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Underwater Image Surveillance/ Recognition

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Abstract **– Underwater Imaging is a challenging task due to the properties of light and the distortion of images caused by the refractive index of water. To address these challenges, the system uses specialized cameras and lighting that are optimized for underwater use. In addition, the system incorporates advanced image processing techniques, including machine learning algorithms, to enhance the quality of the images and enable object recognition. The system can detect and classify a wide range of underwater objects, including marine animals, plants, and human-made objects such as underwater vehicles or debris. The system's accuracy is evaluated through various experiments and field test, where it demonstrated a high level of performance, even in low light conditions or turbid water. The potential applications of this technology are extensive. Overall, the development and implementation of this underwater image surveillance and recognition system represents a significant advancement in the field of underwater imaging, with wide range of potential applications across various industries.**

Index Terms **—Underwater Image surveillance, Image processing, Image recognition, motion detection, object detection.**

I. INTRODUCTION

We are aware that our sea region is having most of the land on the earth but specifically our country is surrounded by 3 different oceans and sometimes it happens that our security forces are unable to keep an eye on the border part of the sea therefore we need some kind of vehicle which move under the water fluently such that it can capture the live movements happening inside the water also it will make us easy to identify the if someone is trying to invade inside our country's sea border without any permission by detection from under the water. The Remote Operated Vehicle could be
a possible solution for the specific operation we are trying to implement also we can use it for various inspection tasks where we need to go underwater many times. It can be beneficial to other young researchers who are trying to explore the life under the water. There might be many undiscovered species under the water which might be unknown to rest of the society, this project may help them to get discovered and get normalized. Water covers over 70% of mass on earth. There lies a vast unexplored land beneath the seas. Moreover, underwater surveillance, videography plays a vital role in a wide range of applications. From dam and bridge inspections to fishing surveillance to sea life videography and oceanography underwater inspection is a very common need.

Also, underwater inspection will help us to keep track of sea life conservation, pollution monitoring in seas as 50 to 80% oxygen we breathe is produced by sea planktons and other sea plants. Extensive damage to seas by pollution and overfishing can cause great damages cross the globe. So here we develop a underwater inspection drone that can navigate easily underwater and allow us to vide live video footage underwater.

The RC underwater surveillance drone provides following advantages including:

- Easy to Navigate Underwater
- 360 Degree Direction Control
- Live Footage Viewing
- Dual Motor Propulsion system
- Lightweight and anti-rust design for long term usage

Autonomous underwater vehicles (AUVs) have increasingly played a key role in monitoring the marine environment, studying its physical-chemical parameters for the supervision of endangered species. AUVs now include a power source and an intelligent control system that allows them to autonomously carry out programmed tasks. Their navigation system is much more challenging than that of land-based applications, due to the lack of connected networks in the marine environment. On the other hand, due to the latest developments in neural networks, particularly deep learning (DL), the visual recognition systems can achieve impressive performance. Computer vision (CV) has especially improved the field of object detection. Although all the developed DL algorithms can be deployed in the cloud, the present cloud computing system is unable to manage and analyze the massive amount of computing power and data. Edge intelligence is expected to replace DL computation in the cloud, providing various distributed, low-latency and reliable intelligent services.

The world's seas, as a precious asset and an essential element of its ecology, must be protected as an important source of life, wealth, and food. This requires monitoring systems to control their condition and ensure their sustainable management, which involves monitoring physical and chemical parameters related to water quality, such as salinity, temperature, dissolved oxygen, nitrates, density, and chlorophyll levels, among others. Other motives for monitoring the seabed are the detection and conservation of archaeological artefacts and the monitoring of the status of marine flora and fauna, particularly sensitive endangered species.

Certain AUV architectures involve the technological challenge of high processing, communication, and connection capacity. This requires an architecture that can integrate with a nearby base station, the Internet and cloud architectures. The information gathered during an operation also requires interpretation, which may be crucial for decision making. This means that not only is the local connection important but also the connection with web services (cloud computing, data centers, etc.). This latter one can be used to create assistants for a specific purpose and processes to which complex and specific tasks can be delegated.

Distributed control architectures can help to solve many of these issues. These can be incorporated into AUV hardware to speed up the transfer of the collected information to the other side (cloud servers).

Higher intelligence capacity can also help to respond to the needs of the sensor side, especially for very high-speed decision-making, which is impeded by the cloud's high latency. However, new architectures have recently been proposed to address this deficiency of latency. The present cloud computing system is increasingly unable to cope with the massive amount of data it receives. Edge computing, which is composed of intelligent nodes and could take the place of cloud processing, is expected to solve this issue since it is closer to users than the cloud. These smart nodes range from intelligent gateways to ruggedized outdoor nodes, on-premises heavy storage nodes and edge data center servers.

II.OBJECTIVES

The objective of this project on underwater image surveillance/ recognition is to develop an efficient and accurate system that can perform object recognition, object detection, underwater image processing, and tracking of unusual activity underwater. The project aims to improve the security and safety of underwater environments by detecting, classifying, and tracking underwater objects and unusual activities that may pose a threat to human activities or the environment.

Specifically, the project aims to:

1. Develop an algorithm for object recognition that can identify and classify different types of underwater objects, such as vessels, divers, marine organisms, and debris.
2. Develop an algorithm for object detection that can detect and locate underwater objects in real-time, using image processing techniques such as edge detection, feature extraction, and machine learning.
3. Develop an algorithm for underwater image processing that can enhance the quality and clarity of underwater images, compensating for factors such as water turbidity, lighting conditions, and camera distortion.
4. Develop an algorithm for tracking unusual activity underwater that can detect and track abnormal behavior, such as sudden movements or changes in speed or direction of underwater objects.
5. Implement and test the system in different underwater environments, including harbors, naval bases, offshore installations, and marine protected areas, to evaluate its accuracy, efficiency, and reliability.

The goal of this project is to provide an effective and reliable solution for underwater image surveillance and recognition, which can be deployed in different underwater environments to improve the safety, security, and sustainability of human activities in these environments.

III.RESEARCH METHODOLOGY

The model structure is made up of polyvinyl chloride pipes. By using this type of structure, the overall weight of the model reduces to make it more efficient underwater. This structure is balanced by center of gravity principle.

Basic structure:

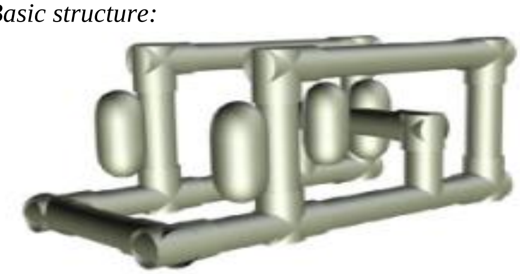

Figure 1. Mechanical Structure

There are 3 important parts of the model hardware:

1. Battery
2. DC motor and propeller
3. Control Box

1) Battery

A 12 V Lead-Acid battery is used in the model to power the control box and to send the input signal to the controlling unit of the rover. This battery has a strong ABS and scaled maintenance free, scaled construction and leak proof, safety value regulated system, deep discharge recovery and wide operating temperature range. These batteries can be recharged using a charger. Hence, they are long durable.

2) DC Motor and propeller

The DC motor and propeller system is used in the model for attaining different heights underwater. For this purpose, pumps can be used, but the speed of DC motor inside the pump cannot be controlled and the system requires two pumps, one for downward direction and second for upward direction. When the propeller rotates in the anticlockwise direction, the bot moves in downward direction and when the propeller rotates in clockwise direction, bot moves in upward direction. But there is a disadvantage of DC motor over pump. DC motor is not waterproof like pumps and for underwater purposes DC motor should be waterproof. For making DC motor waterproof, glue gun and white grease is used.

3) Control Box

The control box consists of-

1. 3 SPDT switches
2. Female ethernet jack
3. Jumper wires
4. PCB board

The control box is a compact electronic enclosure that contains various components for controlling and managing electrical signals. It features a female Ethernet jack that allows for the transmission and reception of data signals over an Ethernet cable. This Ethernet jack provides a reliable and high-speed connection between the control box and other network devices.

In addition to the Ethernet jack, the control box includes three single-pole double-throw (SPDT) switches. These switches allow for the manual control of electrical signals, enabling the user to switch between different modes of operation or to turn on or off specific functions of the system. The switches are designed for easy use, with clearly labeled positions and a durable construction that can withstand frequent use.

The control box also includes jumper wires, which are used to connect the SPDT switches to the printed circuit board (PCB) inside the enclosure. The jumper wires provide a secure and reliable connection between the switches and the PCB, ensuring that electrical signals are transmitted accurately and without interference.

The PCB board is the heart of the control box, containing the electronic components and circuits that manage the signals and control the operation of the system. The PCB board is designed for maximum efficiency and reliability, with a high-quality construction that can withstand harsh environmental conditions and frequent use.

Overall, the control box is a versatile and reliable electronic enclosure that provides a range of control and management functions for electrical signals. Its compact design and high-quality construction make it ideal for use in a variety of applications, from industrial automation to home electronics.

IV.DATA ANALYSIS AND INTERPRETATION

Image recognition is used to perform many machine-based visual tasks, such as labelling the content of images with meta-tags, performing image content search, and guiding autonomous robots, self-driving cars and accident-avoidance systems. While human and animal brains recognize objects with ease, computers have difficulty with the task. Software for image recognition requires deep learning.

Performance is best on convolutional neural net processors as the specific task otherwise requires massive amounts of power for its compute-intensive nature. Image recognition algorithms can function by use of comparative 3D models, appearances from different angles using edge detection or by components. Image recognition algorithms are often trained on millions of pre-labelled pictures with guided computer learning.

Following are the steps involved in the simulation of Underwater Surveillance Drone:

1) Load the data
2) Import Network and Resize Data
3) Transfer Learning
4) Classify on new data

V. RESULTS

Figure 2 shows classified images and their accuracy after testing all images in the validation set which gives a quick assessment of how well the network is trained.

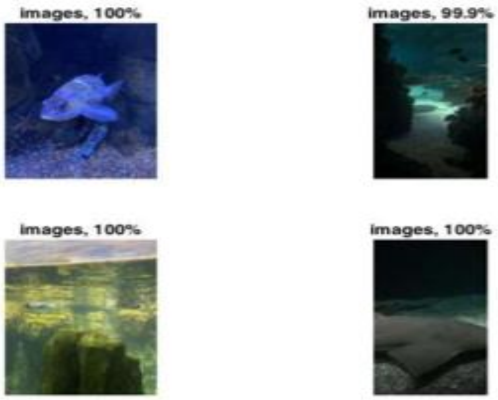

Figure 2. Classified images and their classification accuracy

All processed and classified images gave up to 100 % accuracy as was expected. This happened due to the resizing of data and classification of images on new data. Hence, a satisfactory result was obtained in the simulation of underwater surveillance drone.

When implemented in hardware, the rover showed a significant response as it can travel up to 5 m underwater. After changing the position of the switch, input signal to the controller is provided from the user end, after which the motors and propellers start working. There is a master switch which turns on all the motors at the same time. This process is the phase 1 when user wants to deploy the model under the water. This process will cause the rover to sink while moving in a forward direction. As soon as the motor starts, the propellers are turned on and move the rover in the forward direction opposing the flow and pressure of water.

Figure 3. Actual prototype

Figure 3 shows an actual model of the rover that can travel up to 5 m underwater for surveillance and image recognition.

VI.CONCLUSIONS

This paper describes a mechanical system which can be used to make the rover travel up to 5 feet and an effective electronic control system which can control the rover more effectively and accurately. The rover is installed by many useful features such as a camera for underwater surveillance. Therefore, this rover is very useful in surveillance and research. The rover is made of Polyvinyl chloride pipes so the structure has light weight. The whole system works on a rechargeable 12 V Lead-Acid battery therefore energy is saved. It is a cost-effective system, so it is very useful in military, navy, natural disaster management and many other related fields.

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