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An Analysis on Water Objects Detection Techniques

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Abstract: ***Water object detection is the process of identifying various objects either on the surface of the water or under water through images or videos. The objects to be detected are like floats, marine species, ships, pipelines etc. In this article, an extensive survey has been made on different strategies developed to detect and recognize underwater objects and objects on the water surface. Various methods have been proposed by numerous scientists to detect water targets based on image processing, neural networks, deep learning methods like faster R-CNN, YOLO, adaptive filtering schemes, background subtraction methods etc. The analysed methods can be used in several areas including aquatic study, maintaining and fixing damages of underwater structures.***

I. INTRODUCTION

Water pollution is a significant damage to our planet. The main causes for this hazard are floats such plastic covers and bottles which are not properly recycled due to human activities. These floats harm the water quality. [1] They also harm the marine ecological system and represents an extreme harm to aquatic life. So as to dispose of this risk it is important to identify the different floats and aquatic wastes by using water object detection techniques. [11] Water accidents are also one of the common scenarios which require the detection of human bodies. During those accidents detecting human
would be helpful to them when they are in need. So it is necessary to detect them to mitigate death rate during water accidents.
Several water object detection techniques are existed which are used for many applications like fixing damages of underwater infrastructures, preventing underwater obstacles, applying aquatic technology, mitigate water pollution, studying marine life, during water accidents, for naval purposes. The Remotely Operated Vehicles(ROV's) and Autonomous Underwater Vehicles(AUV's) are utilised to explore deep seas. The ROV's are employed to perform tasks under water but it turned into a complex task since manual intervention is required. So recently AUV's are developed to perform these functions. [5] In order to perform detection of water objects either images or videos are to be taken as input to any detection technique. Sonars and cameras are two general sensors that are used for underwater objects identification. Sonars provide information to interpret the underwater environment even at lesser visibility environments. Cameras provide additional visibility futures like color, intensity etc, which are not provided by sonars. But cameras cannot detect objects clearly due to light attenuation problems. So sonars are mostly utilised for identifying objects. [7]
Several object identification techniques have been developed based on computer vision, deep learning, image processing. In image processing techniques the pictures to be tested are to be preprocessed and then they are to be processed after filtering them to identify the objects. In techniques based on computer vision, the pictures are preprocessed and a neural network model is developed and it is trained using neural network algorithms for identification of objects. In this paper a comprehensive survey has been made on different water object detection techniques based on computer vision, image processing, deep learning.

II. LITERATURE REVIEW

Lili Zhang, Yi Zhang, Zhen Zhang, Jie Shen and Huibin Wang have proposed a method on the basis of Faster R-CNN method to detect the objects on the surface of water. They have taken a three day video-surveillance stream of North canal, Beijing as input. There are four phases in the implementation. Initially they used gamma correction algorithm to remove image contrastness due to variation in the sunlight. Then they have developed a network model which is Faster R-CNN through which they retrieved the image featured maps and combined low and high level feature maps. They have fixed the scale, aspect ratio and number of anchors. Then they have trained the network model which they used to recognize floats and validated its performance. [1]
U.Anitha and S.Malarkkan have proposed a method to detect underwater objects. They have taken a dataset which consists of 25 paired images from diverse equipments of sonar out of them 15 pairs are used for training and 10 are used for testing. The paired images captured at various durations are identified using feed forward and pattern recognition networks. In order to identify objects under water they used Adaptive Neuro Fuzzy Inference System which is trained with input and targeted pair. On implementing 2D gray picture to the system objects are retrieved and their regional characteristics are determined through which the target is detected. [2] Dirk Walther, Duane R. Edgington and Christof Koc have developed an automatic system to detect and track the salient animals in the ocean-going videos of Remotely operated vehicles. They consider few frames from the video recorded by ROV's and

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eliminate their background using background subtraction method. Then they process each frame using bottom-up salient attention algorithm in order to detect the salient animals. Then the detected animals are tracked using equations of Kalman filters. [3]

Niranjan Anand Hule has developed an automatic system to detect underwater objects from the images under water. In this article, he gathered the images of submarines and fishes as input from the internet. The implementation included three phases. Initially the collected images is preprocessed in which RGB images are transformed into only B element images for clear edges and the intensities are modified. Then filters are used to identify the edges and to eliminate noise and then they are scaled. Then they contrasted the object detected by proposed method with inbuilt edge detection methods. [4]

G.L. Foresti and S. Gentili have proposed a visual system to detect human-made objects under water. They considered real underwater images as input. They applied color compensation procedure to minimize problems of water due to attenuation of sunlight. Then the dimensions of the image is minimized to 1/16 and 1/32 which are examined using edge and anode detection modules. Edge detection module uses neural networks and examines all region pairs and chooses the correct pair through which the pipeline edges are identified. Anode detection module uses neural networks and determines the probability of existence of anode in image. Then position of autonomous underwater vehicles is obtained by matching the probability of anode obtained by module and probability of anode from an offline database. The obstacles of the pipeline are also detected by number of pixels categorized as edges in image. [5]

Tajbia Karim and Ebad Zahir have developed a method to identify submerged objects underwater. They have taken red, blue and green colored objects at varying depths and evaluated the special attenuation coefficient of the medium based on irradiance details by implementing Beer-Lambert's law. Through that coefficient value the red, blue and green colored objects are identified at any depth underwater. [6]

Zhe Chen, Zhen Zhang , Fengzhao Dai , Yang Bu and Huibin Wang have designed a monocular vision based system to find targets under water. They have taken different datasets which include images obtained by a monocular camera as input. This is mainly implemented in two stages. Initially, from the image several features such as colour, intensity and ability of light transmitted are examined and retrieved. Then global contrasts of these features are computed and are used to determine Region Of Interest. The retrieved ROI is rectified by using image segmentation method and outputs the detected image. [7]

Sylvain Jay and Mireille Guillaume have proposed a newer variant of matched filter to identify underwater objects. They have taken real and unreal images as input. They used Bathymetric model of subsurface reflectance to rectify the distortions of the spectrum. Then they have developed Bathymetric matched filter to identify the presence or absence of underwater objects. [8]

JianjiangZhu, SiquanYu, ZhiHan , YandongTang and ChengdongWu have proposed a new technique to detect and recognize targets under water. They considered sonar video clips as input. They obtained the features and prepared a prior template based on the survey of acoustic shadows and highlight regions. Then the coarse location of object in the objective image is obtained using saliency detection method. The prior template on affine transformation becomes transformable template. Then resemblance between template and target region is estimated. Then the resemblance score is compared with the user specified minimum score threshold and central coordinates of the recognized object is obtained. Then finally based on the location of the object the minimum outer rectangle is drawn. [9]

Chunhua Yuan, Mahmood R. Azimi-Sadjadi, JoEllen Wilbur and Gerald J. Dobeck have proposed a method to increase the accuracy of identification of objects under water. They used multi channel subband adaptive filtering to pre treat the sonar data to remove clutter and to increase Signal to noise ratio. These outcomes are beamformed to develop a picture for every ping of the sonar. Then these beamformed pictures are post processed using high-order correlation method which specifies the object returns for various successive pings. [10]

Michael Fulton, Jungseok Hong, Md Jahidul Islam and Junaed Sattar have assessed four deep learning methods to identify aquatic waste. They have taken a dataset of 5,720 pictures of waste materials as input. They have trained four deep learning methods like YOLO-v2, Tiny-YOLO, Faster R-CNN, SSD and assessed their performance using metrics like Mean average precision and Intersection over union. [11]

Dr.S.Rathinavel and P.Usha have proposed a method to detect and differentiate between living and non-living things under water by using sensors. They verified their proposed technique by testing on a water tank with a depth of 3m consisting water. They interfaced Infrared cluster sensors and ultrasonic cluster sensors with arduino controller and programmed that hardware. Then they positioned this interfaced hardware on the surface of the water to identify the objects and to classify them. [12]

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III. COMPARISION OF DIFFERENT METHODS USED FOR WATER OBJECTS DETECTION

This table gives the idea about different techniques developed for detecting water objects.

REFERENCE NO	OBJECTIVE	METHOD USED	RESULTS/ OUTCOMES	ADVANTAGES	DISADVANTAGES	RECOMMENDATIONS
[1]	The aim is to detect real-time water surface objects such as floats.	Faster R-CNN, gamma correction algorithm.	The outcomes show that Faster R-CNN accomplished a MAP of 83.7% and a frame rate of 11 FPS on the dataset.	The proposed strategy can be applied to the automatic identification of the water surface floats. It gives good robustness and high identification accuracy.	Poor generalizing ability of existing datasets. Additional computations diminishes the detection speed.	The proposed model is to be additionally enhanced to improve the identification speed.
[2]	To develop a system to detect targets under water from pictures of the sonar using soft computing techniques and also to identify alterations between paired images captured at various durations.	Adaptive Neuro Fuzzy Inference System, feed forward network, pattern recognition neural network	The outcomes show that the proposed system accomplished recognition accuracy of 85%.	The proposed system is less complicated and is efficient for the pictures captured from sonar over existing techniques		Best performance can be achieved by using high quality pictures and by expanding plenty of databases.
[3]	To develop an automated system to detect and track the animals from the underwater video and also classify them into biological taxonomies in the interest of the human annotators.	Background subtraction, saliency-based bottom-up attention algorithm	The results show that on analysing single frame results 89% of the salient objects were detected and on analysing video clips 80% of the 208 animals which are human annotated were detected and out of remaining 41, 22 animals were identified by the proposed method.	The proposed method mitigates the difficulty of multi-target following. It can also recognize the creatures which are also not identified by the human annotators.	The classification task held as an open issue.	
[4]	To build up a procedure for automatic identification of objects from the underwater pictures.	Image processing	The results show the scaled and noise removed log image of the object detected from the original image.	The proposed method provided better results compared to inbuilt edge detection functions.		
[5]	To develop a method for underwater detection of objects like pipelines, trestles , anodes based on visual system	Back propagation method, edge extraction algorithm	The results show that the proposed algorithm detected pipelines, anodes and trestles.	The complexity of the light attenuation in the water has been minimised.		

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[6]	To develop a technique for detection of submerged objects .	Beer-Lambert law	The results show that the proposed system has detected maximum portion of blue objects, green and least portion of red coloured objects at various depths underwater.	The blue, green and red coloured submerged articles can be recognized at any depth underwater.	While travelling through submerged medium of different colored objects the maximum portion may not be detected for shorter wavelength colored objects.	This can be utilised further if the colour was the significant property to detection.
[7]	To develop a method for underwater detection of objects based on monocular vision-based system	Region of Interest detection method, image segmentation method	The outcomes show that the proposed strategy achieved the Area Under Curve value of 0.9000.	The average performance of the proposed technique is increasingly effective contrasted with other strategies .	The difficulty of the proposed technique is moderately high contrasted with other strategies.	
[8]	To generate a model to identify the submerged targets by using hyper spectral remote sensing data.	Bathymetric model of reflectance.	The outcomes show that the bathymetric matched filter identified the underwater objects of pure water upto 50m with probability of identification of 0.5 and of turbid water upto 11m.	The proposed matched filter provides better detection of underwater targets compared to the classical filters		If the depth is unknown then maximum likelihood method can be used for detection
[9]	To develop a method to detect and recognize underwater objects using Transformable template matching	Saliency detection method, affine transformation, template matching	The results show that the designed method acquires recognition rate of 98.1% over other methods. It acquires recognition rate of 94.2% to recognise object rotation and recognition rate of 92.3% to recognize shape of the object.	The proposed method identifies mine-type objects and shaped targets under water and can be used in real-time applications		
[10]	To develop a method for the detection of underwater targets	High order correlation method, subband adaptive filtering scheme	High order correlation process led to correct underwater detection of targets.	It helps on identifying low perceptible targets in very high clutter. It is fast and easy to apply.		
[11]	To assess deep learning based techniques to identify aquatic waste like plastic materials.	YOLO-v2, Tiny-YOLO, Faster R-CNN, SSD	The results show that Faster R-CNN method can be used to identify aquatic waste interms of accuracy which has a mAP of 81%	The aquatic waste can be identified in reality using visual deep learning methods.	Collecting adequate dataset is typical task.	
[12]	To propose a technique to detect objects including human under water.	Infrared array sensor and ultrasonic array sensor method.	The results show that the proposed method achieves an average performance of about 85%.	It mainly detects and classifies between living and non living things underwater.		

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IV. CONCLUSION

It is a challenging and significant task for automatic underwater object detection due to climate variations, temperature variations, changes in water structure and light attenuation problems on the water surface. This paper has presented a study on various strategies proposed to accomplish better accuracy and performance for identifying different objects under water and on the water surface. Most of the methods can be applied to detect targets at any depth underwater. The light attenuation issues are also tackled through a portion of proposed techniques. For some proposed methods constructing datasets has become a complex task. Numerous strategies for automatically identifying the water objects are to be created in future with efficient performance.

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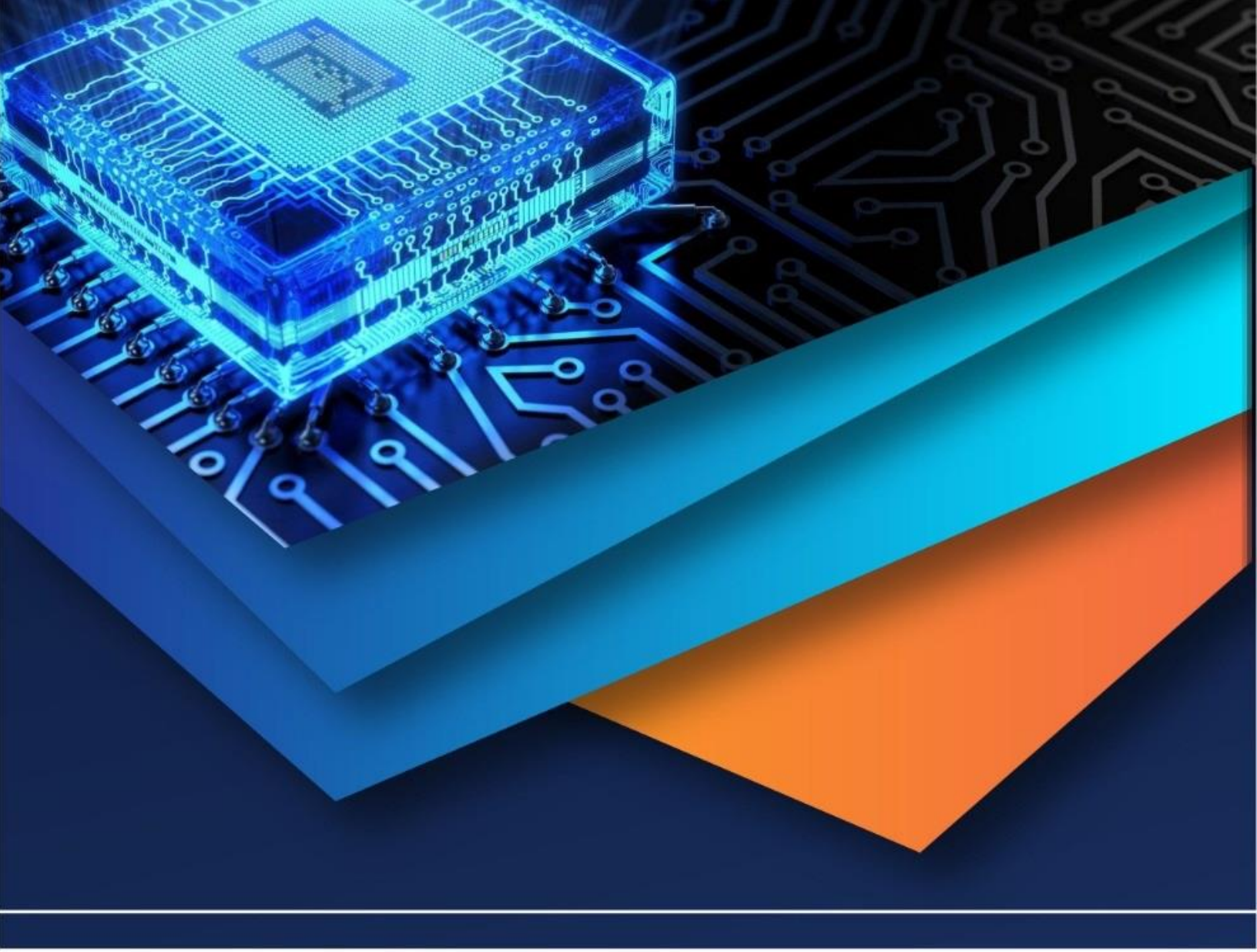
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