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Underwater Surveillance Drone with Camera

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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.

Keywords- Underwater Research, Fish Recognition, Search and rescue, Underwater ROV.

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.

I. DESIGNOFUNDERWATERDRONE A.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 Wi-Fi 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.

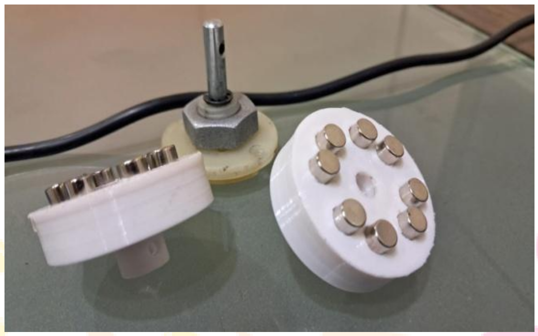
C.DESIGN IMPLEMENTATION

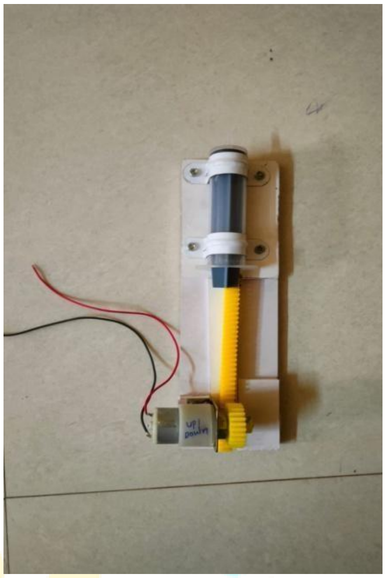
The implementation of the underwater drone involves the integration of the aforementioned components into a streamlined and waterproof housing. Special attention is given to sealing critical electronic components to protect them from water damage. The drone's firmware is developed to manage sensor data,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

1] 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]

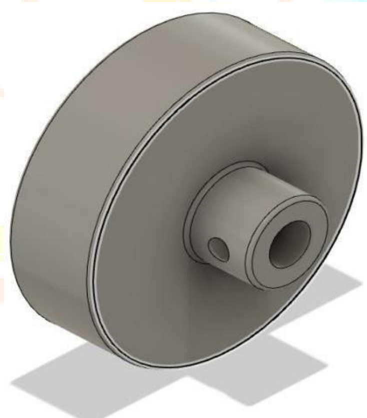
2] Waterproof Mechanism:

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]



Fig[3A]

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II. PERFORMANCEEVALUATION

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.

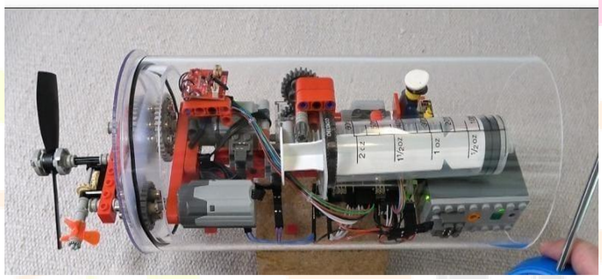
III. EXPERIMENTALRESULTS

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[4A]

Fig[4B]



Fig[5]

Fig[4C]

V. 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 well- suited 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.

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