PROJECT REPORT

On

UNDERWATER SURVEILLANCE DRONE WITH CAMERA

Submitted to the

KIT'S COLLEGE OF ENGINEERING (AUTONOMOUS), KOLHAPUR

In partial fulfilment of the requirement for the

Degree of

Bachelor of Technology

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Submitted By

STUDENT NAME	PRN NO
Tejas Nandurkar	2122010045
Megharaj Yadav	2122010024
Sakshi Desai	2122010159
Shivtej Patil	2122010066

Under the guidance of

Prof. V. B. Gundavade

Electronics and Telecommunication Engineering

KIT'S College of Engineering (Autonomous), Kolhapur

CLASS: FINAL YEAR B.TECH

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KIT'S College of Engineering (Autonomous), Kolhapur

Department of Electronics and Telecommunication Engineering

CERTIFICATE

This is to certify that

Mr. Tejas Nandurkar	[2122010045]
Mr. Megharaj Yadav	[2122010024]
Miss. Sakshi Desai	[2122010159]
Mr. Shivtej Patil	[2122010066]

has completed the project on the subject entitled **"Underwater Surveillance Drone with Camera"**, in the partial fulfilment of the requirement for the award of B. Tech (Electronics and Telecommunication Engineering) of KIT'S College of Engineering, Kolhapur in the academic year 2023-24.

Date:

Place: KIT'S College of Engineering (Autonomous), Kolhapur.

Prof. V. B. Gundavade	External Examiner	Dr. Y. M. Patil
Project Guide		H.O.D ENTC

DECLARATIONS

We hereby Declare that students of Final Year B. Tech in Electronics and Telecommunication Engineering (Autonomous), Kolhapur. The Project Report on **"Underwater Surveillance Drone with Camera"** has been independently carried out by us under the guidance of Prof. V. B. Gundavade. All the mentioned information is true to the best of my knowledge.

SR.NO.	STUDENT NAME	PRN NO	SIGN
1.	Tejas Nandurkar	2122010045	
2.	Megharaj Yadav	2122010024	
3.	Sakshi Desai	2122010159	
4.	Shivtej Patil	2122010066	

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4.	Shivtej Patil	2122010066

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ABBREVIATIONS AND NOMENCLATURE

- IMUs – Inertial Measurements Units
- GPS - Global Positioning System
- ROVs – Remotely Operated Vehicles
- UUVs – Unmanned Underwater Vehicles

ABSTRACT

The exploration of the underwater world has always been an intriguing endeavor, presenting unique challenges and opportunities for scientific discovery, environmental monitoring, and industrial applications. In recent years, underwater drones have emerged as versatile tools for conducting a wide range of tasks in aquatic environments. The primary objective of this research is to examine the evolution and capabilities of underwater drones, also known as unmanned underwater vehicles (UUVs) or remotely operated underwater vehicles (ROVs). These autonomous or remotely controlled vehicles are equipped with sensors, cameras, and manipulators, enabling them to perform various tasks such as oceanographic surveys, marine life monitoring, underwater archaeology, offshore infrastructure inspection, and search and rescue operations. One of the key aspects addressed in this abstracts the technological advancements driving the development of underwater drones. These include improvements in propulsion systems, energy efficiency, communication protocols, sensor technologies, and autonomy features.

CHAPTER 1

INTRODUCTION

The exploration of the Earth's oceans has always been a captivating frontier, offering a realm of mysteries and discoveries yet to be fully unveiled. However, the vastness and inhospitable nature of underwater environments pose significant challenges to human exploration and observation. In recent decades, technological advancements have paved the way for the development of underwater drones, also known as unmanned underwater vehicles (UUVs) or remotely operated underwater vehicles(ROVs),which have emerged as indispensable tools for exploring and studying the ocean depths. This introduction serves as a comprehensive overview of underwater drones, outlining their significance, historical development, capabilities, and applications across various fields of research and industry. It sets the stage for understanding the evolution and impact of underwater drone technology in shaping our understanding of the underwater world and addressing critical societal and environmental challenges

Significance of Underwater Drones: The introduction begins by highlighting the importance of underwater drones in enabling access to otherwise inaccessible underwater environments. By removing the constraints of human limitations, these robotic vehicles offer unprecedented opportunities for scientific exploration, resource management, environmental monitoring, and industrial applications. Their ability to navigate the depths with precision, gather data in real-time, and perform tasks autonomously or under remote human supervision opens new frontiers for understanding and harnessing the ocean's resources.

Historical Development: A historical overview traces the evolution of underwater drones from early experimental prototypes to the sophisticated systems available today. The introduction explores key milestones in the development of underwater drone technology, including the advent of remotely operated vehicles (ROVs) in the mid-20th century and the subsequent advancements in autonomy, sensor technologies, and miniaturization. This historical context provides insights into the iterative process of innovation and collaboration that has propelled the field forward.

Capabilities and Components: An in-depth discussion of the capabilities and components of underwater drones follows, elucidating the essential features that enable these vehicles to operate effectively in underwater environments. This includes propulsion systems for locomotion, sensor suites for environmental monitoring, imaging systems for capturing visual data, manipulators for interacting with the environment, and communication systems for transmitting data to the surface or remote operators. The introduction also explores recent advancements in materials science, energy storage, and computing power that have enhanced the performance and versatility of underwater drones.

Applications Across Industries: The introduction highlights the diverse range of applications for underwater drones across various industries and research domains. From marine science and oceanography to offshore oil and gas exploration, aquaculture, environmental conservation, and defense, these vehicles play a vital role in conducting surveys, inspections, research expeditions, and intervention operations. Examples of specific applications, such as habitat mapping, archaeological exploration, pipeline inspection, and disaster response, illustrate the breadth and depth of underwater drone capabilities.

Challenges and Future Directions: Finally, the introduction acknowledges the challenges and limitations inherent in underwater drone technology, including issues related to navigation, communication, energy efficiency, and environmental resilience. It also Fore shadows future research directions aimed at overcoming these challenges, such as advancements in autonomy, sensor fusion, bio- inspired design, and interdisciplinary collaboration. By addressing these challenges and embracing innovative solutions, the field of underwater drones is poised to continue its trajectory of growth and impact in the years to come.

1.1 PROBLEM STATEMENT

The exploration and inspection of underwater environments pose significant challenges due to limited human access and the hostile conditions of aquatic ecosystems. Traditional methods involve costly manned expeditions or deploying remotely operated vehicles (ROVs), which can be cumbersome and expensive. To overcome these limitations, there is a growing demand for the development of autonomous underwater drones capable of navigating through challenging underwater environments for various applications such as marine research, environmental monitoring, infrastructure inspection, and underwater exploration.

The problem statement aims to address the following key challenges:

Autonomous Navigation: Designing algorithms and systems for autonomous navigation that enable the underwater drone to maneuver effectively in complex underwater environments without human intervention

Sensory Perception: Integrating sensors (e.g., cameras, sonar, depth sensors) to provide the drone with real-time environmental perception, enabling it to detect obstacles, map terrain, and identify objects of interest underwater.

Communication and Control: Establishing reliable communication protocols to remotely control the drone and transmit data between the drone and the operator, overcoming the limitations of underwater communication.

Power Management: Developing efficient power management systems to ensure extended operational endurance and autonomy underwater, considering the limited availability of power sources and the energy-intensive nature of underwater propulsion.

Robustness and Reliability: Ensuring the drone's robustness to withstand the harsh underwater conditions, including pressure, corrosion, and biofouling, while maintaining reliable performance for extended missions.

User Interface and Data Analysis: Designing user-friendly interfaces for mission planning, data visualization, and analysis to enable operators to interpret and utilize data collected by the drone effectively.

1.2 PRESENT THEORY AND PRACTICES

Underwater drones, also known as remotely operated underwater vehicles (ROVs), have become increasingly vital in various fields, including marine research, underwater exploration, offshore industries, environmental monitoring, and even recreational activities like underwater photography. Here's an overview of the theory and practices involved in underwater drone projects

Hydrodynamics and Buoyancy:

- Understanding the principles of buoyancy and hydrodynamics is crucial for designing underwater drones that can maneuver efficiently through water
- Properly balancing buoyancy, weight, and propulsion systems ensures stability and control underwater

Structural design:

- Underwater drones need to withstand high pressures, corrosion, and potential impacts from marine environments.
- Utilizing materials such as titanium, aluminium alloys, or composites can enhance durability while keeping weight manageable.

Propulsion System:

- Electric thrusters or propellers are commonly used for propulsion in underwater Drone.
- Advanced propulsion mechanisms like vectored thrust or thruster arrays enable precise movement in different directions.

Power systems:

- Battery technology plays a critical role in determining the operational endurance and range of underwater drones
- Lithium-ion batteries are frequently used due to their high energy density, but advancements in fuel cell technology are also being explored for longer missions.

Control and Navigation:

- Implementing robust control systems and navigation algorithms is essential for autonomous or remotely operated missions.
- Sensor fusion techniques incorporating depth sensors, inertial measurement units (IMUs), sonar, and GPS enable accurate positioning and obstacle avoidance.

Communication Systems:

- Underwater communication presents challenges due to the limited range and attenuation of electromagnetic signals in water.
- Acoustic communication systems are commonly used for transmitting data and commands to underwater drones over longer distances.

Data processing and Analysis:

- Advanced onboard processing capabilities or data transmission to surface vessels or shore stations facilitate real-time analysis of collected data.
- Machine learning and computer vision techniques can be employed for automated data interpretation and decision-making.

Environmental Considerations:

- Minimizing the environmental impact of underwater drone operations is essential, especially in sensitive marine ecosystems.
- Compliance with regulations regarding underwater activities and wildlife protection is crucial.

CHAPTER 2

LITERATURE REVIEW

1] This paper describes the look and implementation of Underwater Wireless Rover by work the cable with a wireless measure. And there lies an excellent form of its applications. it may be used for obtaining the live video or still footage of the underwater life and every one the underwater activities to find out regarding the underwater life. It makes the duty for diverse, rescuers and gem collectors easier because the rover offers the images, live video and every one the opposite relevant details necessary for having a correct information regarding the underwater parts.

[Abhishek A. Nandyal, Adhitya D M Karthik K, Manikantan G. Dept. of ECE KSIT, Banglore]

2] Two-thirds of the earth's surface is surrounded by water and the majority of it is still unexplored. The underwater monitoring of the oceans and their surroundings is highly crucial from several perspectives, e.g., to unearth the hidden minerals/oils, to monitor the life of underwater species, military and rescue applications, surveillance.

[Dr. P. N. Sudha HOD Dept. of ECE, KSIT]

2.1 EXISTING SYSTEM

- The existing system for the underwater drone project comprises several critical components aimed at facilitating efficient underwater exploration and data collection. Primarily, the system includes a robust underwater drone equipped with state-of-the-art sensors such as sonar, cameras, and depth sensors. These sensors enable the drone to navigate through underwater environments, map terrain, and gather various forms of data.

- Additionally, the existing system incorporates a communication module that allows for real-time data transmission between the underwater drone and the control station on the surface. This feature is vital for monitoring the drone's activities, adjusting its trajectory if necessary, and receiving data promptly for analysis.

- Furthermore, the existing system includes a power management system to sustain the drone's operations during extended missions. This system typically consists of rechargeable batteries and power-efficient components to maximize the drone's endurance underwater.

- Moreover, the existing system may integrate software solutions for data processing and analysis. These software tools assist in interpreting the data collected by the drone, generating detailed maps, identifying underwater structures or objects of interest, and extracting valuable insights.

- In conclusion, the existing system for the underwater drone project encompasses hardware and software components designed to enable efficient underwater exploration, data collection, and analysis. Continual advancements in technology are expected to further enhance the capabilities of these systems, driving innovation in underwater research and exploration.

2.2 BACKGRPUND OF PROJECT

- The underwater drone project represents a cutting-edge endeavor aimed at exploring and innovating in the realm of underwater technology. With the vast majority of Earth's oceans yet to be explored, this project serves as a crucial step towards unlocking the mysteries hidden beneath the waves.

- At its core, the project is driven by the desire to overcome the limitations of traditional underwater exploration methods. Conventional methods often involve human divers or large, costly manned submarines, which are constrained by factors such as depth, time, and accessibility. In contrast, underwater drones offer a more flexible and cost-effective solution, enabling researchers to delve deeper and explore regions that were previously inaccessible.

- The project's objectives encompass a wide range of applications, from scientific research to commercial ventures and environmental conservation. One primary goal is to develop a highly capable and versatile underwater drone platform capable of conducting various tasks, including mapping underwater terrain, surveying marine life, monitoring environmental conditions, and inspecting underwater structures such as pipelines and offshore installations.

- To achieve these objectives, the project draws upon interdisciplinary expertise from fields such as robotics, engineering, marine biology, and oceanography. Collaborations with researchers, engineers, and industry partners ensure that the underwater drone is designed and built to meet the highest standards of performance, reliability, and safety.

- Key components of the project include the design and construction of the underwater drone itself, which must be rugged, maneuverable, and equipped with state-of-the-art sensors and imaging technology. Advanced propulsion systems are essential for navigating the challenging underwater environment efficiently. Additionally, the development of autonomous navigation and control algorithms enables the drone to operate effectively without constant human intervention, even in remote or hazardous conditions.

- Beyond technological innovation, the project also emphasizes sustainability and environmental responsibility. Researchers are committed to minimizing the ecological impact of the drone's operation and ensuring that it complies with regulations governing marine conservation and protection.

- Ultimately, the underwater drone project represents a significant step forward in our quest to understand and harness the potential of the world's oceans. By pushing the boundaries of technology and exploration, it opens up new opportunities for scientific discovery, economic development, and environmental stewardship in the underwater realm.

2.3 PROPOSED SYSTEM

Introduction:

The exploration of underwater environments presents unique challenges due to limited visibility, high pressures, and the need for specialized equipment. In response to these challenges, our team proposes an innovative underwater drone system designed to revolutionize marine exploration. This system combines advanced technology with robust engineering to provide researchers, scientists, and ocean enthusiasts with a versatile tool for underwater investigation.

System Overview:

Our underwater drone system consists of several key components, including the drone itself, a high-resolution camera system, a depth sensor, and a buoyancy control mechanism. The drone is equipped with thrusters for precise maneuverability and can operate at various depths, from shallow coastal waters to deep-sea environments. The high-resolution camera system captures detailed imagery of the underwater landscape, allowing for accurate mapping and analysis. Additionally, the depth sensor ensures safe navigation by providing real-time depth information to the user. The buoyancy control mechanism enables the drone to adjust its position in the water column, maintaining stability even in turbulent conditions.

Features and Capabilities:

One of the standout features of our underwater drone system is its modular design, which allows for easy customization and upgrades. Users can integrate additional sensors, such as sonar or water quality monitors, to enhance the capabilities of the drone for specific research tasks. Moreover, the drone is equipped with advanced obstacle avoidance technology, reducing the risk of collisions with underwater obstacles and ensuring safe operation in complex environments. Additionally, the system is designed to be user-friendly, with intuitive controls and a streamlined interface that simplifies operation for both novice and experienced users.

Applications:

The versatility of our underwater drone system makes it suitable for a wide range of applications, including marine biology research, environmental monitoring, underwater archaeology, and offshore infrastructure inspection. Researchers can use the drone to study marine ecosystems, observe wildlife behavior, and monitor the impacts of human activities on underwater habitats. Likewise, commercial operators can leverage the drone for tasks such as pipeline inspection, offshore platform maintenance, and underwater construction projects. The system's ability to collect high-quality data in real-time enables users to make informed decisions and gain valuable insights into the underwater world.

2.4 PROJECT OBJECTIVES –

- **Design and Development**:

Create a functional underwater drone prototype capable of maneuvering underwater with stability and precision.

- **Depth and Pressure Testing :**

Ensure the drone can withstand various depths and pressures commonly encountered in underwater environments.

- **Navigation and Testing :**

Implement robust navigation and control systems to allow the drone to autonomously navigate underwater and respond to user commands.

- **Obstacle Avoidance:**

Integrate sensors and algorithms for obstacle detection and avoidance to prevent collisions with underwater obstacles.

- **Underwater Imagining:**

Equip the drone with cameras or other imaging devices to capture high-quality images and videos of underwater environments.

- **Data Transmission:**

Develop reliable methods for transmitting data between the underwater drone and a surface control station, considering the challenges of underwater communication.

- **Battery Life Optimization:**

Maximize the drone's battery life to extend its operational duration underwater while maintaining performance.

- **Environmental Monitoring:**

Explore the possibility of incorporating sensors for monitoring environmental factors such as water temperature, pressure, and quality.

- **User Interface:**

Design an intuitive user interface for controlling the drone and accessing data collected during missions.

- **Safety Features:**

Implement safety features to ensure the drone's safe operation, including emergency surface procedures and fail-safes in case of system malfunctions.

- **Mission Customization:**

Allow for customization of mission parameters to accommodate various underwater tasks such as exploration, research, or inspection.

- **Cost Effectiveness:**

Strive to achieve a balance between performance and cost-effectiveness in the design and construction of the underwater drone.

CHAPTER 3

PRESENT WORK

- **Introduction**:

The exploration of underwater environments has long been a challenge due to the limitations of human presence beneath the surface. However, recent advancements in underwater drone technology have revolutionized our ability to explore, study, and monitor underwater ecosystems. This report aims to provide an overview of our ongoing project in developing an advanced underwater drone, highlighting its design, functionality, and potential applications.

- **Design and Development:**

Our project began with extensive research into existing underwater drone designs and technologies. We identified key challenges such as buoyancy control, propulsion efficiency, and communication reliability, which guided our design process. Collaborating with marine engineers and robotics experts, we developed a streamlined drone prototype equipped with state-of-the-art sensors and propulsion systems.

The drone's design features a robust yet lightweight frame constructed from corrosion-resistant materials to withstand the harsh underwater environment. We integrated thrusters for precise maneuverability, allowing the drone to navigate complex underwater terrain with ease. Furthermore, advanced buoyancy control mechanisms ensure optimal depth control and stability during operation.

- **Functionality:**

Our underwater drone is equipped with sensors, including high-resolution cameras enabling comprehensive data collection and analysis. The cameras provide real-time video footage, allowing researchers to visually inspect underwater structures, marine life, and environmental conditions.

- **Applications**:

The versatility of our underwater drone makes it suitable for various applications across diverse industries. In marine research, the drone can be used to study coral reefs, underwater caves, and marine biodiversity, providing researchers with invaluable data for conservation efforts and scientific studies.

Furthermore, the drone's capabilities extend to underwater inspection tasks in industries such as offshore oil and gas, aquaculture, and infrastructure maintenance. By conducting visual inspections and collecting data in hazardous or inaccessible underwater environments, the drone enhances efficiency, safety, and cost-effectiveness.

- **Conclusion**:

In conclusion, our ongoing project in developing an advanced underwater drone represents a significant milestone in underwater exploration and technology. Through innovative design and functionality, our drone offers unprecedented capabilities for studying, monitoring, and exploring underwater environments. As we continue to refine and optimize our drone prototype, we envision a future where underwater exploration is more accessible, efficient, and sustainable than ever before

CHAPTER 4

DESIGN METHODOLOGY

4.1 DESIGN COMPONENTS:

- **ESP32 Microcontroller**:

The ESP32 microcontroller serves as the brain of the underwater drone, responsible for processing sensor data, controlling the propulsion system, and managing communication with the remote control unit. Its dual-core architecture and built-in WiFi capabilities make it well-suited for handling the complex tasks required for underwater navigation and control.

- **DC Motors and Propellers**

The propulsion system of the drone comprises DC motors and propellers, which generate thrust to propel the drone through the water. The motors are controlled by the ESP32 microcontroller, allowing for precise speed and direction adjustments to achieve optimal maneuverability and stability underwater.

- **Camera:**

A high-resolution camera is mounted on the drone to capture real-time images of the underwater environment. The camera module interfaces with the ESP32 microcontroller, enabling the transmission of live video feed to the remote control unit for monitoring and analysis.

- **Wires:**

The drone is equipped with wired connections to facilitate communication and control between the drone and the remote control unit. These wires ensure reliable data transmission and control signals even in challenging underwater conditions where wireless communication may be unreliable.

- **Remote Control:**

The remote control unit allows the operator to command and control the drone's movements, camera settings, and other functionalities. It communicates with the drone via the wired connection, providing real-time feedback and control options to the operator.

B. BASIC DESIGN :

We have designed a waterproof chassis to house all components. Ensuring seals and gaskets are in place to prevent water ingress. We have used a reliable power source, such as rechargeable lead acid battery, with sufficient capacity for extended operation. We have connected the DC motors to the motor driver and controlling them using the ESP32. We have Implemented algorithms for precise control of the underwater drone's movement. We have mounted the wired camera securely on the drone. By using Smartphone to stream the live video feed over the connection. We have integrated control logic for the DC motor based on user input or autonomous decision-making. We have used MAX485 modules for communication with a remote controller. We have developed a user interface on the PC for live video streaming and drone control.

4.2 DESIGN IMPLEMENTATION :

The implementation of the underwater drone involves the integration of the aforementioned components into a streamlined and waterproof housing. Special attention is given to sealing critical electronic components to protect them from water damage. The drone's firmware is developed to manage sensor data, control motor movements, process camera images, and handle communication with the remote control unit.

- **Syringe Mechanism:**

The syringe is a injector which has capacity of 60ml.That should be enough based on our experiences. We put the gear rack into the syringe alongside the syringe plunger. The gear racks are used to push the plunger inside the syringe and pull the plunger outside the syringe. This push and pull operation is controlled with the help of DC motor which is of 100 RPM. The motor is controlled by using Up-Down buttons on the remote control. In this method the sucked-in water acts as an extra weight that will increase gravity. Buoyancy stays always the same. When the water is sucked-in through the pipe which is attached to the plain tip of the syringe then drone will move towards downward direction. When the water is sucked-out through the pipe then drone will move in the upward direction. All the mechanism is shown in the fig[1]

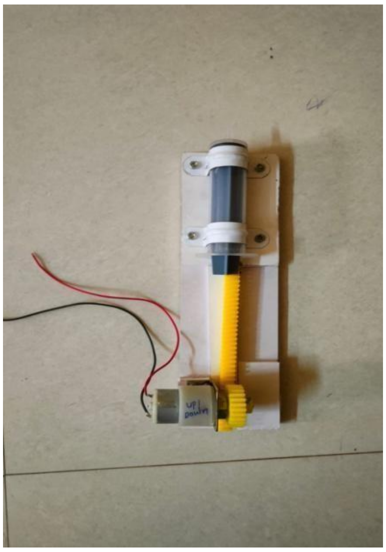


Fig.[1]

- **Waterproof Mechanism:**

The waterproofing of the system is most crucial part in our system design. Any amount of water contents will damage the whole electronics system underwater. So to protect the system underwater we used acrylic material for shielding whole system. For shielding we used acrylic container which is of cylindrical shape. The reason behind cylindrical shape is to maintain the balanced weight.

To connect the propellers with the motor shaft we used the gear assembly. Here two gears are used for one motor and propeller connection. One of these two gear is connected inside the container and other is connected outside the container with the help of button magnets as shown in the fig[2].The magnets used here are the neodymium magnets because the magnetic power required to run the propeller underwater is high.

The 3D printing design of gears is as shown in fig[3] in which 8 holes. In these holes the button magnets are installed. This all waterproof assembly is designed in such a way that there should not be any holes present on acrylic medium so that water should not go inside the acrylic medium to make it waterproof.

Fig.[2]

PERFORMANCE EVALUATION

Maneuverability:

The drone's maneuverability is evaluated through a series of tests in controlled underwater environments. Its ability to navigate through obstacles, maintain stability in varying currents, and execute precise movements is assessed to determine its suitability for different underwater exploration tasks.

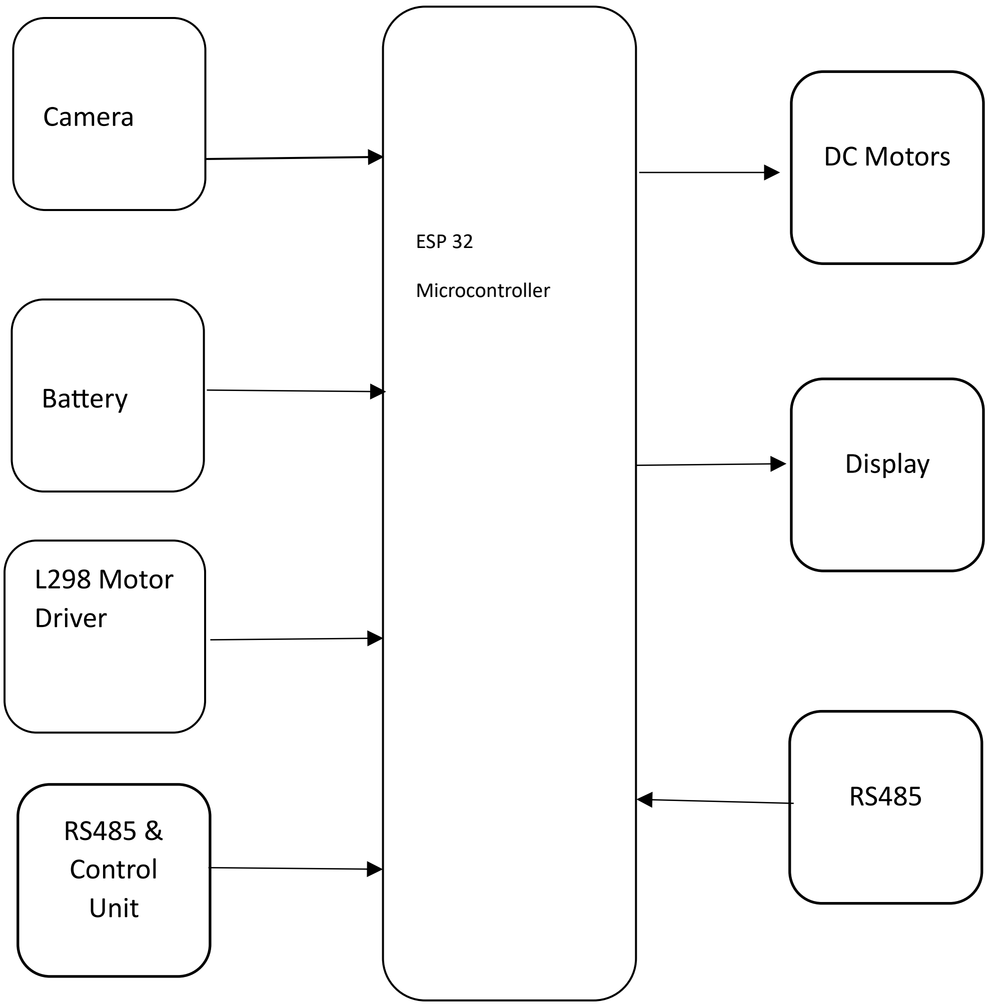
Imaging Capabilities:

The camera's imaging capabilities are evaluated by capturing real-time footage of underwater scenes with varying depths, lighting conditions, and visibility levels. The quality of the images captured, including resolution, clarity, and color accuracy, is analyzed to assess the camera's effectiveness in underwater imaging.

Remote Control Interface:

The usability and effectiveness of the remote control interface are evaluated through user testing and feedback. The interface's intuitiveness, responsiveness, and reliability in controlling the drone's movements, adjusting camera settings, and receiving real-time feedback are assessed to ensure a seamless user experience

4.2Block Diagram



CHAPTER 5

RESULT & DISCUSSION

We designed the underwater drone and achieved the real-time live video streaming underwater at 1280P with viewing angle of 70 degrees. For the experiment we operated the drone in the lake. The drone operated at different depths but we achieved here a small depth. Fig[4] shows the some snapshots of live streaming captured by underwater drone. After performing some successful experiments we realize that this underwater drone required some additional technological components such as sensors for depth measurement, temperature measurement. Additionally a machine learning algorithm for fish detection. Fig[5] shows the complete drone which is ready to dive underwater

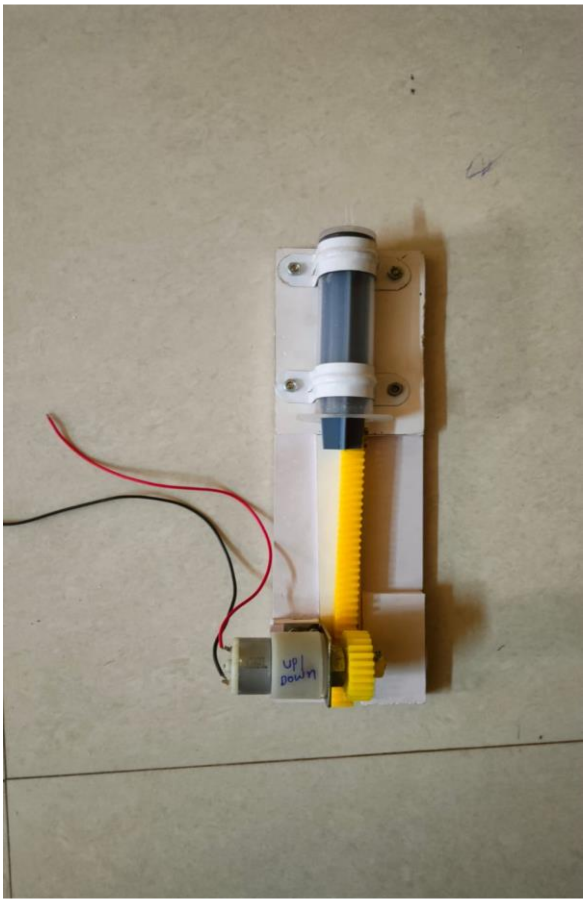


Fig. [3]

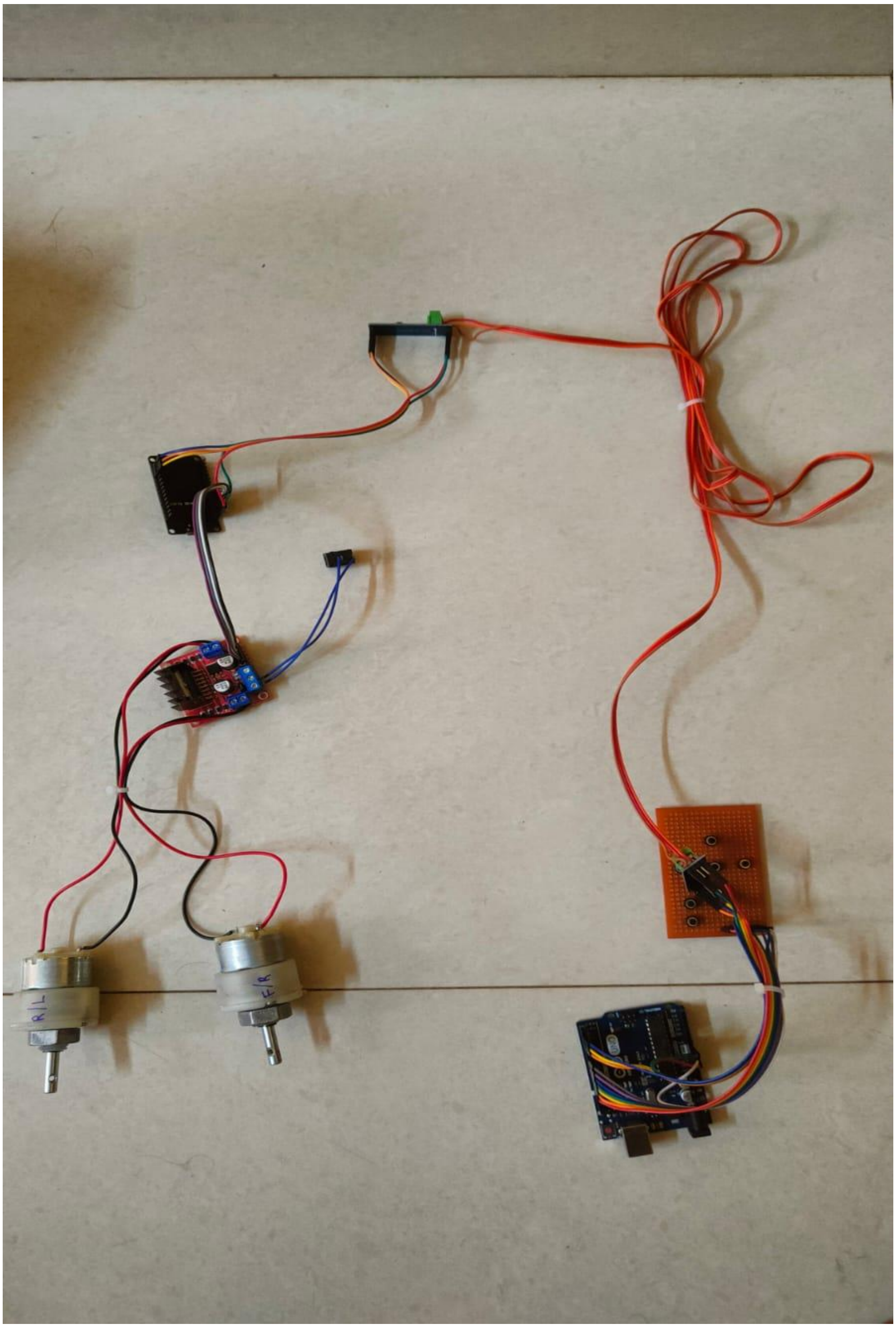
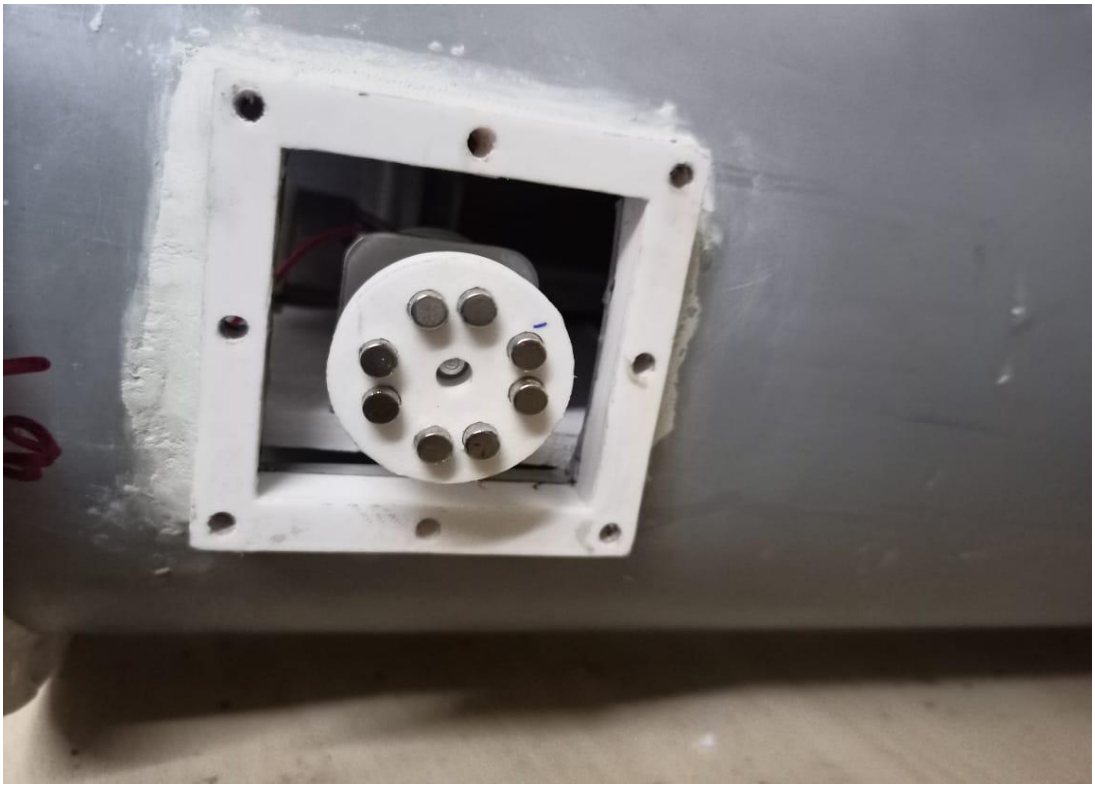


Fig. [4]



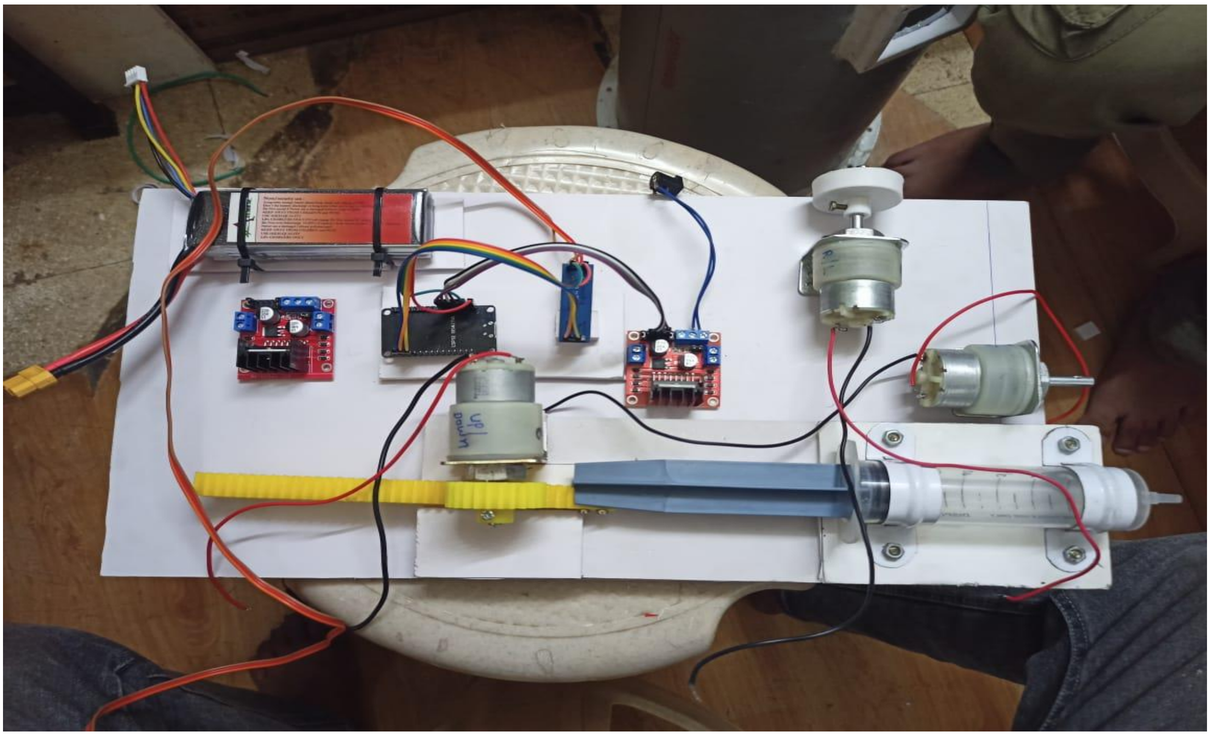
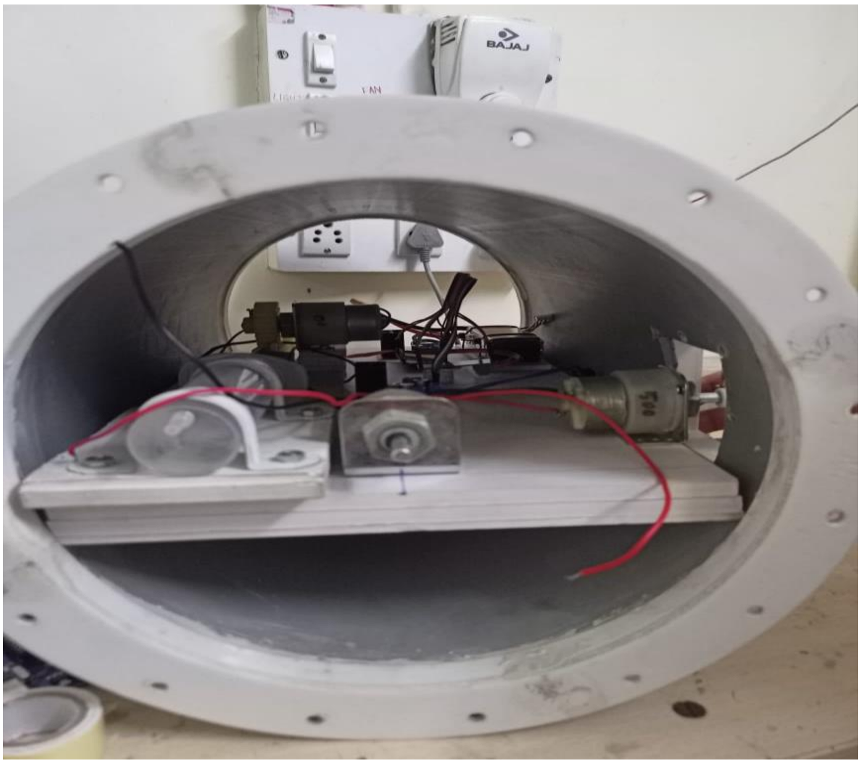
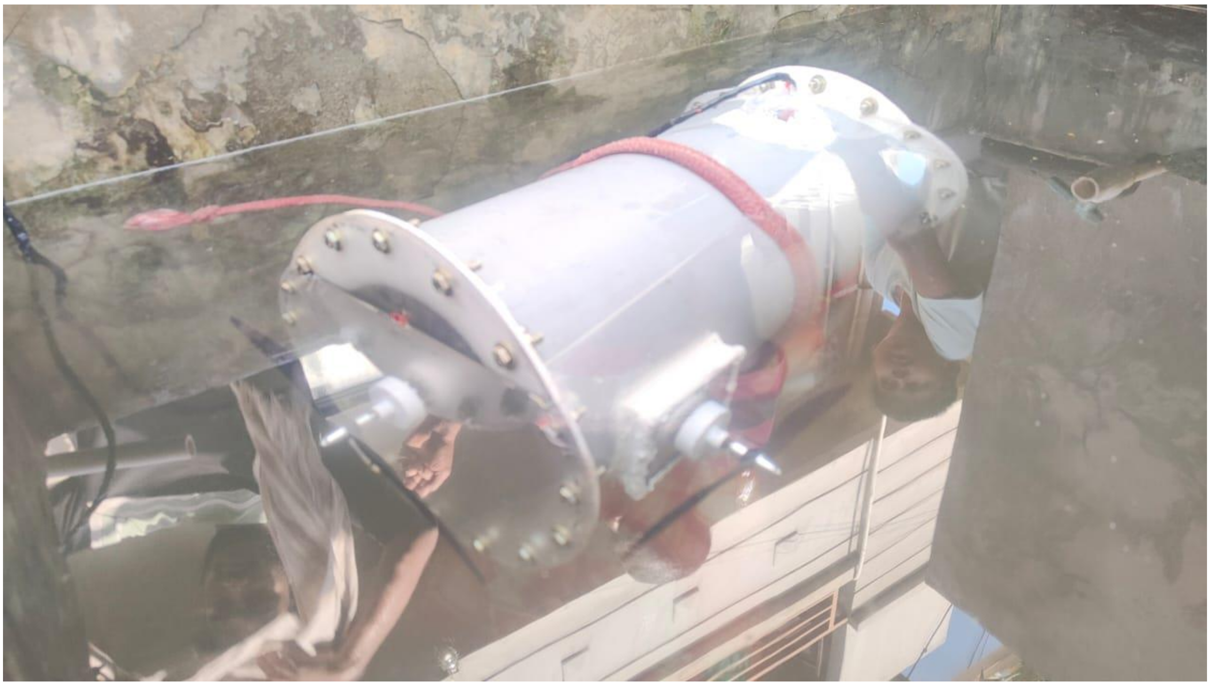


Fig. [5]





Fig[6]

Fig[

CHAPTER 6
CONCLUSION

In conclusion, the development and performance evaluation of the underwater drone equipped with an ESP32 microcontroller, DC motors, propellers, camera, wires, and remote control demonstrate its potential as a valuable tool for underwater exploration and research. Its advanced features, including real-time imaging capabilities, precise maneuverability, and reliable wired communication, make it wellsuited for various applications in marine science, environmental monitoring, and underwater inspection. Future work may involve further optimizing the drone's design, enhancing its capabilities, and exploring additional functionalities to address specific research and exploration needs in underwater environments. Overall, our research contributes to the advancement of underwater drone technology and underscores its importance in expanding our understanding of the underwater world.

FUTURE SCOPE

- **Marine Research:**

Underwater drones can be invaluable tools for marine biologists and oceanographers to study marine life, ecosystems, and ocean dynamics. Future advancements may include equipping drones with more advanced sensors for collecting data on water temperature, salinity, pH levels, and more.

- **Environmental Monitoring:**

With increasing concerns about environmental degradation and climate change, underwater drones can play a crucial role in monitoring pollution, coral reef health, and the impact of human activities on marine environments.

- **Aquaculture and fisheries:**

Underwater drones can aid in monitoring fish stocks, aquaculture farms, and underwater habitats. They can help optimize fish farming practices, detect diseases in fish populations, and prevent illegal fishing activities.

- **Underwater Exploration and Tourism :**

Just as aerial drones have revolutionized aerial photography and exploration, underwater drones have the potential to do the same for underwater exploration and tourism. They can provide immersive experiences for divers and non-divers alike, allowing them to explore underwater environments without the need for specialized diving equipment.

- **Oceanographic Mapping and surveying**

Underwater drones equipped with mapping and surveying capabilities can contribute to creating detailed maps of the ocean floor, which can be valuable for scientific research, navigation, and resource exploration.

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