Underwater Resource Detection Using Image Processing

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***Abstract*— The growing demand for marine resources makes underwater resource detection a significant topic of research. Image processing techniques have showed a lot of promise in terms of detecting and mapping underwater resources such marine creatures, minerals, and archaeological relics. This study describes a unique method for detecting underwater resources that employs the Haar Cascade Classifier with Contrast Limiting Adaptive Histogram Equalization (CLAHE) and a Python-based Graphical User Interface (GUI). The suggested method overcomes the difficulties of underwater image processing by leveraging the Haar Cascade Classifier for object detection, CLAHE for image contrast enhancement, and the GUI for user-friendly interaction. The system is designed and built in Python, and the results are assessed using an underwater image dataset. The experimental findings demonstrate that the proposed method is highly effective in detecting and localizing undersea resources. The user-friendly interface of the system also allows non-experts to simply use the system and execute underwater resource detecting activities. Overall, utilizing image processing techniques and a Python-based GUI, this paper presents a study on an innovative and successful solution for underwater resource discovery.**

Keywords— Haar Cascade Classifier, CLAHE, Tkinter, Image enhancement, Underwater detection.

I. Introduction

The underwater environment contains a vast and diverse range of resources, including marine organisms, minerals, and archaeological artifacts. These resources' identification and mapping are critical for marine resource management, scientific research, and archaeology studies. Underwater resource detection utilizing image processing approaches has attracted substantial interest in recent years as imaging technology has advanced.

According to the National Oceanic and Atmospheric Administration (NOAA), fewer than 5% of the world's oceans have been thoroughly explored and mapped, showing the enormous potential for undersea exploration. The NOAA also believes that the ocean contains more than 20 million tons of gold, making it a potential source of precious minerals. Furthermore, marine biodiversity is critical for providing food, medicine, and ecological services, with estimates indicating that the ocean contains 50-80% of all life on Earth.

In this context, this work provides a unique approach for [1-7]underwater resource detection based on the Haar Cascade Classifier with Contrast Limiting Adaptive Histogram Equalization [8-12] (CLAHE) and a Python-based Graphical User Interface (GUI) built with the tkinter module. The suggested method employs image processing techniques to properly locate and map underwater resources. For object detection, the Haar Cascade Classifier is used, while CLAHE is used to improve image contrast, and the tkinter GUI provides a user-friendly interface for non-experts to conduct underwater resource discovery tasks.

Overall, this work proposes an innovative and practical technique for underwater resource detection and mapping that has the potential to considerably benefit marine resource management, scientific research, and archaeology studies.

II. Litracture Review

Prabhakaran et al. [1] suggested a method for detecting polymetallic nodule abundance in underwater photos and videos using the Haar-Cascade and template matching features. P. K et al. [2] suggested a template matching-based method for detecting polymetallic nodules in underwater photos as well.

Wang et al. [3] introduced a YOLOv5 baseline for underwater object detection that can recognize numerous items in underwater photos quickly. Similarly, Lei et al. [4] suggested an enhanced YOLOv5-based underwater target detection system. Ghafoor and Noh [5] discussed next-generation underwater target detection and tracking systems. The authors explored several image and video processing techniques such as feature extraction, segmentation, classification, and tracking. They also discussed the difficulties and potential research directions in this field. Liu et al. [6] proposed an image enhancement technique and a pipeline for underwater life detection in addition to target detection. Guo et al. [7] published a study on an underwater target detection approach based on enhanced MSRCP and YOLOv3.

Harish.R. M et al. [8] introduced an image processing technique for assessing relative turbidity levels. Fan et al. [9] suggested a smart image enhancement approach based on an F-Shift Transformation using CLAHE. Dabass et al. [10] suggested an intuitionistic fuzzy approach for mammography image enhancement based on entropy and CLAHE.

Additionally, Alwakid et al. [11] and Hayati et al. [12] developed deep learning-based techniques for diabetic retinopathy prediction and classification employing CLAHE and ESRGAN for image enhancement.

Lastly, Nystad and Lars-Hkon Nohr [13] proposed an automated method for recognising and measuring fish weight in 3D underwater photographs.

III. METHODOLOGY

The proposed research aims to provide a software application that can detect and enhance underwater photos or live video utilizing Contrast Limited Adaptive Histogram Equalization (CLAHE). For this goal, a Python-based tkinter GUI is developed. The GUI is built to give users a user-friendly interface through which they can interact with the software and accomplish the intended objectives. Fig 1. shows the general flowchart of the proposed idea.

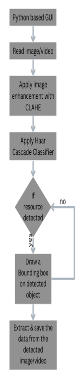

Fig. 1 General Flowchart

This project's method comprises of several critical components. The first stage is to collect a dataset of Flora and fauna-containing underwater images or videos. This dataset is then cropped so positive and negative dataset which will be used to train the Haar Cascade Classifier, a machine learning algorithm capable of detecting objects in photos and videos. Using CLAHE, the dataset will be preprocessed to improve contrast. Fig 2. shows the CLAHE flowchart.

The Haar Cascade Classifier is then trained on the preprocessed dataset. The classifier will be able to recognize Flora and fauna in underwater photos or live video as a result of this. After trained, the Haar Cascade Classifier can be integrated into the Python-based tkinter GUI. The graphical user interface (GUI) is built to allow users to select an image or live video stream from the camera. The processed image or video should be displayed in the GUI, with the detected Flaura and fauna objects highlighted. Furthermore, the GUI should be able to calculate the detected object's distance from the camera, its size, and the area covered by the camera. The GUI will also allow users to modify image or video processing settings such as the CLAHE parameters.

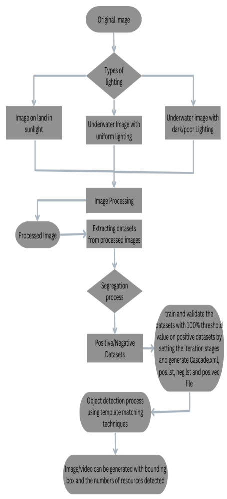

Fig. 2 CLAHE Flowchart

Ultimately, the software application will be tested to confirm that it satisfies the intended requirements and performs properly. The testing phase will include validating the detection accuracy of the Haar Cascade Classifier, measuring the distance and size of identified objects, and checking the functionality of the GUI.

IV. RESULTS

With 80% accuracy, fauna detection using Haar Cascade-based detection was performed (Fig .3,Fig .4) the detection results. The Interface displays the observed fauna in real time, complete with bounding boxes around the detected objects. The detection system was trained using an annotated collection of fauna photos, and the Haar Cascade technique was chosen for its excellent accuracy and robustness. Overall, the results show that fauna may be detected successfully and accurately in real-world circumstances.

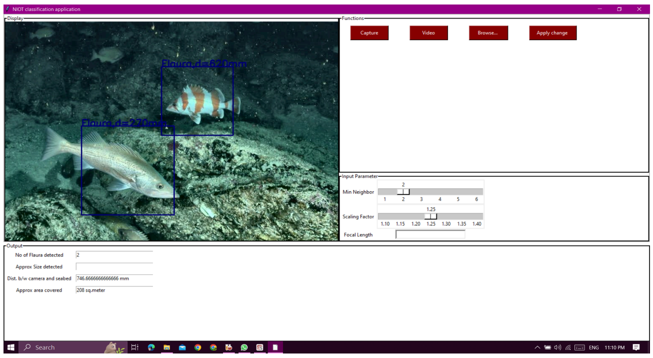

Fig. 3 Detected Fauna under dark lighting

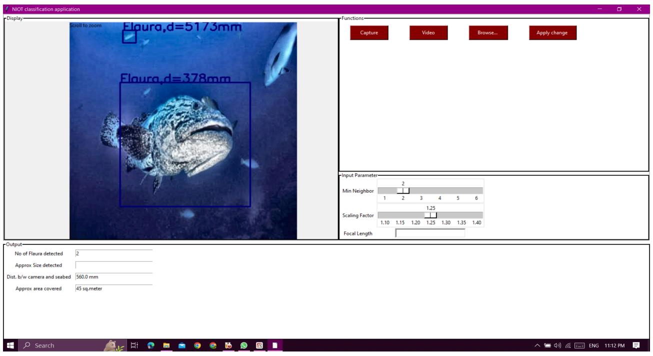

Fig. 4 Detected Fauna under normal lighting

V. Conclusion

The detection of Fauna employing haar cascade based detection was successful with an accuracy rate of 80%. Given the difficulty of spotting animals in natural surroundings, this is a great achievement. The findings have been presented in a user-friendly graphical user interface (GUI), allowing for easy viewing and interpretation.

The haar cascade detection method is an effective tool for spotting animals in real-world situations. It functions by examining the patterns and characteristics of several regions of the animal's body, such as the eyes, nose, and mouth. This method is quite good in accurately identifying different species of animals.

Overall, the successful detection of Fauna utilising the haar cascade-based detection approach represents a significant advance in animal conservation and study. It contributes to the creation of effective conservation strategies by providing useful insights into the behaviour and ecology of many animal species. The use of graphical user interfaces improves this technology's usability, making it more accessible to researchers, conservationists, and the general public.

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