The AQUABOT : Human body detection Underwater, water quality monitoring & marine boundary surveillance using concepts of Artificial Intelligence

[1] Charan Reddy N., [1] Gopinath C., [1] Jayashree K., [1] Revati Hiremath,
[2] Dr. Pavithra G., [3] Dr. Sindhu Sree M., [4]Dr. T.C.Manjunath* Ph.D. (IIT Bombay)

[1] Eighth Semester BE (ECE) Students, Final Year, Dept. of Electronics & Communication Engg.,
Dayananda Sagar College of Engineering, Bangalore, Karnataka
[2]Associate Prof., Electronics & Communication Engg. Dept.,
Dayananda Sagar College of Engineering, Bangalore, Karnataka
[3]Assistant Prof., Electronics & Communication Engg. Dept.,
Dayananda Sagar College of Engineering, Bangalore, Karnataka
[4] Professor & HOD, Electronics & Communication Engg. Dept.,
Dayananda Sagar College of Engineering, Bangalore, Karnataka

*Corresponding author : tcmanju@iitbombay.org

Abstract
This paper focuses on the development and deployment of an AQUABOT, a water-traveling robot designed to detect the presence of humans. Its primary application lies in underwater operations during water accidents, where it can assist in locating individuals. Monitoring and securing marine borders pose significant challenges, given their importance for national security. Additionally, marine exploration plays a crucial role in understanding global climate and environmental changes. Water quality is vital for the cultivation of aquatic organisms, relying on parameters such as dissolved oxygen, ammonia, pH, temperature, salt, nitrates, and carbonates. Continuous monitoring of water quality using sensors ensures the well-being and growth of aquatic life. The sensed data is transmitted to a mobile device through the cloud, enabling timely preventive measures to minimize losses and enhance productivity. In areas lacking proper waste disposal facilities, dumping garbage into nearby water bodies has become a major environmental concern. Aqua Bot offers applications for cleaning and maintaining the quality of water bodies, addressing this issue. The work done & presented in this paper is the result of the final year one year project work that has been done by the final year engineering students of the college and as such there is little novelty in it and the references are being taken from various sources from the internet, the paper is being written by the students to test their writing skills in the final stages of their engineering career and also to test the presentation skills during their final year project presentation and the work done & presented in this paper is the report of the undergraduate project work done by the students.
Keywords Aquatic, Robotic, Sensor, pH, underwater, Detection, Human.

1. Introduction

Robots are mechanical machines that can carry out challenging and sophisticated activities both autonomously and in response to commands. As a result of the current era's rapid advancement in technology, it is safe to utilize robots rather than humans to carry out specific activities. Robots can carry out more difficult duties, be transferred to locations where humans cannot go, and carry out tasks more effectively Underwater robots are valuable tools for ocean exploration because they can reach areas of the ocean that humans cannot. The ability to swiftly and precisely identify and locate objects holds significant research value and promising practical applications, particularly in the context of underwater environments [1]. Real-time detection of submerged objects offers tremendous potential for various domains.

As underwater robot technology advances, we will be able to use it for underwater human body detection, which will improve the diving detection system. as well as other resource applications that aid in the saving of people's lives [2]. Water is the most important natural resource. It is very essential for many things, such as drinking purposes, aquaculture, etc. We need good quality water for all of these purposes, so monitoring water quality is critical [3]. Monitoring water quality parameters such as PH, nitrogen, dissolved oxygen, and turbidity is important in aquaculture. These sensors can be used to collect data on such parameters, which can then be transmitted via IoT to the aqua framer. These IoT applications can be run on the Raspberry Pi, which has an integrated WIFI module. [4] Smart Bin in this model aims to separate items as quickly as possible. Domestic wastes in order to make it easier for the municipality and individuals to segregate them on a large-scale basis. The waste square measure is primarily classified into two types.

Levels of perishability and non-biodegradability These two main categories square measure any two-class classification. Counting on their re-usability [5]. marine boundaries Surveillance is a difficult task, but we can use robots to continuously monitor the marine boundaries, which can detect and attack enemies from afar. This concept addresses the issue of replacing humans with surveillance robots.[6] Object detection involves using computer algorithms to detect instances of objects in digital images and videos.

signal processing, offers numerous advantages compared to analog processing and enables the application of a broader spectrum of algorithms to input data [7]. This opens up a wider range of possibilities and benefits in the field of image processing. Manual scavenging, a dangerous job that involves cleaning sewers manually, has resulted in many deaths due to health disorders caused by exposure to virulent gases such as methane. The use of robots in such hazardous environments can help prevent human casualties. The Smart Bin in this project aims to efficiently separate domestic waste into two main categories: perishable and non-biodegradable, which are further classified based on their reusability. The introduction highlights the importance of proper waste disposal for public health and environmental sustainability [8].

2. Literature Reviews / Surveys.

In their work [1], the authors highlight the significant public health threat posed by annual fatalities of 374,000 individuals, emphasizing the challenging nature of detecting human bodies underwater through live video. To address this, the paper explores the feasibility of utilizing the Faster R-Convolution neural network for detecting humans in underwater environments. Water-related factors, such as water quantity and quality, play a crucial role in enhancing climate-change resilience. To automate water information extraction and intelligent monitoring, artificial intelligence (AI) empowered by remote sensing (RS) technologies has gained prominence. The article offers a comprehensive review of literature incorporating AI and computer vision techniques in the water resources sector, specifically focusing on intelligent water body extraction and water quality detection through remote sensing [2].

This thesis endeavors to develop a Deep Neural Network (DNN)-based detector for underwater human body part detection. Three different DNN-based models (Faster R-CNN, SSD, and YOLO) are implemented and compared for their effectiveness in detecting underwater human body parts. Additionally, the study proposes enhancing the model's performance in small object detection through data augmentation techniques like color distortion and image scaling applied to the existing training dataset [3]. The investigation begins by identifying suitable deep learning algorithms for object detection, followed by experimental evaluations of these algorithms to assess their effectiveness in detecting humans in underwater environments. Leveraging deep learning to construct an underwater human body classifier is regarded as an efficient and cost-effective approach for detecting and tracking humans in underwater settings [4].

This paper they talk about understanding the global climate and environmental changes, marine exploration. This helps in research areas for the purpose of various data collection, weather monitoring, pH sensing and marine border monitoring They are using PH sensor, humidity sensor ,temperature sensor ,air pressure sensor, temperature sensor to monitor water quality and weather .they also use ultrasonic sensor for marine border monitoring We are using AI in addition to ultrasonic sensor so that we can train our robot with known persons and ship Information so when an unauthorized entry is happening our robot will shoot the enemy[5] .Objective of this paper is Detection of objects underwater for security and recovery applications They have used sonar system for detecting and classifying an object of interest underwater in accordance with various embodiments. As sonar is expensive, we are approaching to achieve this using IR sensor, camera and image processing [6].

The underwater human body detection system utilizes image processing, cloud computing, and IoT technology to identify human bodies or objects in the water. The system operates by transmitting IR rays and capturing an image when the IR line is interrupted or obstructed. This image is then sent to the cloud for processing using Python technology. The processed image is displayed in a desktop application where object identification is performed based on their shapes. The primary objective is to develop an object detection and recognition system for underwater images using image processing techniques. This system effectively detects and captures images of objects submerged underwater [7]. This project focuses on the design and fabrication of a watercourse waste improvement machine, considering the prevalent condition of our national rivers that suffer from large quantities of biodegradable pollution, pollutants, toxic materials, and debris. The main goal is to reduce the manpower and time required for watercourse cleaning [8].

3. Proposed Methodologies - Underwater Human Body Detection

Popular object identification algorithms like the YOLO (You Only Look Once) algorithm employ deep learning to identify things in pictures and videos. Detecting human bodies underwater is another application for it. For underwater human body detection, YOLO can be trained on a dataset of underwater images containing human bodies. The input image is divided into a grid by YOLO, which then forecasts the class probabilities and bounding boxes for each grid cell. This method is distinct from existing sliding window-based object detection algorithms. The YOLO model is trained using a convolutional neural network (CNN), which learns to recognize underwater human body features. The bounding boxes for the human bodies in the input image are predicted by the YOLO algorithm during testing. After post-processing the predicted bounding boxes to reduce false positives and duplicate detections, non-maximum suppression is used as shown in the Fig. 1.

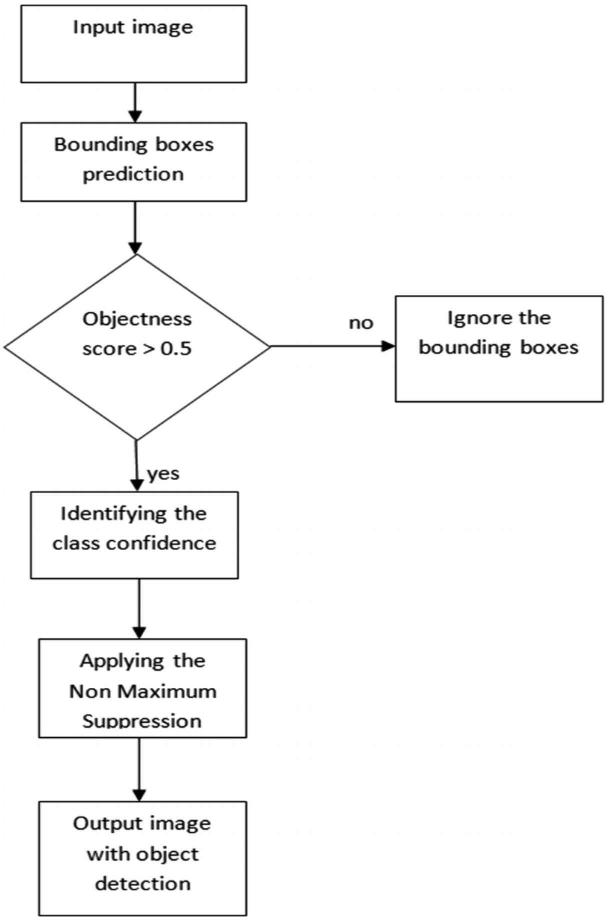

Fig. 1 : Flowchart of the proposed work

4. Proposed Methodology - Water Quality Monitoring

The initial and crucial task involved identifying the water parameters that could effectively indicate water pollution. The next step was to select suitable locations that would provide valuable data. These areas needed to be susceptible to chemical fluctuations caused by either marine life or human interference, as studying pristine and uncontaminated waters would yield predictable results. The third challenge was to determine the most suitable method of data logging. Considering that the equipment offered an SD storage option, data logging was carried out on the hardware itself, in a text format that can be easily interpreted by various applications. The final step entailed selecting a reliable and accurate method of analysis. Given the vast number of unknown factors present in the sea, which can potentially alter the properties being measured, it was essential to choose an approach that accounted for such variations. Failure to do so would result in misleading readings, as depicted in Figure 2.

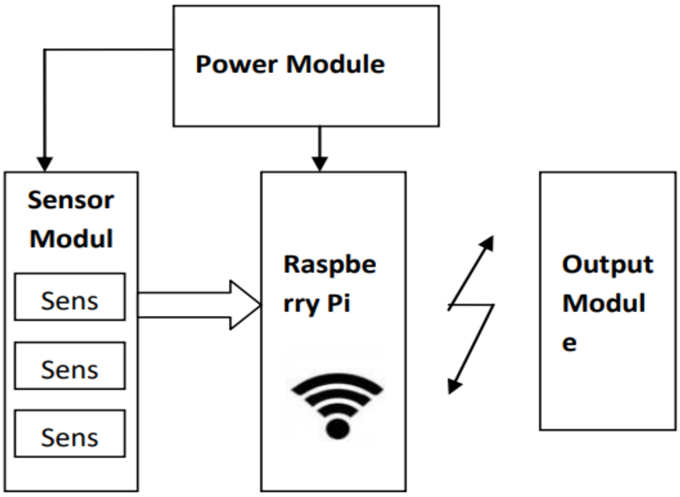

Fig. 2 : Water quality monitoring

5. Proposed Methodology - Marine Boundary Surveillance

The ultrasonic sensors are used to detect the presence of underwater objects and measure the distance between the robot and the object. The cameras are used to capture visual information about the surroundings, such as the type and size of vessels. Secondly, the programming of the robot's control system, which includes the integration of the sensor and camera data. The programming also includes the development of algorithms for object detection, recognition, and tracking. The robot uses cameras to capture images of vessels and individuals on board, and the face recognition technology matches these images against a database of known offenders, enabling the robot to identify and track potential threats. This methodology is particularly useful for preventing illegal activities such as smuggling, piracy, and illegal fishing, and for protecting marine resources and the environment. By automating the surveillance process, the robot increases the efficiency and effectiveness of marine boundary surveillance, enabling law enforcement agencies to respond quickly and appropriately to any potential threats as shown in the Fig. 3.

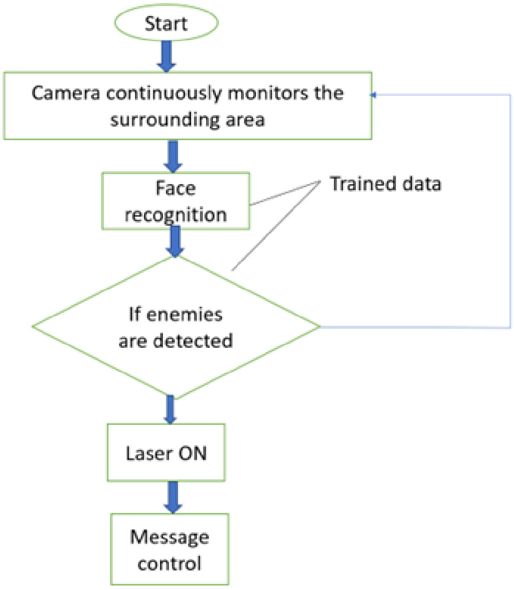

Fig. 3 : Flow Chart for marine boundary surveillance

6. Block diagram of the project

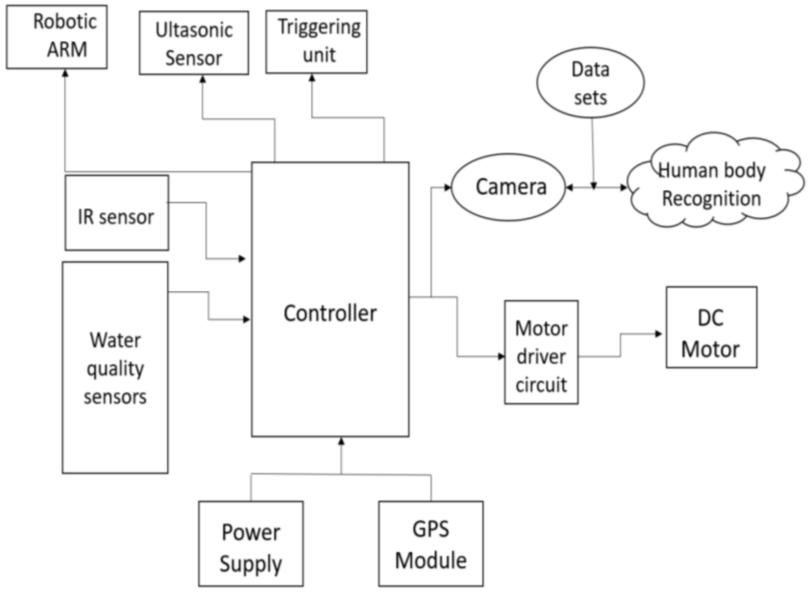

Fig. 4 : Block-diagram

As depicted in Figure 4, the raspberry pi interfaces with three sensors: the passive infrared sensor, ultrasonic sensor, and various water quality sensors. The raspberry pi, a low-cost computer running Linux, offers GPIO (general purpose input/output) pins, enabling control over electronic components for physical computing and exploration of the Internet of Things (IoT). The sensors' outputs serve as inputs to the raspberry pi, while the raspberry pi's outputs act as control signals for the motors and camera.

The ultrasonic sensor functions as part of a RADAR system, coupled with a servo motor, to monitor the presence of enemies or unauthorized objects.

The pH sensor is responsible for measuring the acidity or basicity of a solution, serving as a crucial indicator of water quality. Typically composed of a delicate glass electrode, the pH sensor is connected to an analyzer that facilitates data collection, calibration, and alerts related to water quality.

Turbidity sensors assess the presence of suspended solids in water by measuring the amount of light passing through it. These sensors find applications in river and stream testing, wastewater management, drinking water treatment, sediment transport study, settling ponds management, and laboratory testing.

Servo motors, whether rotary or linear actuators, enable precise control over angular or linear positioning

DC motor: DC motor uses the DC current to convert electrical energy into mechanical energy. It helps in the movement of the robot.

7. Algorithms

R-CNN Algorithm *:* R-CNN was designed with the intention of taking an input image and producing a set of bounding boxes as an output, where each bounding box contains an object and its category (such as a car or a pedestrian) as well. In order to track objects from a drone-mounted camera, locate text in an image, and detect objects, region-based convolutional neural networks have been used. The first step in the R-CNN process is to use a mechanism called Selective Search to extract regions of interest (ROI), where each ROI is a rectangle that could represent the edge of an object in an image. There might be up to 2000 ROIs, depending on the situation. Each ROI is subsequently fed through a neural network to generate output features. A group of support-vector machine classifiers is used to analyze each ROI's output features and determine what kind of object (if any) is contained therein as shown in the block diagram in Fig. 5.

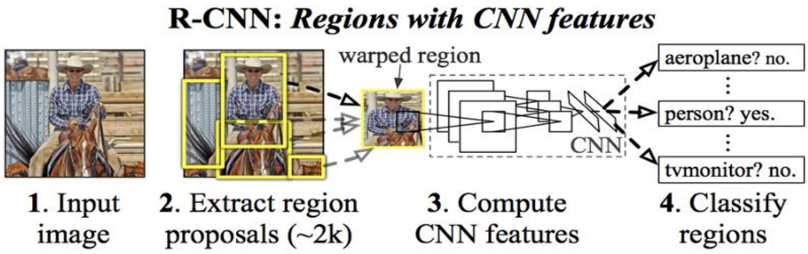

Fig. 5 : Steps of the R-CNN algorithm

Other computer vision tasks can now be completed using R-CNN. The other version of R-CNN is Fast R-CNN, Faster R-CNN, Mask R-CNN, and Mesh R-CNN.

The Fast R-CNN method, introduced by Girshick, overcomes the limitations of R-CNN by incorporating both classification and bounding box regression. It introduces a unique CNN structure called Fast R-CNN, which offers several advantages:

- Improved object localization precision compared to R-CNN.
- It simplifies the process by combining multiple tasks into a single step with minimal loss.
- The entire network architecture is revamped in this method.
- It eliminates the need for additional memory to store calculations.
- In the Fast R-CNN model, the input image undergoes processing using deep convolutional network layers and max pooling layers to generate a convolutional image layer with region proposals. For each region proposal, a pooling layer extracts fixed-length characteristics of the object from the convolutional layer. These characteristics are then passed through a series of fully connected layers, resulting in two common output layers.

The first output layer provides softmax probabilities that indicate the likelihood of the object belonging to either the foreground or the background. The second output layer produces four values representing the position of the selection box for each detected object. Refer to Figure 6 for a visual representation of these concepts.

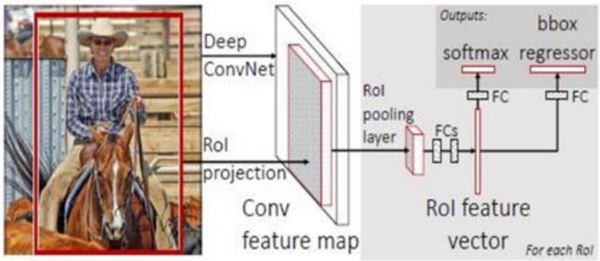

Fig. 6: The architecture of Fast R-CNN

Figure 6 illustrates the structure of Fast R-CNN, which integrates various components such as the convolutional network, region of interest pooling, and classification layer into a unified architecture. The region of interest (ROI) pooling leverages max pooling to transform the object's characteristics into a compact representation, facilitating faster computation. However, if ROIs are generated from diverse images, backpropagation using the spatial pyramid pooling (SPP) layer becomes less effective [4]. To expedite Fast R-CNN, two insights are crucial.

Firstly, hierarchically organizing all tested ROIs in each image enables shared computation among ROIs created from similar images during both forward and backward propagation. Secondly, the time taken to calculate the fully connected (fc) layers during the forward pass is considerably high. To accelerate the detection process, the application of truncated singular value decomposition can be employed to reduce larger layers into smaller ones. While Fast R-CNN incorporates region proposals, all its layers are trained with a multi-task loss in a one-step process. This approach enhances accuracy and testing time while saving storage space. However, the effectiveness is limited by the separate creation of region proposals through an additional costly process.

Moving on to Faster R-CNN, both R-CNN and Fast R-CNN rely on selective exhaustive search for object detection, which is time-consuming and hampers performance. To address this limitation, a research team from Microsoft, including Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun, introduced the Faster R-CNN algorithm in 2015. Faster R-CNN eliminates the selective search algorithm by incorporating an additional region proposal network. This network takes convolutional features from the convolutional network and computes object locations, eliminating the need for further search operations within the image.

Faster R-CNN consists of two sections: the first section utilizes a fully convolutional neural network to generate region proposal networks, and the second section employs the Fast R-CNN detector to classify the proposed regions. This combined algorithm streamlines the object detection process. Figure 7 presents the structure of Faster R-CNN, highlighting its components and flow.

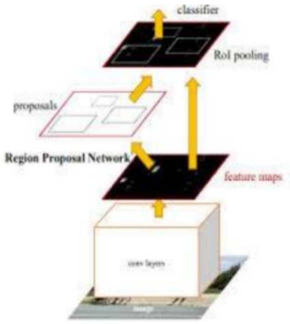

Fig. 7: Faster R-CNN design having combined network

9. YOLO Algorithm

The YOLO (You Only Look Once) algorithm is a highly efficient and accurate solution for real-time object detection using neural networks. Its widespread adoption can be attributed to its impressive speed and precision. The YOLO algorithm has been successfully employed in various applications, including animal detection, pedestrian identification, parking meter recognition, and traffic signal detection. By utilizing convolutional neural networks (CNN), YOLO enables instant object detection. As its name suggests, the algorithm performs a single forward pass through the neural network to detect objects, eliminating the need for multiple passes. This means that a single execution of the algorithm can predict objects across the entire image. The CNN simultaneously predicts multiple class probabilities and bounding boxes. There exist several variants of the YOLO algorithm, with Tiny YOLO and YOLOv3 being among the most popular ones.

10. YOLO algorithm works using the following three techniques

The YOLO (You Only Look Once) algorithm employs several key components to achieve object detection:

Residual blocks: The image is divided into grids of equal size, typically denoted as S x S. Each grid cell is responsible for detecting objects that enter its region.

Bounding box regression: A bounding box is an outline that highlights an object in an image. It includes the width (bw), height (bh), class (c), and the bounding box center (bx, by). YOLO utilizes a single bounding box regression to determine the characteristics of an object, such as its size and position.

Intersection Over Union (IOU): The concept of IOU refers to the extent of overlap between two bounding boxes. YOLO uses IOU to generate output boxes that accurately enclose the objects. Each grid cell predicts bounding boxes and their associated confidence scores. If the predicted bounding box closely matches the actual box, the IOU value is close to 1. This mechanism helps eliminate bounding boxes that do not align with the actual objects, ensuring better accuracy.

By employing these techniques, YOLO effectively detects objects by dividing the image into grids, performing bounding box regression, and utilizing IOU to refine the predicted bounding boxes.

11. Discussions

The results indicates that underwater robots are valuable tools for ocean exploration because they can reach areas of the ocean that humans cannot. They can be used to identify and locate objects quickly and accurately. Therefore, real-time detection of underwater objects has great research value and considerable application prospects. As underwater robot technology advances, it will be able to use it for underwater human body detection, which will improve the diving detection system. as well as other resource applications that aid in the saving of people's lives. Water is the most important natural resource. It is very essential for many things, such as drinking purposes, aquaculture, etc. We need good quality water for all these purposes, so monitoring water quality is critical. Monitoring water quality parameters such as PH, nitrogen, dissolved oxygen, and turbidity is important in aquaculture. These sensors can be used to collect data on such parameters, which can then be transmitted via IoT to the aqua framer. These IoT applications can be run on the Raspberry Pi, which has an integrated WIFI module. marine boundaries Surveillance is a difficult task, but we can use robots to continuously monitor the marine boundaries, which can detect and attack enemies from afar. This concept addresses the issue of replacing humans with surveillance robots.

12. Conclusions

In conclusion, the Aqua Bot offers a versatile solution for underwater applications, including underwater body detection, water quality monitoring, and marine boundary surveillance. It effectively detects human bodies on the water's surface and transmits their location to a remote station using GPS technology. The device offers several advantages, such as full automation, reduced manpower, minimal time requirements, compact size, and low maintenance needs. The GSM signal facilitates easy tracking of the device. The components used in the system are cost-effective and efficient. Our project focuses on implementing the concept of underwater human body detection using IR Transmitter, passive infrared sensor, camera module, and Gear motor. Water quality monitoring is crucial for the well-being of both humans and plants as water is consumed by all. Traditional water quality monitoring systems and some new technology-based approaches face various challenges and issues. The existing systems lack intelligence and do not provide predictive capabilities. To address these limitations, our proposed solution is an intelligent IoT-based water quality monitoring system that leverages Machine-to-Machine communication enhanced by artificial intelligence. This enables communication among devices over a large environmental area compared to a small local area. Moreover, continuous monitoring of naval borders is of utmost importance for national security, as it directly impacts the overall outcome.

References

[1] Uma N. Dulhare, Mohd Hussam Ali "Underwater human detection using faster R-CNN with data augmentation". Muffakham Jah College of Engineering & Technology, Hyderabad, India. 2021.

[2] Yang, L.; Driscol, J.; Sarigai, S.; Wu, Q.; Lippitt, C.D.; Morgan, M. "Towards Synoptic Water Monitoring Systems: A Review of AI Methods for Automating Water Body Detection and Water Quality Monitoring Using Remote Sensing". Sensors 2022, 22, 2416. https://doi.org/10.3390/ s22062416

[3] Maowei Zheng, Wenjie Zhan. "From Body Parts Responses to Underwater Human Detection: A Deep Learning Approach ". June 2020.

[4] Sai Nishant Mattupalli Venkata. "Detection and Tracking of Humans in an Underwater Environment Using Deep Learning Algorithms". Thesis no: MCS-20YY-NN. June -2019.

[5] Pragathi Madhyastha K P, Rashmi Srinivasan, Sanjana S, Santhosh K. "Solar Powered Unmanned Marine Robot using Radar System". International Journal of Engineering Research & Technology (IJERT), http://www.ijert.org, ISSN: 2278-0181, Vol. 8 Issue 05, May-2019.

[6] Massachusetts Institute of Technology JUSTIA patents. "Systems and methods for detecting objects in underwater environments" Published online: 8 January 2018.

[7] Karthik, Keerthan, Preetam Londe , Samraj , Ms. Shyma Zaidi. "Under Water Human Body Detection "International Journal of Electronics Engineering (ISSN: 0973-7383), www.csjournals.com, Volume 11 Issue 1 pp. 532-539 Jan 2019-June 2019 .

[8] Vani H, Lalitha V G, Pamulapati Supriya, Payyavula Rachana Priya, Nandini P. "Floating Objects Collection Using Robotic Arm" International Research Journal of Engineering and Technology (IRJET) www.irjet.net p-ISSN: 2395-0 e-ISSN: 2395-0056 Volume: 07 Issue: 08 -Aug -2020.

[9] Dr. T.C. Manjunath, Pavithra G., Arunkumar K., "Matrix partitioning concept developed for a mechanical system", TEQUIP-Phase II CSI-IEI Sponsored Int. Conf. on Recent Trends & Research Issues in Computer Science & Engg. (ICRTRICSE-2K15), Paper id AIR-001, Dept. of Comp. Sci. &

Engg., A.U. College of Engg. (Auto), Andhra Univ., Technical Session-9 (Parallel) (DPP& AIR), Day-2, Visakhapatnam, Andhra Pradesh-530003, India, 2-3 May 2015.

[10] Dr. T.C. Manjunath, Subiya Yaseen, Pavithra G., "A review on evolution in Telecommunication Infrastructure in the modern-day world", Int. Conf. on Advances in App. Engg. & Tech. (ICAAET-15), Sl. No. 38, Paper id 241, Syed Ammal Engg. College, Ramanathapuram, Tamil Nadu, India, Session : Signal Processing, Day-2, Date & Session: 15.05.2015 FN, Venue: Main Block First Floor Signal Processing Lab, 14-16 May 2015.

[11] Dr. T.C.Manjunath, Arunkumar G., Pavithra G., "Dynamic model development for a compliance machine", Int. Conf. on Info. Sci. & Tech. for Sustainability & Innovation (ICISTSI'15), DOI-10.3850/978-981-09-4426-1_094, Paper id ST-94, Jain Univ., Jain Knowledge Campus, Bangalore, Karnataka, India, Organized by Dept. of CSE & IT of Jain University, ISBN: 978-981-09-4426-1, pp. 309-315, Sl. No. 53, 22-23 May 2015.

[12] Dr. T.C.Manjunath, Arunkumar G., Pavithra G., "Matrix partitioning in kinematic design", Int. Conf. on Info. Sci. & Tech. for Sustainability & Innovation (ICISTSI'15), doi:10.3850/978-981-09-4426-1_095, Paper id ST-95, Jain Univ., Jain Knowledge Campus, Bangalore, Karnataka, India, Organized by Dept. of CSE & IT of Jain University, ISBN: 978-981-09-4426-1, pp. 314-317 (e-proceedings), Sl. No. 54, 22-23 May 2015.

[13] Dr. T.C.Manjunath, Arunkumar G., Pavithra G., "Design of an obstacle collision free path in 2D space", Int. Conf. on Info. Sci. & Tech. for Sustainability & Innovation (ICISTSI'15), doi:10.3850/978-981-09-4426-1_096, Paper id ST-96, Jain Univ., Jain Knowledge Campus, Bangalore, Karnataka, India, Organized by Dept. of CSE & IT of Jain University, ISBN: 978-981-09-4426-1, pp. 318-321 (e-proceedings), Sl. No. 55, 22-23 May 2015.

[14] Dr. T.C.Manjunath, Arunkumar G., Pavithra G., "Normalization concept development in IP", Int. Conf. on Info. Sci. & Tech. for Sustainability & Innovation (ICISTSI'15), doi:10.3850/978-981-09-4426-1_097, Paper id ST-97, Jain Univ., Jain Knowledge Campus, Bangalore, Karnataka, India, Organized by Dept. of CSE & IT of Jain University, ISBN: 978-981-09-4426-1, pp. 321-325, (e-proceedings), Sl. No. 56, 22-23 May 2015.

[15] Dr. T.C.Manjunath, Pavithra G., "Role of Uncertainty in Robot Task Planning", Proc. 2nd Int. Conf. on Networks, Information & Communication (ICNIC-2015), organized by Dept. of ECE of Sri Venkateshwara College of Engg. (SVCE), Bangalore, Karnataka, India, 18-20 May 2015.

[16] Rahimunnisa Nagma, Pavithra G., Dr. T.C.Manjunath, "Traffic aware video coding using scalable video coding (SVC)", Second Int. Conf. on Recent Trends in Signal Processing, Image Processing & VLSI (ICrtSIV-2015), Organized by ECE Dept. of DBIT & Research Publishing Services, Don Bosco Inst. of Tech., Kumbalgodu, Bangalore, Karnataka, Paper id IP-49, 15-16 May 2015.