1) Project Reference Number: 46S_BE_0978

2) Title of the Project: DEVELOPMENT OF AN UNMANNED SURFACE RESCUE VEHICLE: AN I.M.S (INDIGENOUS MARINE SAVIOUR) AS A LIFE SAVING DEVICE FOR SEARCH AND RESCUE

3) Name of the College & Department: REVA University

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4)Name of the Students and Guide:

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5)Keywords:

Deep learning techniques, object detection, image processing GPS, manipulator, Pi camera, V380 Pro camera, Blynk, remote operation, unmanned surface vehicle (USV), an indigenous marine savior (IMS), Raspberry Pi 3B+, pi camera, servo motors, surveillance, guidance, seek, support, victims, lifeguards and military

6) Introduction:

The Indigenous Marine Savior (IMS) prototype is a groundbreaking solution for aquatic rescue missions and border protection. It incorporates an unmanned surface vehicle (USV) with three key modules—Seek and Support, Surveillance and Guidance, and Remote Operation—the IMS USV offers great potential in crisis situations. Equipped with deep learning techniques and GPS capabilities, the IMS USV can accurately detect and locate distressed individuals, providing vital coordinates for rescue teams. The integration of the V380 Pro camera enables real-time surveillance and guidance, ensuring the safety of both victims and rescuers. Additionally, the IMS USV's differential thrust approach grants exceptional maneuverability even in hazardous conditions. Its capabilities extend beyond rescue missions to border protection efforts, assisting individuals near borders and monitoring suspicious activities. With long-range communication using LoRa technology and remote operation capabilities, operators can access Blynk and V380 Pro applications seamlessly this integration facilitates aiding decision-making processes. Moreover, the IMS USV features a manipulator powered by servo motors, enabling smart aid delivery with precision. This versatile tool significantly reduces response times, enhances aid delivery, and increases situational awareness for lifeguards, rescue teams, and border patrols. The potential impact of the IMS USV in saving lives and protecting borders is immense.

7)Objectives:

- Develop an unmanned surface vehicle (USV) with specialized modules for search and rescue operations in aquatic environments.
- Create an efficient object detection system using computer vision and deep learning techniques to locate humans in aquatic environments.
- Implement a smart aid delivery system with servo motors to provide life jackets, medical kits, and other aid to distressed individuals.

- Establish a live video surveillance system using the V380 Pro camera to monitor and guide victims in real-time without endangering rescuers.
- Enable long-range control of the USV using LoRa technology for remote operation and communication.
- Design a cost-effective USV prototype capable of transporting aid and potentially saving lives.
- Deploy the IMS USV for lifeguard and military rescue missions, ensuring efficient aid delivery and minimal time delays.
- Utilize the IMS USV in disaster response scenarios for quick victim location and precise coordinate provision to rescue teams.
- Employ the IMS USV in border protection efforts, locating and providing aid to individuals in aquatic environments near borders, while monitoring the border.

8)Methodology:

The system employs three modules to achieve this, namely Seek and Support, Surveillance and Guidance, and Remote Operation.

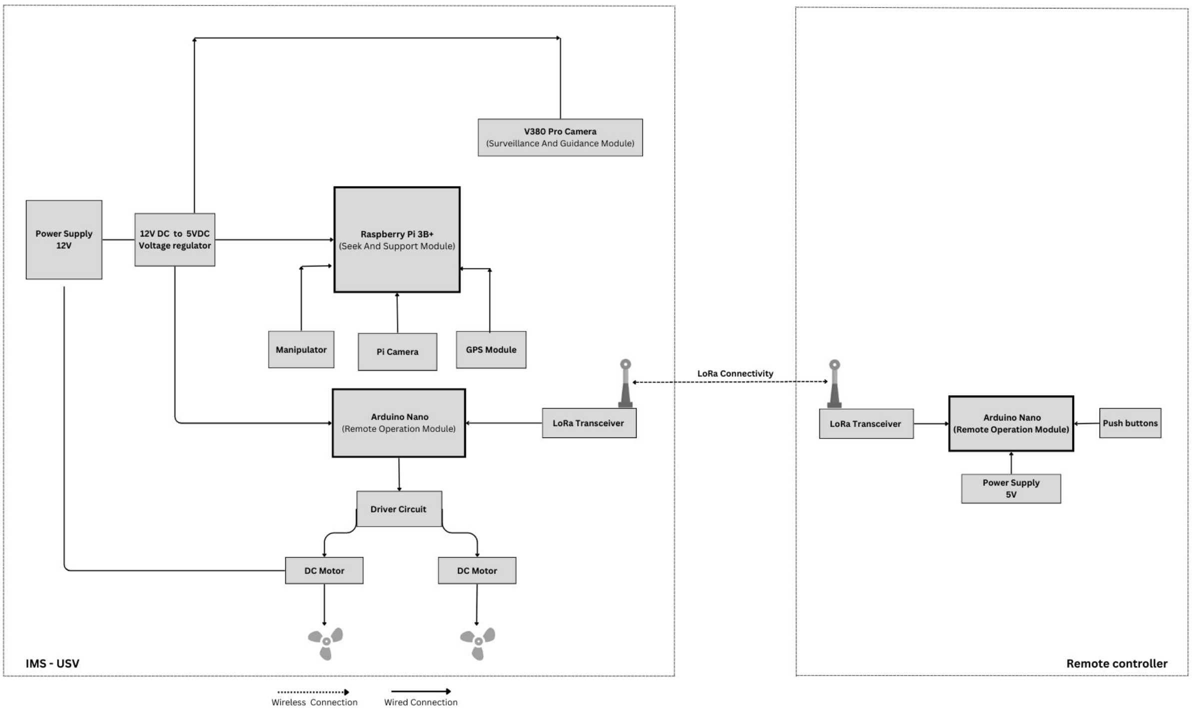

Fig. 1. Block diagram of the proposed system

Seek and Support module:

The seek and support module incorporates computer vision, deep learning techniques, and image processing to develop an object detection system. This system is integrated with a manipulator and GPS for smart aid delivery. The manipulator, powered by servo motors, performs functions such as picking up, turning, and dropping objects. The object detection system, with an accuracy of 0.9364, utilizes Raspberry Pi 3B+, a Pi camera, OpenCV, Darknet framework, and YOLOv3 algorithm trained on the COCO dataset to detect humans in a video stream. When humans are identified, the system transmits precise coordinates using a GPS module, and the manipulator delivers aid. Blynk, a smartphone application, reflects the USV's GPS location on Google Maps and shows person detected as shown in the flowchart fig. 2. This system efficiently identifies victims in need and provides them with necessary assistance.

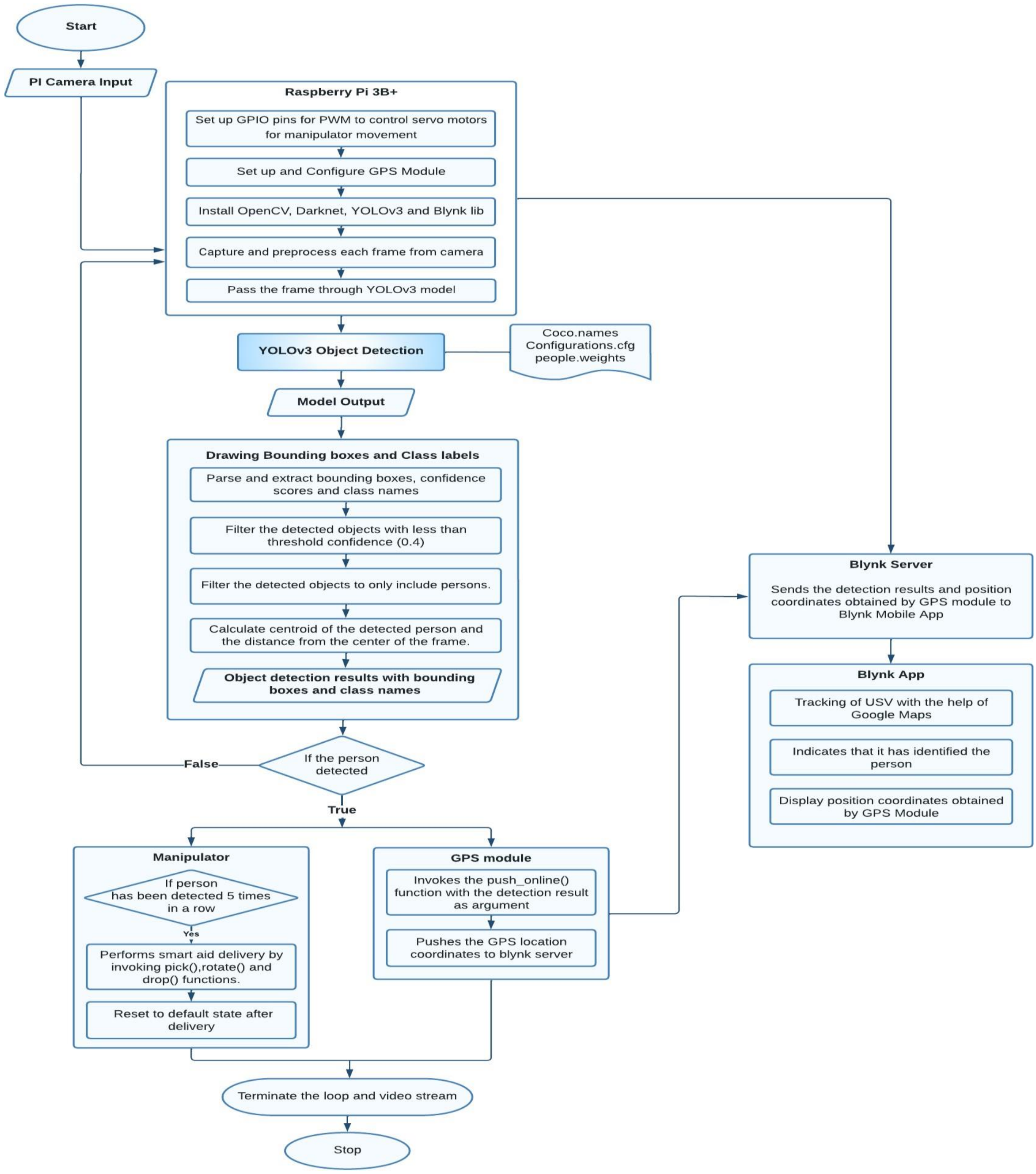

Fig. 2. Flow chart of the seek and support module

Surveillance and Guidance module:

The surveillance and guidance module utilizes the V380 Pro camera for 360-degree monitoring, day and night. It enables live video streaming, recording, and two-way audio communication through the V380 mobile app. This module ensures real-time surveillance and guidance for distressed individuals.

Remote Operation module:

The remote operation module is built for long-range operation utilizing LoRa technology, and a remote controller to run the USV using two SX1278 LoRa Module Ra- 02 where one is integrated in remote controller and another in IMS USV. The LoRa transceiver is linked to the Arduino nano, the heart of the remote controller, and is incorporated with push buttons to communicate over long distances. For USV maneuverability, the remote controller comprises four pushbuttons for start, stop, left, and right movements. Coming to the remote operation module in the USV, having LoRa transceiver that is connected to an Arduino nano that receives commands from the remote controller and tends to assist the L298 2A Dual Motor Driver Module, which is also connected to an Arduino nano and is used to control the propellers using two DC motors for propulsion based on commands provided from pushbuttons of the remote controller. The remote operation module in IMS USV and remote controller provides maneuverability and control over the USV. The USV uses a differential thrust approach for movement control from long range. To move forward, both the left and right propellers are run at their maximum RPM. To turn left, the left propeller is run in the opposite rotation to the right propeller, and vice versa for turning right. The parallel connection of the propellers ensures that the thrust generated is directed towards the desired direction of movement, allowing precise control of the USV's movement

Mechanical Design:

The mechanical design of the IMS USV is based on the concept of a lifebuoy with propellers constructed with 4mm PVC pipes to create a lightweight and floatable body. Its dimensions are 1371mm x 813mm x 381mm (54in x 32in x 15in), with a V380 Pro camera positioned 762mm (30in) above the water level. The PVC tub housing protects the internal modules from water damage, while parallel propellers enable a differential thrust approach for movement control from long range. To move forward, both the left and right propellers are run at their maximum RPM. To turn left, the left propeller is run in the opposite rotation to the right propeller, and vice versa for turning right. The parallel connection of the propellers ensures that the thrust generated is directed towards the desired direction of movement, allowing precise control of the USV's movementy. Operating at 3000 RPM, the IMS USV can carry and drag loads up to 8-10kg. This design achieves the project's goals and provides a foundation for future enhancements.

9) Results and Conclusions:

Results:

Prototype system tested in intended environment close to expected performance. The measured main parameters are as follows:

- Speed with the payload: approximately 2m/s
- Endurance (at a speed of 2m/s): 30 minutes
- Effective communication range: approximately 2km.

Fig. 3. Proposed sytem result

The seek and support module incorporates computer vision and deep learning techniques to detect humans using a Raspberry Pi 3B+, Pi camera, OpenCV, Darknet framework, and YOLOv3 algorithm. It achieves an accuracy of 0.9364 and uses a manipulator with servo motors and GPS for smart aid delivery. The surveillance and guidance module utilizes the V380 Pro camera for 360-degree monitoring and real-time communication. The remote operation module utilizes LoRa technology and a remote controller with push buttons for long-range control of the USV. The USV's mechanical design is based on a lightweight and floatable lifebuoy concept, featuring PVC pipes and parallel propellers for precise movement control. The IMS USV can carry loads up to 8-10kg and provides a foundation for future improvements.

Conclusions:

The Indigenous Marine Savior (IMS) prototype utilizes unmanned surface vehicles (USVs) to provide cost-effective disaster response and border protection. Equipped with various modules, such as seek and support, surveillance and guidance, and remote operation, the IMS USV can locate and aid distressed individuals using autonomous delivery. It offers real-time monitoring and guidance without endangering rescue teams. The IMS USV's movement control and communication capabilities enable precise maneuverability in challenging conditions. It can also assist in border protection by locating and aiding individuals near borders and providing situational awareness to border patrols. The remote operation module allows control in sensitive regions. The IMS USV has the potential to save lives and reduce fatalities in NDRF rescue missions and border protection efforts. Ongoing USV technology development can further enhance and adapt the IMS prototype for various marine applications, making it a promising solution for future challenges

10) Scope for future work:

Although the USV prototype is well designed, There is still room for improvement. Since the IMS USV has a good features, a lot of new features can be added. The future improvement of the IMS USV includes:

- Development of a PE plastic version of the product with an enhanced aesthetic outlook.
- Upgrade the propulsion system to water jet thruster to improve the speed and maneuverability of the vehicle.
- Incorporation of a rechargeable battery with solar energy to increase the vehicle's battery performance and Reduce its environmental impact.
- Improvement of the vehicle's IMS capability to carry an average person in a danger zone to a safer location.
- Upgrade of the wireless communication system to enhance the vehicle's communication.
- Development of a user-friendly software interface and remote controller to operate the IMS USV.
- Enhancement of the manipulator's functionalities
- Enhancing detection system based customized data sets and voice detection with deep learning.
- Incorporation of surveillance technology to gather better knowledge about underwater environments.