International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST52310361

A Novel Approach Towards Development of Automated Intelligent Lifesaving Buoy

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ARTICLEINFO

Article History:

Accepted: 05 May 2023
Published: 22 May 2023

Publication Issue
Volume 10, Issue 3
May-June-2023

Page Number
320-329

ABSTRACT

The main goal of this integrated application is to design an intelligently controlled and automated lifebuoy that can detect living people and save them from drowning. The article gives an overview of the development of a battery-powered remote-control boat for various applications. The Lifebuoy is a revolutionary upgrade of an invention created 300 years ago, including a remote control, thrusters, and a battery that can be sent to someone in the water in need. It's a clever lifesaver that gives these lifebuoys a U-shape to give a person who is drowning or injured and unable to swim a good grip to keep and stay in the U-shaped area of the buoy remain.

The U-shaped lifebuoy can be moved through the water by remote control, allowing it to reach the victim quickly and bring them to safety if necessary. The U-shaped remote-controlled buoy can work in adverse conditions thanks to its navigation and guidance systems. The remote-controlled submarine buoy is a quick and effective way to save lives. Once it reaches the victim, the U-shaped buoy has enough power to carry it to safety, which can be very useful on large ships that would otherwise have to launch lifeboats. It also allows those on board to start the device without having to turn around, saving time at the beginning of a rescue operation. The waves can't stand up to the U-shaped buoy that you'll see racing by to reach your destination.

Water is a dangerous place, and despite the fact that a remote-controlled U-shaped buoy is a lifesaver, people are easy to reach. Object tracking is an important task in many image-processing applications. Optical flow is one of the most widely used image processing and video analysis techniques. This article implements an object-tracking algorithm based on the optical flow method for computation on a Raspberry Pi microcomputer. The Lucas-Kanade method was used to compute the velocity vector of an object moving between two consecutive frames.

This paper represents a face recognition mechanism carried out as part of the developing an intelligent lifebuoy. It utilises the technologies available

in the Open Computer Vision (OpenCV) library and the methodology for their implementation with Python. Haar Cascades was used for face detection, and eigenfaces, fisherfaces, and local binary pattern histograms were used for face recognition. An experiment was performed to evaluate the robustness of the proposed algorithm against the new computing device. The results were encouraging for the use of the proposed real-time application in a variety of contexts.

Keywords-- Man Over Board (MOB), Electronic Drive Control (EDC), Machine Vision(MV), Brushless DC Motor (BLDC)

I. INTRODUCTION

A lifebuoy, ring buoy, life-ring, buoy, life-saver, life-donut, or preserver, also known as a "Kirby ring" or "perry buoy", possibly a lifeboat designed to be thrown at a person in the water to become to provide buoyancy and arrest by drowning. Some modern lifebuoys are fitted with one or more seawater-activated lights to aid in rescue efforts in the dark. The lifebuoy is usually in the form of a ring or horseshoe and has a line to pull the victim towards the rescuer while sailing.

They are transported by boats and are found near the water column where there is depth or the possibility of drowning. They are often victims of vandalism, which can kill them because they don't have lifebelts. The submarine buoy can rescue adults and children and can be used in harsh environments. The U-buoy operator should be able to see the man-overboard (MOB) signal, but the speed of the device means he still needs to be close enough to see the signal, assuming he notices it incident immediately.

Video tracking is an important task in computer vision. This is a critical step in many civilian and military applications. Many tracking algorithms have been well-studied and implemented in different environments over the past decades. Optical flow is the distribution of apparent velocities associated with apparent motion in time-varying images [2]. Many methods support optical flow calculations. It can be divided into global and local methods.

Global methods such as the Horn/Schunk method provide dense flow fields, while local methods such as the Lucas-Kanade method are more robust to noise [10]. The Lucas-Kanade method was based on a logarithmic calculation of the optical flow around a pixel [3]. Therefore, the Lucas-Kanade method is preferred in single object tracking applications. In general, object tracking is a very difficult task with many challenges to solve. The loss of information when projecting a 3D world into a 2D image is the main cause of these problems. It also takes good care of messy backgrounds, image noise, partial or full apertures, lighting changes, and real-time processing needs. Known difficulties [1-3].

Various types of limitations are considered in applications such as remote surveillance, troop tracking, and terrorist tracking that can be achieved with unmanned aerial systems (UAS). Minimum weight and dimensions, low power consumption, acceptable cost, and real-time processing capabilities are the main requirements. The Raspberry Pi microcomputer is among the promising embedded systems that can meet most needs with acceptable results.

II. RELATED WORK

a) Principle Concept

The principle concept used is Archimedes' principle. This principle states that a body partially or fully immersed in a liquid experiences an upward force known as buoyancy. The magnitude of this buoyant force must be equal to the weight of the liquid whose volume is equal to the volume of the solid fully or partially immersed in the liquid. As a result, the body does not sink or rise completely above the liquid level.

Image classification assigns a class designation to an image, while object localization draws a boundary around one or more objects in the image. Object detection is more difficult and combines these two tasks and draws a bounding box around each object of interest in the image and assigns it a class label. Collectively, all of these problems are known as object detection.

Object recognition refers to a set of related activities for identifying objects in digital photographs.

What is object recognition?

- Object recognition is a generic term for several related computer vision tasks that involve identifying objects in digital photographs.
- Image classification is based on predicting the class of an object in the image. Object tracking involves determining the position of one or more objects in an image and drawing a generous rectangle around their extent. Object detection combines these two tasks and locates and classifies one or more objects in an image.

Thus, we can distinguish these three computer vision tasks:

Image Classification: Predicting the type or class of an object in an image.

Input: An image with a single object, e.g. B. a photo.

Output: class labels (e.g. one or more integers associated with class labels).

Locate Objects: Locate the presence of objects in an image and identify their position using bounding boxes.

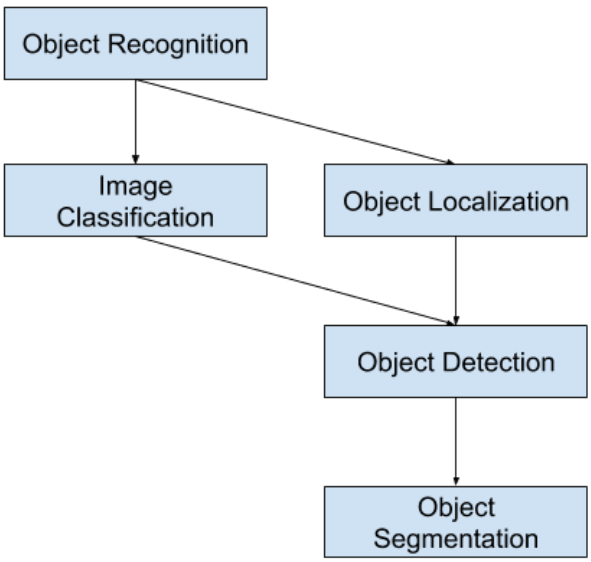
Input: An image containing one or more objects, e.g. a photo.

Output: One or more bounding boxes (e.g. defined by point, width, and height).

Object Detection: Detects the presence of objects based on the bounding box and the types or classes of objects present in the image. defined by point, width, and height) and a class label for each bounding box.

A further extension of this division of computer vision tasks is object segmentation, also called "object instance segmentation" or "semantic segmentation", in which recognized object instances are displayed by highlighting specific pixels of the object instead of a rough bounding box.

In this list, you can see that object recognition relates to several difficult computer vision tasks.



Overview of Object Recognition Computer Vision Tasks

III.SYSTEM DESIGN

Tracking Algorithm Environment The proposed tracking algorithm is programmed on a Raspberry Pi microcomputer using Python and OpenCV to take advantage of each of their components. It implements an object-tracking module for use in various unmanned systems, especially drones. Other Python

libraries like Numpy are also used due to their importance.

A. **Raspberry Pi Hardware** The Raspberry Pi is a small, inexpensive computer the size of a credit card [8]. It is essentially a system on a chip (SoC) with connection ports. It has a 32-bit ARM processor with processing speeds of 700 to 1000 MHz and a Videocore 4 graphics processor. The Raspberry Pi Model B has 512 MB of SDRAM, two USB ports, and can be connected to an Ethernet network. network [8]. It supports modern technologies like OpenGL ES2 and hardware-accelerated audio/video processing. These properties make Raspberry Pi a unique platform for computer vision applications. The Raspberry Pi processor runs at 700MHz by default. But you can easily overclock it in all speed modes [8] by increasing the frequency.

B. **Raspbian Operating System** Although the Raspberry Pi can use various types of Linux distributions for its default operating system "OS", Raspbian is recommended. It is a free Debian-based operating system optimized for Raspberry Pi hardware. Holds over 35,000 packages; precompiled software in a good format for easy installation on Raspberry Pi hardware, [9].

C. **Python and OpenCV** It can be programmed in Python or any other language compiled for ARM v6, [10]. Python is a powerful and widely used general-purpose programming language. Its design philosophy emphasizes code readability, and its syntax allows you to express ideas in fewer lines of code than is possible in languages like C++ or Java. Python supports many programming paradigms, including object-oriented, imperative, and functional programming, as well as procedural styles. It offers all the services needed for programming, from basic operations to advanced features. It integrates with many third-party tools to make anything possible in Python [11].

In the field of image processing and computer vision, OpenCV, PIL, and Numpy are popular built-in Python libraries. OpenCV is an open-source library that contains a large number of computer vision algorithms. In general, Python is slower than other languages like C/C++. But it can easily be extended with C/C++ by writing computationally intensive code in C/C++ and creating a Python wrapper around it. Then use these wrappers as Python modules. This has two advantages: first, the code is as fast as the original C/C++ code (because it's real C/C++ code running in the background), and second, it's very easy to write in Python. This is the way that OpenCV Python works i.e. a Python wrapper around the original C/C++ implementation, [12]. Numpy is a basic scientific computing package in Python. It is very important to use Numpy due to the minimal computation time requirements. It is used to speed up linear algebraic calculations.

Drowning victims, especially adults, are often dangerous: Panicking drowning victims will instinctively grab anything to get back up, essentially pinning the rescuer down. We named this device “Intelligent lifebuoy".

The Intelligent lifebuoy hopes to avoid keeping lifeguards out of the water. Saving many lives in the sea or ocean without endangering the life of the rescuer was a great challenge met with this revolutionary lifebuoy. It is a unique and exclusive detector and equipment; a unique product created by our team and was developed with the ambition to save many lives in India and maybe the world. Submarine buoys often carry victims to safety or act as a floating devices until further help arrives. The Intelligent lifebuoy combines robust construction with lightweight materials to withstand even the harshest weather conditions. The Intelligent lifebuoy can reach top speeds of up to 10 m/s and run for up to 25 minutes.

The Intelligent lifebuoy is self-propelled rescue device that reaches victims quickly without

endangering rescuers and can be added at any location on the water.

1. The Intelligent lifebuoy contains 1 MV Camera, 1 battery, 2 fly wheels, 2 motors, 1 Electronic Drive Controller (EDC)
2. Once victim is drowning, the intelligent lifebuoy once placed in the water, automatically drives towards the victim tracking the image of the drowning person.
3. This EDU circuit requires 12V power supplied by LiPo batteries which can run for up to 25 minutes.
4. The LiPo battery used supplied the motors with additional electrical energy via an Electronic Drive Controller (EDC).
5. EDC is the component used to make the connection between the power source and the motor in the boat propulsion system.
6. When the circuit is activated, the energy supplied by the battery is transferred through the EDC to the BLDC motors.

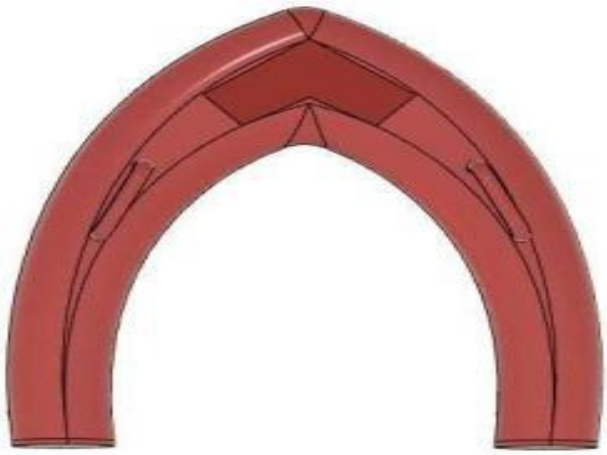
Types of Buoy:

1. Ring Buoy:

Lifebuoy & buoyant 30mtr floating line; This tough lifebuoy set features a 2.5kg or 30" diameter Lifebuoy with a 30M floating line SOLAS/MCA approved

2. U-Shaped Buoy:

Outer diameter - 520 mm, Thickness – 100 mm, Inner diameter–250mm



3. Intelligent Lifebuoy:

This device is designed to save people from drowning in water without endangering the life of the rescuers. The likelihood of rescuing a person from drowning increases with the time it takes for the rescue team to reach the person. The adoption of autonomous devices and robots is constantly increasing in different fields, which is why this project focuses on rescue operations. In rescue operations, there are certain limits within which a lifebuoy may be thrown. To eliminate restrictions, this intelligent lifebuoy is made.

Thanks to image processing, they eliminated some problems, such as the range and the speed at which the rescue operation is carried out. This device uses a component such as a plastic electric battery chassis to provide electric charge to the EDC or drive motor.

IV.SYSTEM IMPLEMENTATION

System architecture

1. The Intelligent Lifebuoy contains the following:
   (i) 1 MV Camera
   (ii) 1 battery
   (iii) 2 flywheels
   (iv) 2 motors

(v) 1 Electronic Drive Controller (EDC)

Figure 1 Proposed design of lifebuoy

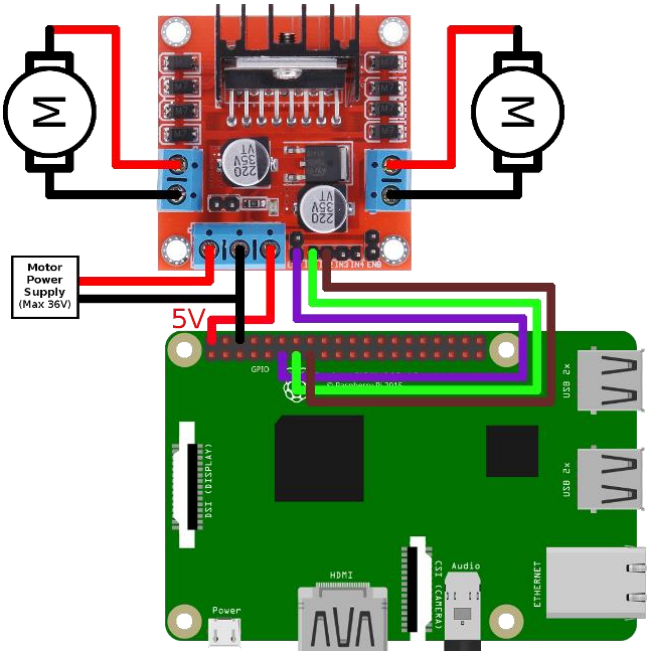


Figure 2 Proposed system architecture

2. Once tossed into the water, the Intelligent lifebuoy automatically tracks the image of the drowning person.
3. Image is processed for the positional information in the EDU and drive the motors for operation of the flywheels towards the victim.
4. The motors requires the power of 12 volts at 1.3amp which is supplied by the LiPo batteries of which can work up to 25mins.
5. A LiPo battery is used to provide electric power to motors also with the use of an electronic drive controller (EDC).
6. The EDC is a component that is used to provide a link between the power source and the motor within the power train of a remote-control boat.
7. When the circuit is ON the power supplied by the battery is transmitted through EDC to the BLDC motors which rotates as per the voltages supplied to the motors.

Algorithm

Haar Cascade Algorithm

Exploring a slightly older algorithm that proves challenging even in the age of deep learning. This project is about using Viola-Jones' facial recognition technique, known as Haar Falls, and exploring some of the interesting concepts it offers. This work was done well before the dawn of the deep learning era. But compared to the powerful models that can be built using modern deep learning techniques, it's a great job. The algorithm is still used almost everywhere. Fully trained models are available on GitHub. It's fast. It's pretty accurate.

The process of detecting and locating a face from a single image or a series of images and identifying the face is called face recognition. As humans, we are very good at recognizing and recognizing faces. However, computers have difficulty recognizing and recognizing faces. Face recognition has a variety of applications including CCTV systems, security, access control, law enforcement, general identity verification, gender detection, missing person identification, etc. In the implementation of these applications, face recognition takes precedence over detection. Face recognition can be divided into two

categories namely face verification and face recognition. Face verification is a process that can identify whether a pair of photos belong to the same person or not.

Face ID, on the other hand, means tagging the target face using the training set or database. Face recognition can be performed using the following methods:

1) Holistic matching method
2) Structural method
3) Hybrid method

In a holistic approach (e.g. Eigenfaces, PCA [4] [5] or linear discriminant analysis [6]), the entire face image is considered for face recognition. While structural methods take into account the basic features like nose, mouth, eyes and their location and native statistics for the purpose of detection. Hybrid methods use a combination of holistic and structural methods. Using the face recognition system, the input facial image is compared to previously recorded facial images stored in the system's training database.

The Haar wavelet is a mathematical fiction that produces square waves with a beginning and an end and is used to generate box-like patterns to detect signals with abrupt transformations. An example is shown in Figure 1. By combining multiple wavelets, you can create a waterfall that can identify edges, lines, and circles with different intensities of color. These sets are used in Viola Jones' face recognition technique in 2001 and since then other models [10] for object recognition have been introduced, as represented in Figure 1.

To analyze an image based on the Haar Cascades, a smaller scale than the target image is selected. It is then superimposed over the image and the pixel values in each section are averaged. If the difference between the two values exceeds a certain threshold, this is considered a match. Facial recognition of a human face is done by matching a combination of different hair-like features. For example, the forehead, eyebrows and eyes contrast with the eyes, as does the nose, as shown in the image below. A single classifier is not accurate enough. Multiple classifiers combine to provide the accurate facial recognition system, as shown in the block diagram in Figure 3 below. The architecture of the model is summarized in the following image

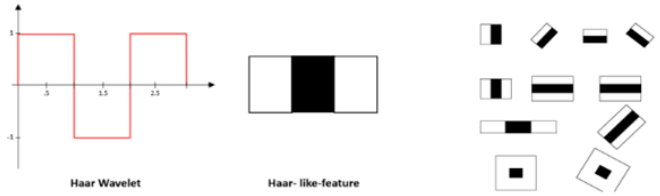


Figure 3: A Haar wavelet and resulting Haar-like features.

Features of Haar Cascade

The first contribution to the research was the introduction of the haar features. These features on the figure 2 makes it easy to find out the edges or the lines in the image, or to pick areas where there is a sudden change in the intensities of the pixels.

In this project uses a similar method to identify faces and eyes in combination, resulting in better face recognition. Similarly, in the Viola-Jones method [7], several classes were combined to create more powerful classifiers.

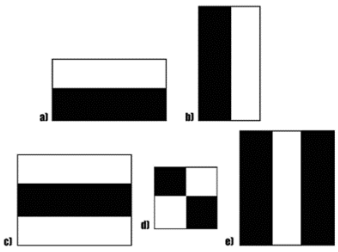


Figure 4. A sample of Haar features

The haar feature continuously traverses from the top left of the image to the bottom right to search for the particular feature. This is just a representation of the whole concept of the haar feature traversal. In its actual work, the haar feature would traverse pixel by pixel in the image. Also all possible sizes of the haar features will be applied.

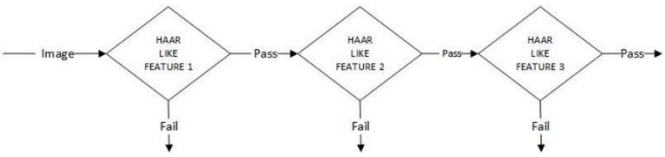


Figure 5: Haar-cascade flow chart

ADA Boost is a machine learning algorithm that tests week-long classifiers in a selected location and chooses the most appropriate one [7]. It can also reverse the direction of the classifier and get better results if needed [7]. Also, the weight update steps can be updated only on errors for better performance. The cascade is scaled by and iterated to find faces of different sizes. Running a cascade on an image using traditional loops requires a lot of computing power and time. Viola Jones [7] used a cumulative area table (integral image) to quickly calculate the matches. It was first developed in 1984 [11] and became popular after 2001 when Viola Jones implemented Haar Cascade for face recognition. By using an integral image, you can adjust features in a single pass through the image.

The model is much faster to train and predict but still requires that a set of candidate regions be presented with each input image.

Local Binary Pattern Histogram

Local binary models were proposed by Li Wang [4] as classifiers in computer vision. The combination of LBP with histogram-oriented gradients was introduced in 2009, which improved performance in some datasets [5]. With feature coding, the image is divided into cells (4 x 4 pixels). When used clockwise or counterclockwise, the surrounding pixel values are compared to those of the center, as shown in Figure 6.

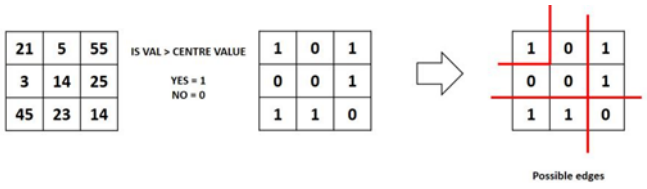


Figure 6: Local binary pattern histogram generating 8-bit number

Each neighbor's intensity or brightness value is compared to the central pixel. Depending on whether the difference is greater or less than 0, the position is assigned a value of 1 or 0. The result gives the cell an 8-bit value. The advantage of this technique is that even if the brightness of the image is changed as in figure 7, the result is the same as before. Histograms are used in larger cells to find the frequency of values, speeding up the process.

By analyzing the results in a cell, you can see edges when the value changes. By calculating the values of all cells and combining the histograms, we get the feature vectors. You can classify images by processing them with an attachment ID. The input images are classified using the same method and compared to the data set, resulting in a distance. By setting the threshold, you can tell if it's a known or unfamiliar face. Eigenface and Fisherface calculate the dominant features of the entire formation, while LBPH analyzes them individually.

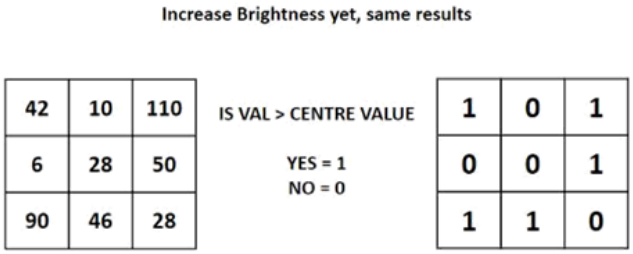


Figure 7: The results are same even if brightness is changed

Cascade Classifier

Face recognition plays an important role in the face recognition process. Face and eye detection using Haar-based cascade classifiers and Haar cascade object detection can be done using the cv::CascadeClassifier class to detect objects in the video stream and cv::CascadeClassifier::load to load the classifier's .xml file.

This can be a Haar or LBP classifier and cv::CascadeClassifier::detectMultiScale for detection.

Object detection using Haar feature-based cascade classifiers is an efficient method for object detection proposed by Paul Viola and Michael Jones in their 2001 paper. Rapid Object Detection using a Boosted Cascade of Simple Features. It is a machine learning approach in which a cascade function is formed from various positive and negative images. It is then used to detect objects in other images.

The main principle of the design is to use the OpenMv camera to identify the drowning person and

send the collected position information of the person to the EDC. The collected positional information from the MV camera is trained through deep learning techniques and EDU sends the appropriate information to the Motor driver to drive the motor based on the instructions from the EDU.

If the drowning person is on the left or right side of the lifebuoy, it controls the differential rotation of the motor behind the lifebuoy so that the lifebuoy is facing the drowning person. If the drowning person is directly in front of the lifebuoy, the EDU controls the motor drive module to control the rotation of the motor behind the lifebuoy to make the lifebuoy gradually approach the drowning person, which can save life. The Motor driver controls the DC motors attached with each of the wheels placed on the either side of the craft for the rotational and lateral movement of the watercraft.

V. CONCLUSION

They can reach places that can be hard for the lifeguard to reach bare-bodied. This makes it possible for the distressed, but conscious victim to be rescued without even the guard reaching for them in person. They offer a simple time to form a rescue even when the lifeguard is at a great distance far away from the victim. This is due to the throw line which comes with the buoy. Most of the rings come with or the lines can also be bought separately to accessorize a buoy making it more effective in rescue missions. This can be vital since the safety of the victim is assured before the guard can get to them.

They come in different sizes, making it possible for the lifeguards to choose the best for rescuing both children and adults. With the road well attached, they create the duties of a lifeguard are easier since they only got to be thrown to the victim and pulled to safety once the victim holds on thereto securely. They are designed to save time in tricky, but dangerous situations.

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Cite this Article

YM Kalyan, Dr. Saniya Ansari, "A Novel Approach Towards Development of Automated Intelligent Lifesaving Buoy", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 3, pp. 320-329, May-June 2023. Available at doi : https://doi.org/10.32628/IJSRST52310361
Journal URL : https://ijsrst.com/IJSRST52310361