such as searching for underwater objects or monitoring underwater ecosystems. Most AUVs are self-contained, meaning they can be programmed to follow a predefined path without human involvement (18). This means they can be used for long-term activities such as mapping the ocean floor, monitoring ocean currents, and exploring the ocean floor for resources' data may be utilized to better understand the ocean ecosystem, as well as to help in resource discovery and identification of environmental dangers. AUVs may be utilized for a number of jobs because to

their tiny size and low power consumption, such as search and rescue operations, scientific research, and military applications. They are also increasingly being utilised for underwater surveys and pipeline inspections in the oil and gas industry.

2.3 SATJA SIVCEV, JOSEPH COLEMAN, EDIN OMERDIC SEP 2018- UNDERWATER MANIPULATORS A REVIEW

Underwater manipulators are robotic arms used in underwater environments to perform a variety of functions. They are commonly used for sophisticated underwater operations including assembly, welding, cleaning, maintenance, insulation and inspection. These manipulators can be remotely or independently operated and are powered by electric, hydraulic or pneumatic systems. The first underwater manipulators were developed in the 1950s, when mechanical weapons were used to perform underwater tasks. Technology has since advanced by developing complex electrical, hydraulic and pneumatic systems. Manipulators are manufactured in several types such as articulated arms, linear arms and telescopic arms. The most common type of manipulator is an articulated arm, which is made up of several segments that can move in different directions. Precision work such as welding or inspection is often done using these weapons. Linear arms are generally used for simple operations such as picking and moving objects. Telescopic arms, on the other hand, can be extended and contracted to provide a greater range of motion.

2.4 KAI REN, JIANCHENG YU, MAR-2021 A REVIEW OF THE STATE OF BIONIC AMPHIBIOUS ROBOT RESEARCH

Bionic amphibious robot research has gained popularity in recent years. BARS, or Bionic Amphibious Robots, are intended to mimic the behavior of aquatic organisms such as fish and eels, allowing them to move in both water and air. BARS will be used for many purposes, including underwater exploration, search and rescue, and environmental monitoring. Because of the intricacy of their design and the difficulties in controlling their mobility, developing bionic amphibious robots is a demanding undertaking (7). To address these issues, academics have devised a variety of novel ways. They employed biomimetic ideas, for example, to construct robot bodies that can adapt to varied settings, and they analysed aquatic creature behaviour to develop control algorithms for the robots. Furthermore,

researchers have looked at the use of various propulsion systems such as air-water thrusters, propellers and undulating fins. They also explored the use of sensors and actuators to allow robots to interact with their surroundings. Finally, researchers have devised ways to integrate multiple sensors into a single platform for improved navigation and handling.

2.5 CHAENXIN LYU, LIAN LIAN, YUFEI JIN, YUANBO BI, FEB 2022-CROSS-DOMAIN MOBILITY AND TRANSITIONS HYBRID AERIAL UNDERWATER VEHICLE

Evaluation of a hybrid air-underwater vehicle is an essential research problem due to its potential to explore both air and aquatic habitats. There is a growing need to move between these two domains, and a better knowledge of the control strategies needed to do so. HAUV is a sophisticated system requiring mechanical, electrical and software engineering (2). The complexity of the system has resulted in multiple ways to operate the vehicle and switch between areas. Previously, researchers focused on controlling the HAUV by integrating the transition between air and water using a combination of algorithms such as PID or fuzzy logic. This performance has increased recently as a result of recent advances in control approaches and machine learning. AI and ML enable it to learn, adapt and make judgments from its environment. Change stability and control strategies are improved as a result.

2.6 EIICHI KOBAYASHI ,HIDETAKA SENGU ,HAJIME CHIBA NOV 2017-AN DETECTING AND OBSERVING SUB-SEA PLUMES FOLLOWING OIL SPILLS

Research can be beneficial for a variety of reasons. Autonomous underwater vehicles (AUVs) can detect and measure ocean currents, water temperatures and chemical concentrations. This can help determine the cause and extent of a leak or leak and track its journey in a cost-effective manner (4). An AUV can also be used to collect samples of oil, gas or other contaminants that have been spilled into the environment. This information can be used to better understand the environmental impact of such incidents and inform improved decision-making and situation management. AUVs can also be used to identify and monitor the spread of other contaminants in the environment, such as microplastics. This will help identify potential sources of pollution and monitor their environmental impact.

Finally, the AUV can be used to clean up and mitigate an oil spill or gas leak, and to control and remove contaminants from water by deploying equipment such as booms and skimmers.

2.7 E.KELASID,K.Y.PETTERSEN,A.M.KOHL JULY 2017-AN EXPERIMENTAL STUDY OF THE EFFECTIVENESS AND MOVEMENT UNDERWATER

Snake robots are attracting increasing interest because of their potential applications in underwater research and search and rescue. Conducting experiments to compare the performance of different designs is essential to understand the locomotion performance and path following capabilities of snake robots. The performance of several snake robot designs with and without a caudal fin was investigated in this study. Experiments were performed on two types of snake robots, one with a caudal fin and one without. According to experimental data, a snake robot with a caudal fin was more successful in locomotion and had stronger path-following abilities than a snake robot without one (3). Also, it was found that the caudal fin increased the snake robot's navigation and ability to maintain a specific path. These findings indicate that caudal fins allow snake robots to move more efficiently and follow courses precisely. This research is a significant resource for future snake robot designs.

2.8 CHANGHUIA SONG AND WEICHENG CUI OCT 2020-SURVEY OF METHODS FOR CLEANING SHIP HULLS UNDERWATER

Cleaning the ship's hull underwater is important to preserve the ship's performance and reduce drag on the ship's hull. Crucial to keeping a ship's hull free of fouling is the collection of barnacles, algae and other marine life. Fouling can limit a ship's speed, cause significant hull damage and increase fuel consumption. Scrubbing, sandblasting and chemical cleaning are some of the methods used to clean ship hulls. Scrubbing is the removal of fouling from the surface using brushes, scrapers and other abrasive equipment (1). High pressure jet sand is used in sand blasting. Chemical cleaning breaks down fouling on the surface with various substances. The most effective and efficient method for cleaning a ship hull is the use of robots. Robots are a very effective and efficient way to clean a ship's hull. These robots can travel through the hull of a ship using high-pressure currents.

Robots can identify areas of contamination and focus cleaning efforts there. Also, robots can access areas that are difficult or impossible for humans to reach.

2.9 HOUSSAM ALBITAR,KINAN DANDAN,IVAN KALAYKOV,JAN 2016- UNDERWATER ROBOTICS: SURFACE CLEANING TECHNIQS, ADHESION

Underwater robotics is a rapidly expanding field of engineering and marine science that is becoming increasingly essential in businesses such as marine energy generation, aquaculture, ocean exploration, and coastal defense. Advances in underwater robotics technology linked to surface cleaning and adhesion and locomotion systems will be the focus of this paper. Surface cleaning is an essential aspect of underwater robotics, as removing marine life or other sediment is essential for the robot to function properly. State-of-the-art surface cleaning procedures include ultrasonography, high-pressure water jets, and treatments. Ultrasound is frequently used to remove tough surface coatings, but it may also be utilised to remove big items. Electro chemical treatments employ electrodes to produce an electric field that can break down organic debris and other surface contaminants (5). Adhesion is also an important component of underwater robotics since it allows the robot to cling to a surface and prevent being blown away by currents. Suction cups, electrostatic pads, and magnetic pads are some of the strategies developed for underwater robots adhesion.

2.10 HSING-CHENG CHANG,YU-LIANG HSU,SAN-SHAN HUNG,FEB 2021- AUTONOMOUS WATER QUALITY MONITORING AND WATER SURFACE CLEANING

Autonomous water quality monitoring and water surface cleaning for unmanned surface vehicles (USV) is a rapidly growing field of research. USVs are becoming increasingly important for a variety of applications, such as environmental monitoring, search and rescue operations, and military operations. The topic of autonomous water quality monitoring and water surface cleaning for unmanned surface vehicles (USV) is rapidly expanding (6). USVs are becoming increasingly important for a variety of purposes, including environmental monitoring, search and rescue, and military operations. Water sampling, data collection and analysis, and water surface cleaning are key components of autonomous water quality monitoring and water surface cleaning. Water samplers take samples of water

from the environment and analyze them for toxins and pollutants. Data collection and analysis involves gathering information from the environment and examining trends and patterns. Finally, water surface cleaning entails the use of robotic technologies to clean the surface of bodies of water. Autonomous water quality monitoring and water surface cleaning provide a number of advantages. They enable more efficient and accurate water quality evaluation, give a more comprehensive perspective of water quality, and can enhance reaction times to environmental events. Furthermore, using USVs for water quality monitoring and surface cleaning can lower the expenses associated with traditional techniques of water quality evaluation and surface cleaning. Finally, the usage of USVs helps mitigate the dangers associated with manual operations.

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The project "Design and Development of Underwater Device - Boat Propeller Blade Algae Detection and Cleaning" aims to develop a system to detect and remove algae growth on boat propeller blades. The main objective of this project is to improve boat propeller performance by reducing algae growth on the blades, which results in reduced efficiency and increased fuel consumption. The project's goal is to achieve this by developing a device that can be mounted on a boat's propeller, use sensors and algorithms to detect the presence of algae, and use a cleaning mechanism to remove the identified algae. The building and design of the device will take place. The overall objective of the program is to provide boat owners with a low-cost, high-efficiency method of maintaining their boats' propellers, reducing fuel consumption and extending the life of their engines. Additionally, the idea hopes to contribute to environmental sustainability by reducing the need for hazardous cleaning agents or the labor-intensive physical labor required to remove algae buildup from boat propeller blades.

3.2 SCOPE

Water cleaning robots are usually one-of-a-kind creations and come in a wide range of styles and concepts. Young industries often take a piecemeal strategy with little standardization. (Most of the progress has been made only in the last ten years). According to Noord strand (2020), the underwater robotic cleaning industry is now plagued by the usual problems faced by growing companies. The current state of the industry with its design diversity has various reasons:

The type of paint used on the surfaces soft-dissolving self-polishing co-polymer paints, machine-sensitive odor-emitting coatings, or hard varnishes determines the best cleaning strategy.

The total market size of the water cleaning sector is very modest and highly fragmented. Hull Viper is a pioneer in the field of robotic in-water cleaning, employing a maximum of 50 people in a small to medium business setting.

In the "do-it-yourself" style typical of emerging industries, cleaning companies create their own designs and fabricate or fabricate them in nearby workshops (Consider how early autos or personal computers were built and assembled in home garages). Standards for the creation of such robots do not yet exist. In due course, we should observe some market and robot design consolidation, much like we did for other industries (automotive, aviation, personal computers, etc.). The service providers may eventually receive mass-produced or at least mini-series-produced in-water robot cleaners from specialised in-water robot cleaning robot manufacturers. These robots may even use modular design strategies to retain cheap production costs while allowing for the required flexibility. Additionally, as predicted by Lee et al. (2012), robot design will transition from "do-it-yourself" assembly design to more professional approaches using computer-aided design, including hydrodynamic optimisation. There are many ways to categorize in-water cleaning robots, including:

- Cleaning technology (brushes, high-pressure or cavitation-alwater-jets, laser)
- Adhesion technology (magnetic, vacuum (negative pressure), thrusters)
- Level of autonomy (diver controlled, remotely controlled, more or less autonomous)
- Region/country (USA, Europe, Japan)
- Market (pleasure boats, commercial ships, navies, ...)

The majority of technologies available today prefer magnetic adhesion, making them unsuitable for the common materials used in the construction of pleasure craft, such as aluminium, reinforced plastics, and wooden hulls. While using thrust force, as in Ishii et al. (2014), Souto et al. (2015), or adhesive elastomer materials in research applications is fairly innovative, vacuum (= negative pressure) adhesion is also frequently utilised, according to Song and Cui (2020). Freyer and Eide (2020) assert that adhesion brought on by flow forces of a

moving ship only pertains to the primarily flat sides and not the ends or the bottom.

3.3 PROBLEM STATEMENT

The development of an underwater robot to detect and remove algae from boat propeller blades is an innovative solution that can greatly benefit the marine industry. Here are some steps to consider in the design and fabrication process.

Determine the design specifications: This includes identifying the size and shape of the robot, as well as the materials needed for its construction. The robot should be able to move easily in the water and have the necessary tools and mechanisms to remove the algae from the propeller blades.

Choose the propulsion system: The robot should have a propulsion system that allows it to move easily underwater. Options include using thrusters, propellers, or a combination of both.

Develop the sensing system: The robot should be equipped with sensors and a camera to detect the presence of algae on the propeller blades. The sensors can be used to measure the thickness of the algae, and the camera can capture images of the blades for analysis.

Design the algae removal mechanism: The robot should be fitted with a mechanism to remove the algae from the blades. Options include using brushes, scrapers, or water jets to dislodge the algae from the surface of the blade.

Test and refine the design: The robot should be tested in a controlled environment to ensure that it functions properly. Feedback from testing should be used to refine the design and make any necessary modifications.

Consider environmental impact: The robot should be designed to minimize any negative impact on the environment. This includes using eco-friendly materials and ensuring that the robot does not damage the propeller blades or surrounding marine life.

Overall, the development of an underwater robot to detect and remove algae from boat propeller blades can greatly benefit the marine industry by reducing fuel consumption and improving overall performance. The design and fabrication process should focus on creating a robot that is efficient, effective, and environmentally friendly.

3.4 FUTURE SCOPE

An inventive approach to the issue of marine fouling, which may seriously harm boat propellers and have an impact on their performance, is the design and manufacture of an underwater boat propeller blade algae detection and removal system. In order to find and remove algae accumulation on propeller blades, the system makes use of cutting-edge sensors, algorithms, and cleaning mechanisms. This increases boat efficiency and lowers maintenance costs. Future applications for this system's potential to change the marine industry by providing an affordable and environmentally friendly solution to marine fouling are very diverse. Some potential uses of this technology in the marine transportation industry include the following: The marine transportation industry is one of the biggest boat users, therefore any improvements to boat performance and efficiency can have a significant impact on the bottom line. The underwater boat propeller blade algae detection and removal system can increase the overall productivity and profitability of the industry by reducing fuel consumption, maintenance costs, and downtime. Environmental surveillance The device can also be used to assess the health of marine ecosystems by scanning the water for the presence of algae and other potentially harmful substances. This can help in identifying areas that need immediate care and in deciding the best way to protect the environment.

CHAPTER 4

MATERIAL & EXPERIMENTAL METHODS

4.1 SQUARE TUBE

A metal profile called hollow structural steel (HSS) with a hollow cross-section is often used. Because of its excellent strength-to-weight ratio and resistance to bending and twisting, HSS is frequently used. The term HSS is commonly used in the United States and other countries that use US construction or engineering terms. HSS members come in various shapes including oval, round, square and rectangular. It is essential to highlight that HSS conforms to building requirements as it is made entirely of steel. Although both are dimensioned and classified into different types, rectangular, square, and circular HSS are known as tubular steel or box section, and occasionally, steel pipe. HSS corners are rounded and the wall thickness is maintained throughout the section with a radius approximately twice as large as the wall thickness. In the UK or other countries that follow British construction or engineering nomenclature, the term "HSS" is not used. The basic shapes are instead referred to as CHS (circular hollow sections), SHS (square hollow sections), and RHS (rectangular hollow sections). Due to the fact that these designations also apply to metric sizes, the dimensions and tolerances are slightly different from those of HSS. The use of HSS in engineering and building applications brings many advantages. For example, HSS is often used in the planning of steel structures such as towers, skyscrapers and bridges. HSS is also used in the manufacture of furniture, sports goods and other products that require a high strength-to-weight ratio. Because HSS can take high compressive loads and has excellent bending and torsion resistance, it is a popular choice for many applications. In conclusion, HSS is a specific type of hollow cross-sectional metal profile that is manufactured entirely from structural steel to meet building requirements. HSS members come in a variety of shapes, such as circular, square, and rectangular, and they have many uses in engineering and construction. While the word "HSS" is predominantly used in the United States, other nations may use the terms "CHS," "SHS," or "RHS" to refer to these profiles.

4.2 LEAD SCREW

A lead screw is a mechanical device that converts rotational motion into linear motion. It is sometimes referred to as a power screw or a translation screw. Compared to other types of couplings, the screw threads of lead screws often have a large area of sliding contact between the male and female components, which leads to relatively high frictional energy losses. Lead screws are typically not used in high power applications because of their considerable friction. Instead, they are mostly used in positioner and actuator systems with intermittent consumption of low power. They can be found in many different types of equipment, such as jacks, vices, presses, and linear actuators. Similar to other kinds of thread shapes, lead-screws are made using a rolling, cutting, or grinding process. A split nut, commonly referred to as a half nut, may occasionally be used with a lead-screw. As single-point threading requires on a manual lathe, it allows the nut to be free of threads and move independently of screw rotation. Although it has high position accuracy, very low friction and very low wear, the hydrostatic lead-screw has some disadvantages compared to the static lead-screw. For example, a hydrostatic lead-screw costs significantly more than other linear motion couplings because it requires a constant supply of high-pressure fluid and high-precision output. For instance, a hydrostatic lead-screw requires a continuous supply of high pressure fluid and high-precision manufacturing, which results in significantly higher costs compared to most other linear motion linkages.



Fig : 4.1 : Lead Screw Steel Rod

4.3 WIPER MOTOR

Electrical energy is converted into mechanical energy via a specific class of rotating electrical device known as a motor. The majority of motors use magnetic fields to produce forces. Every type of motor has an internal

electromechanical or electronic mechanism that intermittently changes the current flow in a particular section of the motor. Motors were the first form of motor that was widely used because they could be powered by the direct-current lighting power distribution networks that already existed. A motor's speed can be varied widely by changing the amount of current flowing through its field windings or by using a variable supply voltage. Little motors are used in a lot of toys, gadgets, and appliances. The universal motor, a compact brushed motor that can run on direct current, is used in portable power tools and appliances. Larger motors are widely used for electric vehicle propulsion, lift and hoist propulsion, and steel rolling mill drives. Thanks to the development of power electronics, AC motors may now be utilised in many applications in place of motors. An electromagnetic field is created and is centred on a wire coil that is conducting current. The magnetic field's direction and intensity can be changed by varying the coil's current's direction and intensity. This fundamental concept of electromagnetic fields and currents is the basis of every electric motor. In conclusion, motors are a crucial component of many pieces of machinery and systems. They have evolved over time to become more potent, versatile, and effective.



Fig : 4.2 : Wiper Motor

4.4 CAMERA

A camera is a highly developed tool that takes pictures using optics. While more sophisticated versions can also record 3D images, the majority of cameras can only capture 2D images. A light-sealed box, commonly referred to as the

camera body, with a small hole known as the aperture is the basic building block of a camera. This enables light to pass through and create an image on a surface that is sensitive to light, such as a digital sensor or photographic film. Lenses that focus the light and shutters that control how long the photosensitive surface is exposed to light are just two of the technologies used by cameras to control the amount of light that enters the device. Modern cameras come in a variety of shapes and sizes and are capable of accurately capturing high-resolution photographs and films. They are present in smartphones, tablets, digital cameras, and other portable electronics as well as professional cameras used in photography, filmmaking, and cinematography. In addition to taking still photos, cameras are used to record movies, documentaries, and other types of video. Since captured images are frequently duplicated through digital imaging or photographic printing, the still image camera is an essential piece of gear in photography. The capacity to preserve memories and experiences that were before unrecordable has revolutionised the discipline of photography. Images and movies may now be stored in digital formats, making it simpler to modify, share, and save them on a global scale. The word "camera" comes from the Latin word *camera obscura*, which translates as "dark chamber." This expression originally referred to a device that projected a 2D image onto a flat surface. Using a camera obscura, Joseph Nicéphore Niépce created the first ever permanent photograph in 1825. This invention later led to the development of the modern photographic camera. Since that time, cameras have made enormous technological strides that have increased their usability and accessibility. Cameras are an indispensable part of our daily lives, whether they are used to record and share family memories or for use in professional photography and filmmaking.



Fig :4.3 Ip67 Underwater camera

4.5 BATTERY

A rechargeable battery, storage battery, or secondary cell (formally a type of energy accumulator) is an electrical battery that can be charged, discharged into a load, and recharged numerous times. This is in contrast to a disposable or primary battery, which is supplied fully charged and is thrown away after use. Its structure is composed of one or more electrochemical cells. The term "accumulator" refers to how it stores and gathers energy through a reversible electrochemical reaction. Rechargeable batteries are produced in a wide range of shapes and capacities, from button cells to megawatt systems connected to stable an electrical distribution network. Among the many electrode materials and electrolytes used are lead-acid, zinc-air, nickel-cadmium (Ni-Cd), nickel-metal hydride (NiMH), lithium-ion (Li-ion), lithium iron phosphate (LiFePO₄), and lithium-ion polymer (Li-ion polymer). A battery is a device that stores electrical

energy and consists of one or more electrochemical cells with external connections for powering electrical equipment. When a battery is supplying electricity, its positive terminal serves as the cathode and its negative terminal as the anode. The source of the electrons that will flow from the terminal marked "negative" to the terminal marked "positive" is an external electric circuit. When a battery is connected to an external electric load and the free-energy difference is transferred to the external circuit as electrical energy, redox reactions convert high-energy reactants into lower-energy products. The term "battery" was first used to describe a device made up of numerous cells, but it has now come to apply to anything made up of a single cell.

4.6 ARDUINO



Fig: 4.4 Arduino

Arduino is an open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices. Its hardware products are licensed under a CC BY-SA license, while software is licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),^[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially

from the official website or through authorized distributors. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards ('shields') or breadboards (for prototyping) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs. The microcontrollers can be programmed using the C and C++ programming languages, using a standard API which is also known as the Arduino language, inspired by the Processing language and used with a modified version of the Processing IDE. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) and a command line tool developed in Go.

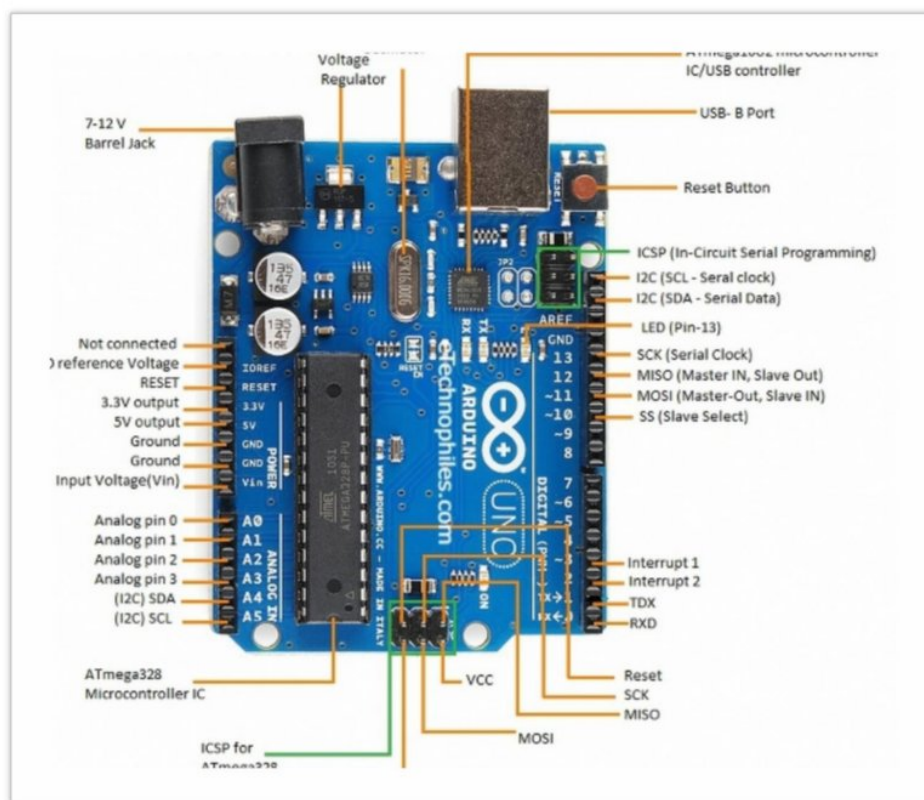


Fig 4.5 PIN DIAGRAM

4.7 BLUETOOTH

bluetooth module is a slave bluetooth module designed for wireless serial communication. It is a slave module meaning that it can receive serial data when serial data is sent out from a master bluetooth device(device able to send serial data through the air: smart phones, PC).When the module receives wireless data, it is sent out through the serial interface exactly at it is received. No source code specific to the Bluetooth module is needed at all in the arduino chip. An app on the phone is used to send out inputs to the module which receives and then transfers this to the arduino. The arduino and actuators in turn responds accordingly, as specified in the source code. When the module is not in a paired state, the LED on the module blinks rapidly whereas when paired with the app on the phone, the LED on the module is a steady red.

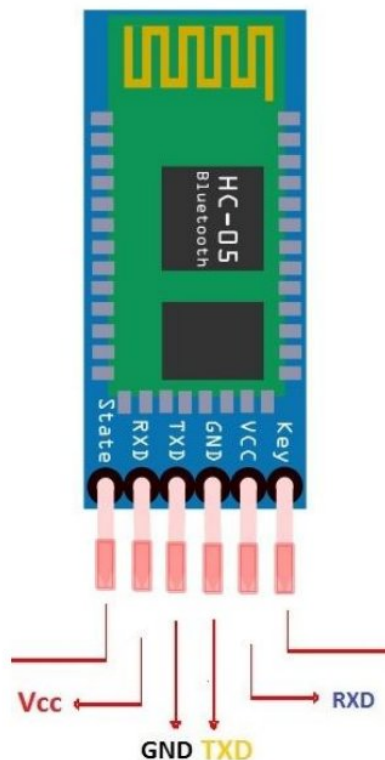


Fig 4.6 Bluetooth

Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the ISM bands, from 2.402 GHz to 2.48 GHz, and building personal area networks (PANs). It is mainly used as an alternative to

wire connections, to exchange files between nearby portable devices and connect cell phones and music players with wireless headphones. In the most widely used mode, transmission power is limited to 2.5 milliwatts, giving it a very short range of up to 10 metres (33 ft). Bluetooth is managed by the Bluetooth Special Interest Group (SIG), which has more than 35,000 member companies in the areas of telecommunication, computing, networking, and consumer electronics. The IEEE standardized Bluetooth as IEEE 802.15.1, but no longer maintains the standard. The Bluetooth SIG oversees development of the specification, manages the qualification program, and protects the trademarks. A manufacturer must meet Bluetooth SIG standards to market it as a Bluetooth device. A network of patents apply to the technology, which are licensed to individual qualifying devices.

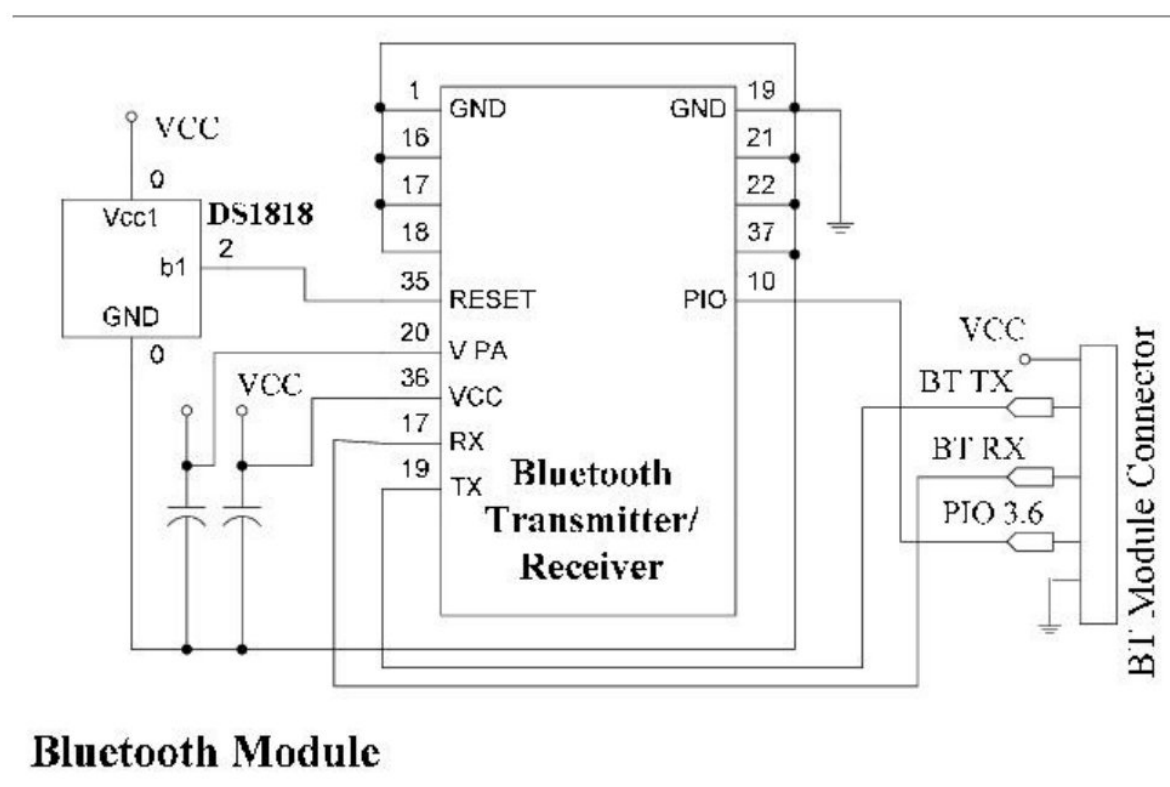


Fig 4.7 PIN DIAGRAM

4.8 SIX CHANNEL RELAY

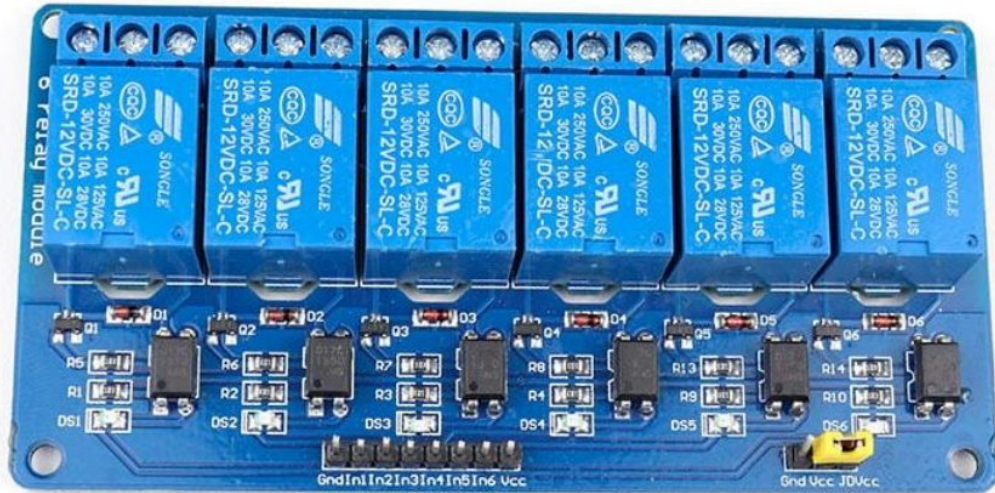


Fig:4.8 Six Channel Relay

A **relay** is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. The traditional form of a relay uses an electromagnet to close or open the contacts, but relays using other operating principles have also been invented, such as in solid-state relays which use semiconductor properties for control without relying on moving parts. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called protective relays. Latching relays require only a single pulse of control power to operate the switch persistently. Another pulse applied to a second set of control terminals,

or a pulse with opposite polarity, resets the switch, while repeated pulses of the same kind have no effects. Magnetic latching relays are useful in applications when interrupted power should not affect the circuits that the relay is controlling.

4.9 EXPERIMENTAL WORK

Underwater investigation robots are becoming increasingly popular in the marine industry due to their ability to provide a safer, more efficient means of working in underwater environments. One of the key applications of these robots is to identify and fix problems in ship turbines. These turbines are vital components of ships and are responsible for generating power to propel the vessel. Ensuring that the turbines function efficiently is critical to the safety and reliability of the vessel. Traditionally, inspecting and repairing ship turbines required workers to enter the water, which can be a dangerous task due to the inherent risks of working in underwater environments. However, with the use of underwater investigation robots, workers can now perform these tasks remotely. This significantly reduces the risk of injury to marine workers and increases safety in the workplace. The underwater investigation robot is equipped with a motorized mechanism and a lead screw system that allows it to move smoothly and accurately along the surface of the turbine blades. This mechanism is capable of cleaning the blades and identifying any problems that may exist. The use of a camera also provides live video feedback to the operator, allowing them to monitor the progress of the robot and ensure that it is performing its intended function. The ability of the robot to clean and maintain the turbine blades is critical to ensuring the efficiency of the turbine. The buildup of debris on the blades can cause the turbine to function poorly, leading to increased fuel consumption and decreased power output. This can result in costly repairs and downtime for the vessel. By using an underwater investigation robot, ship owners can avoid these issues and reduce the cost of maintenance and repairs. Moreover, the robot's ability to identify problems with the turbine blades before they become critical is another significant advantage of this technology. Regular inspections using the robot can detect issues such as cracks or wear on the blades, allowing for timely repairs to be made before the blades fail completely. This not only reduces the cost of repairs but also increases the

safety and reliability of the vessel. The use of underwater investigation robots is also a cost-effective solution for ship owners. With the high cost of hiring skilled marine workers to perform underwater inspections and repairs, the use of robots can significantly reduce labor costs. The initial investment in the robot technology may seem high, but the long-term benefits in terms of reduced labor costs and increased efficiency make it a valuable investment for the industry. Furthermore, the use of underwater investigation robots has environmental benefits as well. The robot's ability to efficiently clean and maintain the turbine blades reduces the risk of oil spills and other environmental hazards that can result from a malfunctioning turbine. Additionally, by avoiding costly repairs and maintenance, ship owners can reduce the environmental impact of their operations and promote sustainability in the industry. In conclusion, the use of underwater investigation robots is an increasingly popular solution for the marine industry. These robots provide a safer, more efficient means of working in underwater environments and offer a cost-effective solution for ship owners. By ensuring the efficient function of ship turbines, underwater investigation robots increase the safety and reliability of vessels, reduce labor costs, and promote sustainability in the industry. As the technology continues to develop, the use of underwater investigation robots is expected to become even more prevalent in marine applications.



Fig: 4.9 Box Setup

CODING

```
#include <Wire.h>
```

```
#include <LiquidCrystal_I2C.h>
```

```
// Set the LCD address to 0x27 for a 16 chars and 2 line display
```

```
LiquidCrystal_I2C lcd(0x3f, 16, 2);
```

```
const int IN1 = 5;
```

```
const int IN2 = 4;
```

```
const int IN3 = 3;
```

```
const int IN4 = 2;
```

```

char flag2 = 0;

char inByte;

int spd = 0, en_r = 0, rpm_r;

int ms0p5 = 0;

char disp_flag = 0;

void setup()
{
    Serial.begin(9600);

    pinMode(IN1, OUTPUT); digitalWrite(IN1, LOW);
    pinMode(IN2, OUTPUT); digitalWrite(IN2, LOW);
    pinMode(IN3, OUTPUT); digitalWrite(IN3, LOW);
    pinMode(IN4, OUTPUT); digitalWrite(IN4, LOW);

    // initialize the LCD

    lcd.begin();

    // Turn on the backlight and print a message.

    lcd.backlight();

    analogWrite( 9, en_r);

    analogWrite(10, en_r);

    cli();//stop interrupts

    //set timer0 interrupt at 2kHz

    TCCR0A = 0;// set entire TCCR2A register to 0

    TCCR0B = 0;// same for TCCR2B

    TCNT0 = 0;//initialize counter value to 0

    // set compare match register for 2khz increments

```

```

OCR0A = 124; // = (16*10^6) / (2000*64) - 1 (must be <256)

// turn on CTC mode

TCCR0A |= (1 << WGM01);

// Set CS01 and CS00 bits for 64 prescaler

TCCR0B |= (1 << CS01) | (1 << CS00);

// enable timer compare interrupt

TIMSK0 |= (1 << OCIE0A);

sei(); // allow interrupts
}

ISR(TIMER0_COMPA_vect)
{
  ++ms0p5;

  if(ms0p5 > 1000)
  {
    disp_flag = 1;
    ms0p5 = 0;
  }
}

void loop()
{
  if(Serial.available() > 0)
  {
    inByte = Serial.read();

    Serial.write(inByte);
  }
}

```

```

if(inByte == 'F')flag2 = 1;

else if(inByte == 'B')flag2 = 2;

else if(inByte == 'L')flag2 = 3;

else if(inByte == 'R')flag2 = 4;

else if(inByte == 'S')flag2 = 0;

if(inByte >= '0' && inByte <= '9')

{

    spd = inByte - 48

    en_r = map(spd, 0, 9, 0, 255);

    analogWrite( 9, en_r);

    analogWrite(10, en_r);

    rpm_r = en_r * 2.745098;

}

inByte = '\0';

}

if(disflag == 1)

{

    lcd.setCursor(0, 0);

    lcd.print("Speed: ");

    if(rpm_r < 10)lcd.print("");

    else if(rpm_r < 100)lcd.print("");

    lcd.print(rpm_r);

    lcd.print(" RPM ");

    disp_flag = 0;

```

```

}

if(flag2 == 1)
{
    digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH);
    digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH);
}

else if(flag2 == 2)
{
    digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
    digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW);
}

else if(flag2 == 3)
{
    digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
    digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH);
}

else if(flag2 == 4)
{
    digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH);
    digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW);
}

else if(flag2 == 0)
{
    digitalWrite(IN1, LOW); digitalWrite(IN2, LOW);

```

```

digitalWrite(IN3, LOW); digitalWrite(IN4, LOW);

}

}

```

4.10 METHODOLOGY

The goal of this methodology is to describe the process of setting up a box to clean underwater propeller blades using an L bend frame that is fitted to handle up and down moment on the vertical axis and left and right moment on the horizontal axis. The first step is to assemble the L bend frame. This involves attaching the frame components together to create a stable structure that can handle the up and down moment on the vertical axis and left and right moment on the horizontal axis. The frame should be securely fastened using bolts and nuts to ensure it is sturdy enough to hold the weight of the box and withstand the underwater environment. The next step is to mount the box onto the L bend frame. The box should be designed to fit snugly onto the frame, with bolts and nuts used to secure it in place. The box should be positioned in such a way that it is aligned with the propeller blades that need to be cleaned. This will require careful planning to ensure that the box is positioned correctly and securely. The third step is to fit the cleaning mechanism into the box. This will involve selecting the appropriate cleaning tools and attaching them securely to the box. The cleaning mechanism should be designed to effectively remove algae and other debris from the propeller blades, without damaging the blades themselves. The cleaning mechanism should be able to move freely within the box, with the box providing a protective environment that minimizes the risk of damage. The fourth step is to connect the box to the underwater vehicle that will be used to transport it to the propeller blades. This will involve attaching the box to the vehicle using a secure mounting system. The box should be positioned in such a way that it does not interfere with the movement of the vehicle, and the mounting system should be designed to withstand the forces exerted by the underwater environment. The final step is to test the system to ensure that it is working effectively. This will involve conducting a trial run to test the cleaning

mechanism and the box's ability to withstand the underwater environment. The trial run should be carefully monitored to ensure that the system is operating as intended and that there are no issues with the frame, box, or cleaning mechanism. In conclusion, setting up a box to clean underwater propeller blades using an L bend frame that is fitted to handle up and down moment on the vertical axis and left and right moment on the horizontal axis requires careful planning and attention to detail.

CHAPTER 5

RESULT AND DISCUSSION

5.1 DESIGN THE ROBOT

The process of designing a robot is intricate and incorporates many different elements, from artificial intelligence to mechanical engineering. Because a robot is fundamentally a machine that can carry out activities independently or with human guidance, it must be designed to meet a number of criteria, including functionality, safety, efficiency, and cost-effectiveness. When it comes to mechanical engineering, a robot often comprises of a variety of stiff or flexible materials, such as metal, plastic, or composites, placed in a certain configuration to allow it to do the duties for which it is designed. The physical structure of the robot must be strong enough to endure any stresses and strains that it may experience while in use, while yet being light enough to enable effective mobility and flexibility. Additionally, a robot's capabilities are greatly influenced by the way its sensors and actuators are built. While actuators allow the robot to interact with its surroundings, sensors allow it to sense and understand its environment. As an illustration, a manufacturing-oriented robot might have sensors to locate objects on a production line and actuators to move those objects in accordance with pre programmed instructions. The design of a robot's control system is essential to its functionality in terms of artificial intelligence. The robot's processing of sensor data and decision-making over how to respond are determined by the control system. For instance, a robot created for search and rescue operations may utilise AI algorithms to assess the information from its sensors and decide how to move around a catastrophe site. The design of a robot must also take social and ethical issues into account. Questions regarding how robots will affect jobs, privacy, and human autonomy are growing more urgent as society integrates robots more deeply. Designers must be aware of these problems and make sure that their robots are built in a way that benefits both people and machines. In general, designing a robot is a diverse and challenging process that calls for careful consideration of a variety of variables. Each component of a robot's design, from mechanical engineering to artificial intelligence to ethical and social issues, is vital

in deciding its capabilities and effect on society. Numerous industries, including industry, healthcare, agriculture, and space exploration, have benefited greatly from the development of robots. Numerous advantages, including higher production, enhanced efficiency, and decreased labour costs, have come from the deployment of robots in various areas. These advantages do, however, come with some possible disadvantages that should also be taken into account. The ability of robot design to accomplish jobs precisely and accurately is one of its main benefits.

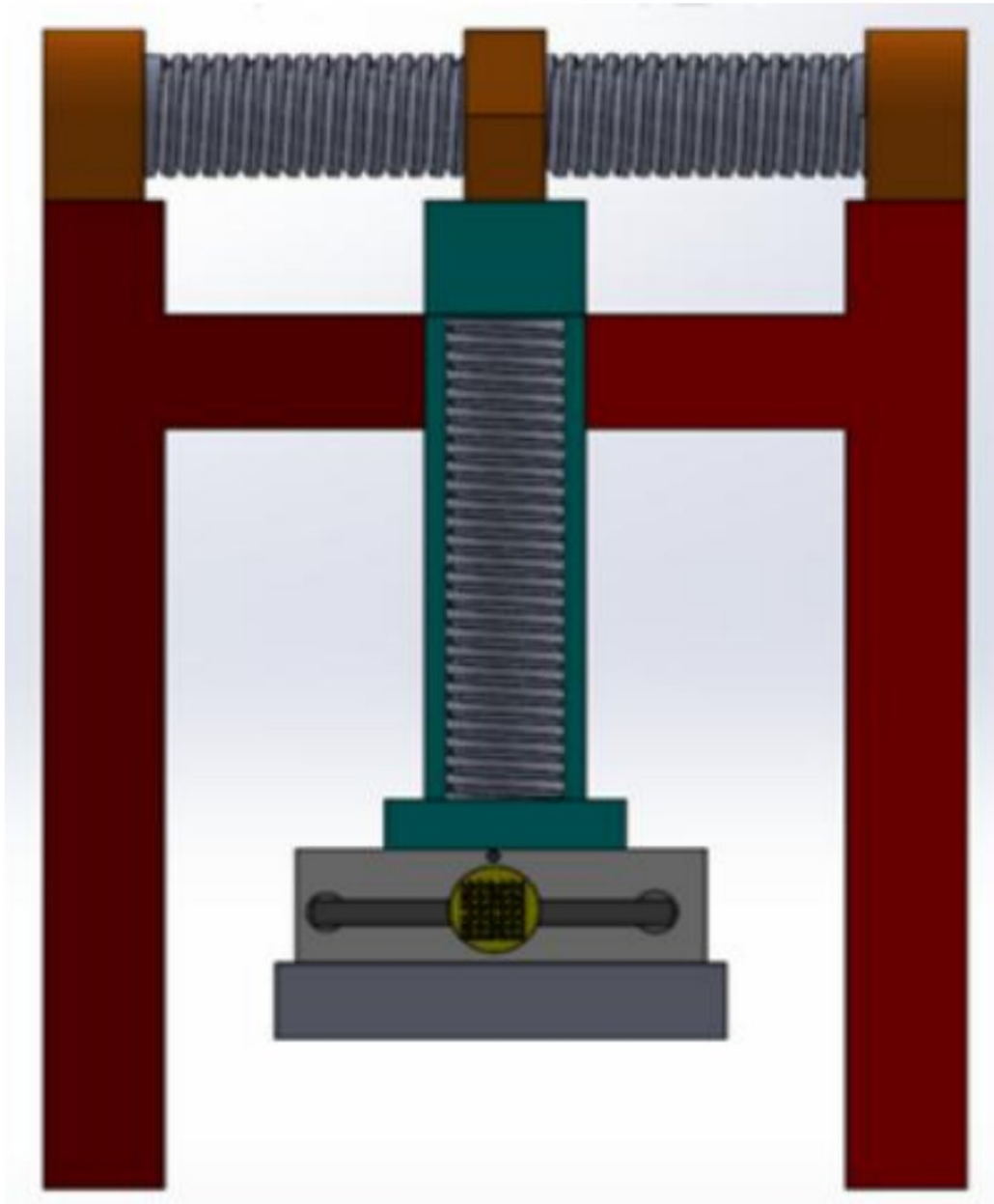


FIG :5.1 : Front View

Robots' ability to complete repetitive activities without getting fatigued or making mistakes leads to higher-quality products and less waste. Robots may operate around-the-clock in sectors like manufacturing, which boosts output and lowers labour expenses. Another benefit of robot design is its capacity for hazardous and risky activities, such as operating in locations with explosive chemicals or in conditions with high radiation levels. Robots can be deployed in certain circumstances to carry out jobs that would be dangerous for people, lowering the possibility of harm or death.

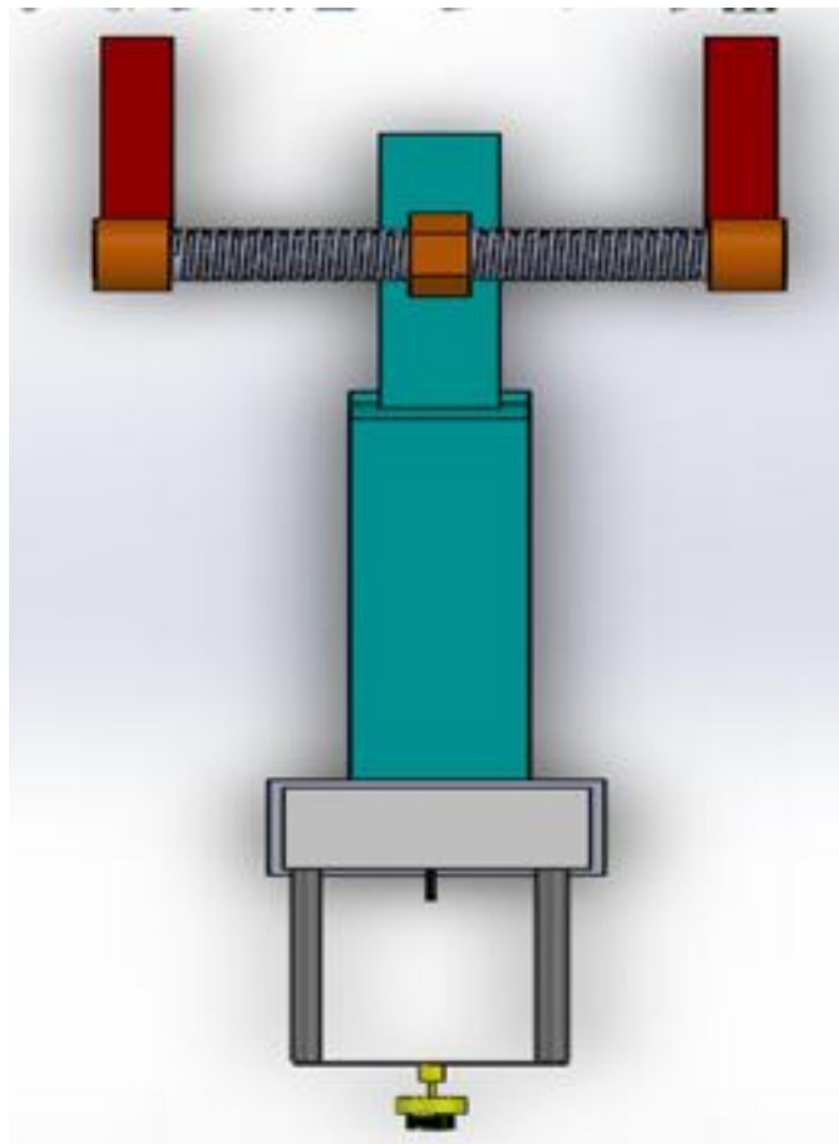


FIG : 5.2 : Top View

Furthermore, robots can be created to carry out physically taxing or specialized operations, like surgery or welding. Robots' capacity to perform monotonous tasks

without growing weary or making mistakes results in higher-quality output and decreased waste. In industries like manufacturing, robots may work around-the-clock, increasing productivity and reducing staff costs. The ability of robots to perform dangerous and risky tasks, such as working in environments with explosive chemicals or in environments with high radiation levels, is another advantage of their design. In some situations, robots can be used to complete tasks that would be hazardous for humans, reducing the risk of injury or death. Robots can also be built to do physically demanding or specialist tasks, like surgery or welding. Concerns exist regarding the ethical ramifications of robot creation. For instance, there are concerns over the employment of autonomous weaponry and the possibility of using robots for monitoring. Concerns exist over the loss of human control over autonomous robots as well, which might provide safety issues and unforeseen effects. In conclusion, it is important to carefully balance the advantages and disadvantages of robot design to make sure that the former exceed the latter. While deploying robots in many industries has numerous benefits, there may also be negative effects that need to be considered.

5.2 FABRICATION OF ROBOT

Robots with machine vision are becoming more and more common in industrial settings because they are capable of performing intricate jobs precisely and accurately. Machine vision robots are very helpful for inspecting propellers for algae. A boat's propellers are essential for travelling great distances, and any damage to them might have negative effects. Algae in the propeller can be hard to find, and conventional inspection techniques can be expensive and time-consuming. Robots with machine vision can be quite helpful in this situation. Building a mechanical framework with cameras and other hardware and software components is required to create a machine vision robot. The robot may be trained to examine the propeller's surface for algae or other flaws. Images of the propeller are captured by the cameras and analyzed by specialized software to spot any anomalies. Machine vision robots are extremely adaptable since they can be made to function in a variety of settings, including the sea or in cramped quarters. Depending on the application, they can be set up to run independently or under human direction. The ability of machine vision robots to perform significantly more

quickly than conventional inspection techniques is one benefit of deploying them for propeller inspection.



Fig : 5.3 : Front view of the prototype

They are able to scan the surface of the propellers in real-time and accurately find any flaws. This lowers the possibility of accidents and environmental harm by allowing for speedier damage diagnosis and restoration. Machine vision robots can be used for propeller inspection, although there are certain restrictions. They can only identify surface flaws; deeper flaws may need to be discovered using more sophisticated examination techniques. In addition, machine vision robots may be expensive to construct and maintain, and their efficient use may need specialized knowledge and abilities. In conclusion, the creation of a machine vision robot for propeller inspection is a process that calls for careful consideration of a number of variables, including the design of the robot's hardware and software components, the particular environment in which it will operate, and the necessary

degree of autonomy. Machine vision robots are a useful tool for the upkeep and repair of vital infrastructure, despite various restrictions on their usage for propeller inspection due to their benefits in terms of speed, precision, and safety. The capacity of machine vision robots to work swiftly and precisely is one of the key advantages of utilizing them for propeller inspection. They are able to scan the surface of the propeller in real-time and precisely identify faults, facilitating faster damage diagnosis and repair. This can lessen the possibility of mishaps and environmental harm. The adaptability of machine vision robots for propeller inspection is an additional benefit.



Fig : 5.4 : side view of the prototype

They are helpful in a variety of applications because they can be made to function in different settings, including as underwater or in small areas. In addition, depending on the particular requirements of the application, machine vision robots

can be configured to function independently or under human control. However, deploying machine vision robots for propeller inspection may have significant unintended consequences. Their price is one of the primary issues. Machine vision robots can be expensive to build and maintain, and they may need specialized knowledge and abilities to work well. Additionally, pipeline surface flaws may be difficult for machine vision robots to identify, which might result in damage that goes unnoticed. The ethical ramifications of utilizing robots to carry out duties that were previously performed by people are another possible problem.

5.3 FOCAL LENGTH OF THE THE CAMERA TO GET THE CLEAR IMAGE UNDER THE WATER

The focal length formula and requires knowing the distance from the original object to the lens u and the distance from the lens to the image v . The lens formula says that the inverse of the distance from the object plus the distance to the image equals the inverse of the focal distance f .

Formula is $1/o + 1/i = 1/f$: where o refers to the distance from the object to the lens, i refers to the distance from the lens to the image and f is the focal length. In clear water:

$$O = 1/25$$

$$I = 1/15$$

$$F = 1/25 + 1/15 = 1/25 + 1.7/25 = 2.7/25 \text{ and the ans } 9.25 \text{ cm}$$

centimeter $F = 9.25 \text{ cm}$

In salt water:

As it's in salt water or immersed in the the refractive index decreases and the focal length increases

$$O = 1/33$$

$$I = 1/18$$

$$F = 1/40 + 1/18 = 1/40 + 2.2/40 = 3.2/40 \text{ and the Ans is } 12.5 \text{ cm}$$

Focal length of the camera in salt water is 12.5 cm

5.4 THE RANGE OF MOVE HOW MUCH FAR THE PROTOTYPE CAN GO UNDER THE WATER

* The peek length up-to where the prototype can withstand the weight of the frame is 85 cm depth under the water and can do the cleaning and the identification process , as this is a prototype the distance may vary in a live project .

* The movement of left and the movement to the right to Clean the propeller blade is that the size the maximum movement to the left is 43 cm and the maximum move movement to the right is 43 cm as the mid point of the track is 23 cm



FIG: 5.5 : model propeller blade image

5.5 PRESSURE ACTING

The pressure acting on a motor during a cleaning process can vary depending on the specific cleaning method being used and the type of motor being cleaned. For example, if a high-pressure water jet is being used to clean the motor, the pressure acting on the motor could be quite high, potentially reaching several thousand pounds per square inch (psi). This could place a significant amount of stress on the motor components, particularly if the cleaning process is prolonged or the pressure is not properly controlled. On the other hand, if a less intense

cleaning method is used, such as wiping the motor with a damp cloth or using a low-pressure air blower, the pressure acting on the motor would be much lower and may not pose a significant risk of damage. In general, it is important to carefully consider the cleaning method and pressure being used when cleaning a motor, and to follow any manufacturer recommendations or guidelines to ensure that the motor is not damaged during the cleaning process.

Table 5.1 pressure acting in different situations

S.I no	Situations	Amount of pressure
1	Non touching the propeller	03 kg
2	While touching the propeller with the algae presented	2.8 kg
3	While touching the propeller after the algae is removed	1.0 kg
4	The peak pressure the device can withstand	3.2 kg

5.6 CURRENT ACTING

There required to run the motor and the motor underwater and input given the motor and how much input will it take after the pressure is given to the motor to run the motor is the required amount of speed.

Table 5.2 : Current Acting In Different Areas

S.I no	situations	output
1	In Off Position	0 A
2	In On Position	0.2 A
3	In Load Is Presented On The Motor	4.28 A

Underwater investigation robots are a type of specialized equipment used in marine applications to identify and fix problems in underwater systems. These robots are particularly useful for investigating issues with ship turbines, which are vital components of ships and are responsible for generating power to propel the vessel. The main purpose of the underwater investigation robot is to identify problems with the turbine blades and clean them. This can help to ensure that the turbine continues to function efficiently and reduces the risk of the blades becoming damaged or breaking down, which can lead to costly repairs and downtime. The use of an underwater investigation robot can also help to reduce the risk of injury to marine workers. By performing the task remotely, workers are no longer required to enter the water to inspect or repair the turbine blades, which can be a dangerous task due to the inherent risks of working in underwater environments. The robot setup typically includes a motorized mechanism and a lead screw system that allow the robot to move smoothly and accurately along the surface of the turbine blades.



FIG :NO: 5.6 BOAT PROPELLER

5.7 CALCULATION

Force required for rank selection = 50 N(actually measured)

Link Length = 51 mm

Linear velocity for Gear Shifting

= Stroke required / time

= $22/0.45 = 49$ mm/sec

Linear velocity for Rank Selection

= Stroke required / time

= $14/0.45 = 31$ mm/sec

Force required for rank selection = 50 N(actually measured)

Link Length = 51 mm

Linear velocity for Gear Shifting

= Stroke required / time

= $22/0.45 = 49$ mm/sec

Linear velocity for Rank Selection

= Stroke required / time

= $14/0.45 = 31$ mm/sec

Motor torque required = Force x link length = $50 * 0.051$

= 2.55 Nm

Angular velocity require for motor

= Linear velocity / link length = $50/51 = 0.98$ rad/sec

Speed required for motor

= Angular velocity x 60 / (2 x 3.14) = $0.98 * 60 / (2 * 3.14) = 9.3$ rpm = 10 rpm

Gear ratio = 5

Radius of rotation for plunger = 45 mm

Torque at arc gear pivot point = Force at plunger x radius of rotation = 500×0.045
= 22.5 Nm

Torque required for motor

= Torque at arc gear pivot point x (motor shaft diameter / Arc gear diameter) =
 $22.5 \times (10 / 50) = 4.5$ Nm

Angular speed for arc gear = linear speed / Arc gear diameter = $60 / 45 = 1.33$
rad/sec

Speed required for arc gear = Angular speed for arc gear x $60 / (2 \times 3.14) = 1.33 \times$
 $60 / (2 \times 3.14) = 13$ rpm

Speed required for motor = Speed required for arc gear x gear ratio = $13 \times 5 = 65$
rpm

Motor torque required = Force x link length = 50×0.051
= 2.55 Nm

Angular velocity require for motor

= Linear velocity / link length = $50/51 = 0.98$ rad/sec

Speed required for motor

= Angular velocity x $60 / (2 \times 3.14) = 0.98 \times 60 / (2 \times 3.14) = 9.3$ rpm = 10 rpm

Gear ratio = 5

Radius of rotation for plunger = 45 mm

Torque at arc gear pivot point = Force at plunger x radius of rotation = 500×0.045
= 22.5 Nm

Torque required for motor

= Torque at arc gear pivot point x (motor shaft diameter / Arc gear diameter) =
 $22.5 \times (10 / 50) = 4.5$ Nm

Angular speed for arc gear = linear speed / Arc gear diameter = $60 / 45 = 1.33$
rad/sec

Speed required for arc gear = Angular speed for arc gear $\times 60 / (2 \times 3.14) = 1.33 \times 60 / (2 \times 3.14) = 13 \text{ rpm}$

Speed required for motor = Speed required for arc gear $\times$ gear ratio = $13 \times 5 = 65 \text{ rpm}$

5.8 WIPER MOTOR

Given data:

Volt 12v

Speed=145rpm

Length of base=380mm

Width of base =203mm

Height =175mm

Material =mild steel

Weight =1.5kg

T =60 N-m

Power=W/t = V.I

W= electric energy

v = volt

I = Current amp)

T= time

M/r power(P)

i) Low speed

$P = I \times V$

$= 3 \times 12$

$P = 36 \text{ watts}$

ii) High speed

$$P = I_2 \times V$$

$$= 5 \times 12$$

$$P = 60 \text{ watts}$$

$$\text{Torque at are given pivot point} \times (M/V \text{ shaft diameter} / \text{are gear diameter})$$

$$= 22.5 \times (10/50)$$

$$4.5 \text{ Nm}$$

$$\text{Angular speed for arc gear}$$

$$= \text{linear gear} / \text{arc gear diameter}$$

$$= 60/45$$

$$= 1.33 \text{ rad/sec}$$

$$\text{Speed required for arc gear}$$

$$= \text{angular speed for one gear} \times 60/2 \times 3.14$$

$$= 1.33 \times 60/2 \times 3.14$$

$$= 13 \text{ rpm}$$

$$\text{Speed required for m/r}$$

$$= \text{speed required for arc gear} \times \text{gear ratio}$$

$$= 13 \times 5$$

$$= 65 \text{ rpm}$$

$$\text{Low speed}$$

$$P = 2\pi Nt/60$$

$$36 = 2 \times 3.14/60 \times N \times T$$

$$\text{Gear ratio} = 5$$

$$P = 500 \text{ N}$$

$$\text{Radius of rotation for plunger} = 45 \text{ mm}$$

Torque at are given p Not point

Force at plunger $\times$ radius of rotation

$$= 500 \times 0.045$$

$$T = 225 \text{ N.m}$$

Torque required for M/r

CHAPTER 6

CONCLUSION

The development of a robotic system that monitors the boat's propeller rudder is a significant achievement that can have a far-reaching impact in the maritime industry. The system is designed to provide real-time monitoring of the boat's propulsion system, ensuring that the propeller and rudder are functioning optimally and efficiently. This will result in improved safety, reduced fuel consumption, and lower emissions. The project involved extensive research into the design and operation of propellers and related technology. The team conducted numerous tests under various conditions to validate the system's performance and reliability. The results of these tests provided valuable insights into the functioning of propellers and how they can be optimized for maximum efficiency. The potential applications of this technology are significant, with potential benefits for the shipping industry, recreational boaters, and the environment. The system's ability to monitor the propeller and rudder in real-time can help prevent accidents caused by malfunctions, reduce maintenance costs, and improve the overall performance of boats. The success of this project may lead to the publication of a paper that describes the development of the system and its applications. The research findings may also be patented as a new technology, providing an opportunity for commercialization and further development. In conclusion, the creation of a robotic system that monitors the boat's propeller rudder is a significant achievement that has the potential to revolutionize the maritime industry. The extensive research and testing involved in the project have provided valuable insights into the functioning of propellers and related technology. The system's potential applications are numerous, and its success may lead to the publication of a paper and the patenting of a new technology.

REFERENCES

- [1] Changhui Song¹ & Weicheng Cui¹ Review of Underwater Ship Hull Cleaning Technologies
- [2] Chaenxin Iyu,lian lian,yufei jin,yuanbo bi, feb 2022-cross-domain mobility and transitions hybrid aerial underwater vehicle
- [3] E. Kelasidi , A.M. Kohl a, K.Y. Pettersena, B.H. Hoffmannb, J.T. Gravdahl. experimental study of the effectiveness and movement underwater.
- [4] Eiichi kobayashi ,hidetaka senga ,hajime chiba nov 2017-an detecting and observing sub-sea plumes following oil spills.
- [5] Hai Huang Qirong Tang , Jiyong Li, Wanli Zhanga, Xuan Bao, Haitao Zhu, Gang Wang , A review on underwater autonomous environmental perception and target grasp, the challenge of robotic organism capture
- [6] HoussamAlbitar^{1*}, KinanDandan¹, Anani Ananiev¹ and Ivan KalaykovUnderwater Robotics: Surface Cleaning Technics, AdhesionandLocomotion System Regular Paper.
- [7] Hsing-ChengChang, Yu-Liang Hsu * , San-Shan Hung, Guan-Ru Ou, Jia-RonWuand Chuan Hsu. Autonomous Water Quality Monitoring and Water SurfaceCleaning for Unmanned Surface Vehicle
- [8] Kai Ren, Jiancheng YuResearch status of bionic amphibious robots: Areview
- [9] KelasidiE.Kelasidi,A.M.Kohl , ,B.H.Hoffmannb,J.T.Gravdahl.Experimental investigation of locomotion efficiency and path- followingfor underwater snake robots with and without a caudal fin
- [10] Liang, J., Yang, X., Wang, T., Yao, G., Zhao, W., 2013. Design and experiment of a bionic gannet for plunge-diving. J. Bionic Eng. 10 (3), 282–291.
- [11] Liang, J., Yao, G., Wang, T., Yang, X., Zhao, W., Song, G., Zhang, Y., 2014. Wing load investigation of the plunge-diving locomotion of a gannet Morus inspired submersible aircraft. Sci. China Technol. Sci. 57 (2), 390–402.
- [12] Lu, D., Guo, Y., Xiong, C., Zeng, Z., Lian, L., 2021. Takeoff and landing control of a hybrid aerial underwater vehicle on disturbed water's surface. IEEE J. Ocean. Eng.

- [13] Lu, D., Xiong, C., Lyu, B., Zeng, Z., Lian, L., 2018. Multi-mode hybrid aerial underwater vehicle with extended endurance. In: 2018 OCEANS-MTS/IEEE Kobe Techno-Oceans (OTO). IEEE, pp. 1–7.
- [14] Lu, D., Xiong, C., Zeng, Z., Lian, L., 2019. A multi-modal aerial underwater vehicle with extended endurance and capabilities. In: 2019 International Conference on Robotics and Automation (ICRA). IEEE, pp. 4674–4680.
- [15] Maia, M.M., Mercado, D.A., Diez, F.J., 2017. Design and implementation of multirotor aerial-underwater vehicles with experimental results. In: 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), pp. 961–966.
- [16] Maia, M.M., Soni, P., Diez, F.J., 2015. Demonstration of an Aerial and Submersible Vehicle Capable of Flight and Underwater Navigation with Seamless Air-Water Transition, 01932 arXiv:1507.
- [17] Mercado, D.A., Maia, M.M., Diez, F.J., 2017. Aerial-underwater systems, a new paradigm in unmanned vehicles. In: 2017 International Conference on Unmanned Aircraft Systems, pp. 1690–1695. Icuas'17.
- [18] Santhosha k,p,s robi,2019 jun-advancements in the field of autonomous underwater vehicle
- [19] Naomi Kato a, *, Mahdi Choyekh a , Ryan Dewantara , Hidetaka Senga a, Hajime Chiba b,Eiichi Kobayashi c, Muneo Yoshie d, Toshinari Tanaka , Timothy Shor. An autonomous underwater robot for tracking and monitoring of sub sea plumes after oil spills and gas leaks from seafloor
- [20] Zheng Zeng Chenxin Lyu , Yuanbo Bi Yufei Jin Di Lu Lian Lian Review of hybrid aerial underwater vehicle: Cross-domain mobility and transitions control
- [21] Zheng Zeng a,b,c,*, Chenxin Lyu a,b,**, Yuanbo Bi a,b, Yufei Jin a,b, Di Lu a,b, Lian Lian Review of hybrid aerial underwater vehicle: Cross-domain mobility and transitions control

ANNEXTURE

- Review paper on the title of " DESIGN AND FABRICATION OF AN UNDERWATER ROBOT FOR BOAT PROPELLER BLADE ALGAE DETECTION AND REMOVAL -A REVIEW by S.Venkatesh, Melvin Anderson P, Ruban k has been presented in ICMMSE conference conducted by Sri Venkateswara College of Engineering and Technology, Chittoor, on December 30th ,2022.
- Review paper on the title of "DESIGN AND FABRICATION OF AN UNDERWATER ROBOT FOR BOAT PROPELLER BLADE ALGAE DETECTION AND REMOVAL -A REVIEW" by S. Venkatesh , Melvin Anderson P, Ruban K has been presented in ICAARS conference conducted by PSG college, coimbatore on 10 th December 2022
- Review paper has been communicated to Scopus journal
- Research on the title of "Design and fabrication of an underwater device for cleaning and identification of algae" by S Venkatesh, Melvin Anderson P, Ruban k have been communicated in RASET Conference which will held on 4 th may 2023



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This certificate is awarded to **Prof./Dr./Mr./Ms. MELVIN ANDERSON, Sathyabama Institute of Science and Technology(Deemed to be university)** for participating and presenting a paper titled **DESIGN AND FABRICATION OF AN UNDERWATER ROBOT FOR BOAT PROPELLER BLADE ALGAE DETECTION AND REMOVAL-REVIEW** in 4th International conference on Manufacturing, Material science & Engineering organized by Department of Mechanical Engineering, Sri Venkateswara College of Engineering and Technology, Chittoor, Andhrapradesh, India. During 30th & 31st December 2022.

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