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An Active Drowning Detection System on Swimming Pool: A Virtual Eye Lifeguard

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ABSTRACT: This project describes the drowning detection system for the prevention of drowning incidents in swimming pools. The problem boundary clearly distinguishes between the positive samples which are inside the boundary to those that are less relevant and outside the boundary. It works like an "extra lifeguard" under the water of swimming pools. For instance, if it happens to someone to drown inside the swimming pool, it makes them take an excess amount of water content which affects the internal organs and sometimes it may be the cause of death. This detection system tracks the movements of everything inside the water bodies and will help to guard the lives by finding them easily. To detect and classify the various drowning stages of victims in swimming pool using YOLO Network based on a deep learning approach.

KEYWORDS: Pre-processing, Feature Extraction, YOLO.

I.INTRODUCTION

According to the World Health Organization (WHO) report, drowning is the third most common reason for unintentional fatalities worldwide for children and young people aged 1–14 years, with children under the age of 5 at highest risk. There are an estimated 236,000 annual drowning deaths around the world [1]. The main causes of drowning during bathing are the loss of consciousness of the swimmer. Therefore, in this study, we try to automatically detect the sensor [2]. Drowning is by far the most devastating from of death till date, as it puts the victim in a confused state of trying to gasp for breath and at same time trying not to allow the passage of water in the nostrils or mouth [3].

II.RELATED WORK

In this paper [1], Maa Shatnawi et.al, the proposal of ground-breaking technique that quickly and automatically detects drowning victims based on deep learning convolutional neural networks (CNNs). In this paper [2], Yoshiaki Endo et.al, Intel Real Sense D415 depth sensor is used. It measures distance by the active stereo method. In this paper [3] Samuel Ndueso John et.al, the design of the drowning alert system works on the principle of heart rate pressure. In this paper [4], Seiji Matsuguma et.al, A bathroom monitoring system with a 79GHZ sensor has been suggested where a K-means clustering method to estimate some state of bathing person against waving in a bathtub and the other interference such as multipath.

Drowning is by far the most devastating form of death till date, as it puts the victim in a confused state of trying to gasp for breath and at same time trying not to allow the passage of water in the nostrils or mouth. According to the International Lifesaving Federation [ILS], 2007, Drowning is defined as the "act of experiencing difficulty in breathing as a result of excess entry of liquid into mouth or nostrils leading to a lightening of the blood in the lungs. The blood then rapidly loses its ability to carry oxygen effectively. This can lead to death [5].

Drowning is one of the most painful and unforeseen cause of death today in the world not only among children but also adults. As swimming pools, bathtubs, seas, lakes, and oceans constitutes the agents of drowning, mortality rates are said to have increased drastically over the years due to these agents. Agents are widely used for leisure, sports and

temperature relief especially during hot climates which possess drowning risks on the groups of individuals who are attracted by it.

Drowning also occurs when the victim had no intention of going into the water. For instance, accidents which results in collapsing into the water body or boats colliding with objects thus bringing about sinking which in turn affects passengers. About 1.2 Million individuals die by drowning every year, indicating that more lives are lost from drowning than from natural disasters annually [6]. Cases which occur among children Identification of a drowning individual still seems to be a challenge even for the experience lifeguards, especially the and amateur swimmers, as there is no specific behaviour which is expressed by all individuals in near -drowning experiences [7]. With technological advancement, wearable devices for reduction of drowning are rapidly emerging. Two systems which are wearable and used for anti-drowning have already have been put in place.

***Sen*TAG** is an anti-drowning system that offers a safety solution for swimming pools which helps to check individual swimmers via a wristband given to the individual, it is used to monitor the individual's depth in water, motion and time. Sensors are mounted on the wall of the pool to check if any swimmer wearing the wristband is approaching the pre-set limits for depth and time. It then evaluates whether the swimmer is spending a lot of time in water under a pre-set depth of field. If so the wristband then sends a wireless alert signal through a radio or by an ultrasonic transmission frequency to a control unit alarm. At this point the alarm which is situated on the wristband begins to sound and then the LED lights comes on, which is used to indicate that the swimmer is to return back to a safe point. If the swimmer fails to respond as demanded, the unit then sends a full emergency alert to the authorized personnel only. This really cuts down the probability of false alarms [8]. The alarm system is a wrist band that triggers an alarm when a swimmer has been motionless under water for twenty seconds.

[9] A headband was used to send an alarm to a receiver in the event that a swimmer stays too long under water. The system did not take into cognizance, the complexities of the near-drowning experience. Video based drowning monitoring systems have been proposed [10], but the technology is very prone to visual and sensor disturbances especially when the pool or water-body is crowded [11]. A lot of other electronic drowning prevention systems like the swimming cap have also been proposed, especially those that make use of physiological features. A lot of users are very selective about the drowning prevention system to adopt [12]. Many swimmers opt for the swimming cap because it is a must in certain public water pools [11]. A drowning person usually panics [7]. This causes an increase in nervous activities and heart beat. To effectively differentiate the near drowning symptoms of increased nervous activity and faster heartbeat from those of the swimming activity itself, people in near-drowning situations tend to struggle vertically in one position for an unusually long time, indicating that there is probable drowning danger [7].

The heart rate can be analyzed by the use of electrocardiography (ECG) or Photo Platysma Gram (PPG) signals. A flexible and small piezo film polymer sensor that can be placed inside a swimming cap and around the location of the superficial temporal artery to measure the heart rate was proposed by [9]. An accelerometer or gyroscope was used to measure perpendicularity [11]. The measurements from the piezo film sensor and gyroscope were used as the basics for triggering a drowning danger alarm. Laboratory experiments carried out on the piezo film

polymer sensor showed that the sensor was susceptible to noise due to motion and electromagnetic interferences [14]. The Weight Factor Mode (WFM) which employs Ensemble Empirical Mode Decomposition (EEMD) was used to solve the noise problem of the piezo film polymer sensor [12], [7]. A system prototype was also presented [11]. In several drowning cases, a white, ample, coriaceous and tenacious fizz displays at the nostrils, mouth and trachea which increases the compression of chest and leads to the squeezing of lungs. The lungs then become voluminous and cover the chest wall and the impressions of the ribs are found. On dissection the lungs, white fizz with blood oozes out with a crackling sound [16] Some drowning detection systems are built around video surveillance. Automated video surveillance systems are an effective means of detecting striking events in real-time [17-20].

These systems consist typically of a computer vision component which detects segments and keeps track of objects in motion underwater and an inference module that interprets the detected motions. The challenges faced by these systems are divided into two-folds; this includes the problems which are related to object detection and tracking (e.g. dealing with the shadows, lighting changes and the effects of moving elements that may appear in the background etc.) and the

interpretation of the objects' motions into a description of detected actions and interactions[21].In general, automated video-based surveillance system is used for real-time human behaviour analysis and helps to provide an effective way of monitoring any unusual activity in any surrounding. Due to the rapid lighting evolvement in the environment, there are high dynamic backgrounds and thus vague visibility of targets is a major difficulty and this continues to be faced by most advanced systems [22]. In yet another study, a camera sensor system was introduced for early detection of drowning incidents, this study presented a camera-centered approach to spot drowning incidents or the potential for one occurring in a swimming pool [23]. The study's motivation was because of a lack of timely efforts to initiate rescue to drowning victims which leaves them at risk to irreversible brain injuries. The study was carried out in order to provide some on the job assistance to lifeguards and therefore improve the safety of public pools with no lifeguards. In another study on the detection of human fall incidents for enhanced safety in indoor environments (like a swimming pool), an intelligent video surveillance system was utilized [24].

The major parts of this system were a vision component for the detection and track movement of individuals who are in the view of the camera and for the analysis of the observation sequence of individuals features. An event inference module is used for possible falling behavioural signs. Thus, the system could be used to robustly detect human falls in real time [24]. Amazingly, some camera-based drowning detection systems have been reported. To identify stationary bodies at the base of pools, this system uses underwater cameras. None of this system involves the detection of physiological or early drowning behavioural signs, such as wrestle on the water surface, which is mandatory for on time rescue and reliable drowning detection. The use of underwater cameras does not only incur high level and protected installation and maintenance cost but also it has the problem the underground cameras have which is being easily obstructed by nearby swimmers. So, the aim is to build a camera-based system which would have the capability of detecting potential cases of drowning at the incubator stage using only off-the-shelf overhead cameras [15]. In another study related to a robotic arm project, a robotic arm was designed to rescue a person automatically from the water. A microcontroller was programmed with the capability of driving basically three stepper motors designed to form an anthropomorphic structure, an essential part of the robotic arm. The study also detailed the way in which the robotic arm is interfaced with the programmed 8051 micro-controller that is used to control its operations [25].

In order to find the exact position of the person drowning, sonar method was employed, it is also a technique used to detect the presence of computer users [26]. This technique already exists on laptop computers and other kinds of electronic devices. It employs the fact that all human bodies have a unique effect on sound waves than on air waves and other objects [26]. A user study was conducted in which 20 volunteers were made to use computers equipped with ultrasonic sonar software. The results then brought to the realization that just after ten seconds of measurement; it is achievable to sense the presence or absence of users with efficient accuracy [26].

A database search from the US patent was used to identify inventions which are aimed at preventing drowning, so as to disseminate the information among various classes of stakeholders. The survey was able to identify inventions that could be broadly classified into: physical barriers (e.g. pool fences, gates, etc.) [27], detection and signalling devices [24], floatation devices [29], later rescue devices [26], devices for emergencies involving water sport events [31], devices for preventing drowning in home sanitary wares (e.g. pools, spas, bathtubs etc.) [32], devices for preventing scuba diving related drowning [29], and other assorted inventions [34]. However, there are many inventions that require the systematic evaluation of the invention's effectiveness in prevention of drowning, especially, the cost-effective devices, which can be affordable for deployment in under developed and developing countries. This should receive particular attention, as these countries endure about 97% of deaths through drowning globally [35] [36] [37] [38]. A system to prevent accidental drowning during bathing using the processing of information acquired by an Intel Real Sense D415 depth sensor. It gives the false positive during drowning.

III.METHODOLOGY

Authentication Process Most of the problem in the detection and monitoring of swimming players are with occlusion, scale changes, changes of appearance. These problems can be overcome using the proposed YOLO model.

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Pre-processing: Pre-processing is an essential step to clear image data before it is ready to be used in a computer vision connected model. Because Pre-processing is an fully layers in convolutional neural networks, a common architecture in computer vision, require that all image are the same size array.

Feature Extraction: Feature extraction helps to reduce the amount of redundant data from the data set**.**

YOLO (You Only Look at Once): Its built-in convolutional layer reduces the high dimensionality of images without losing its information.

Stage1: Head is above the water.

Stage2: Half of the head is under water, and hand gestures are in the climbing ladder motion.

Stage3: Head is underwater, and hand gestures are in the climbing ladder motion.

Casual Swimming: Regular Swimming and floating motions.

Loss Function: It essentially calculates how good the model is making predictions using a given set of values.

The measurements were conducted in the bathroom where the room is of a bathtub without a toilet. The detail specifications are shown in Table I. Fig.6 shows 79GHz band sensor module. The simplified block diagram of sensor is given in Fig.1. That module is housed in an acrylic case for waterproofing. We experimented according to three scenarios are ordinary bathing, and there is supposed that no any risk of accidents. However, it is required not to make a false alarm. Scenario.2 and Scenario.3 are assumed drowning and falling respectively and we need to detect them. We conducted scenario.1 six times and performed clustering using first to third of them. We verified the other fourth to sixth data, scenario.2 and scenario.3 four times each. B. Measurement Results Three subjects (male in their 20s) were measured according to the scenarios. Regarding the state of the subjects, four conditions “without person”, “in the washing place”, “in the bathroom” and “danger” were judged. In addition, “danger” state stands for “static” and “without person”.

The states detection rate shows the ratio of the period in which the 4 states (“bathtub”, “washing place”, “without person” and “danger”) match the true value with respect to the measurement time. The "danger" detection rate is only "danger" states of the states detection. The states estimate accuracy was 87.0%. The detection rate in the “danger” state was 93.4%.

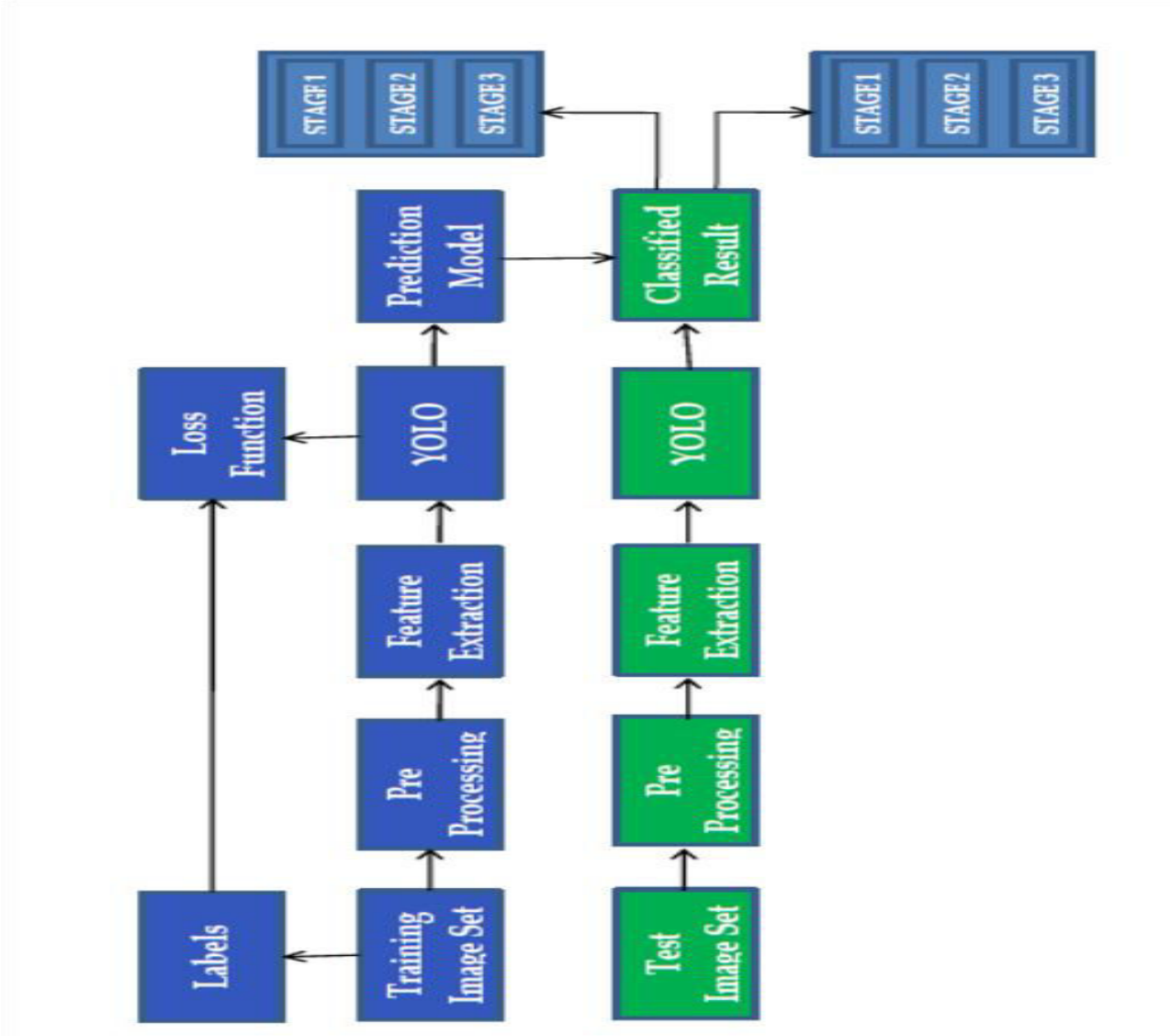

Figure 1: Proposed Block Diagram

IV. RESULT AND CONCLUSION

The approach to this project is to first detect a person, drawing a blue rectangle around them. The program will now store the centre of that rectangle (the person's) position, and compare it to the person's position is more or less the same or they are falling, and this continues for 10 seconds, the blue rectangle will now turn red and the word 'DROWNING' will appear on top of it. If the person´s centre is above water, the word ´DROWNING´ will be removed as they are just standing in the pool. Doing some research, discovered that when someone drowns, they tend to stay in a vertical position to try to keep their head above water level. This could be analysed by seeing the ratio of height to width of the triangle to determine if the person is vertically (drowning) or horizontally (swimming or diving) positioned. After comprehensive research, we came to the conclusion that the duration time of staying at the bottom of the pool beyond

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safety is the most conspicuous situation. Using the swimmer's velocity, depth, and duration to determine if a swimmer is drowning or not is the primary purpose of this paper.

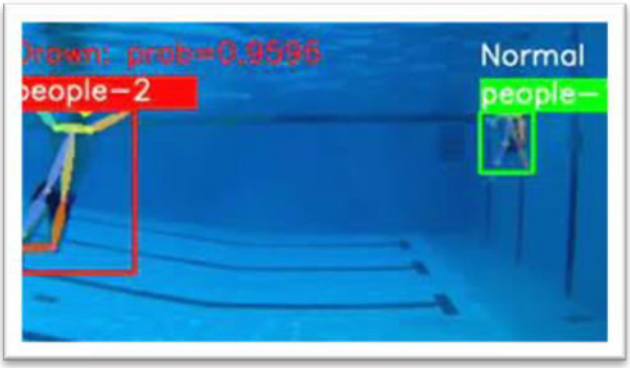

Figure 2: Response of the Drowning Detector

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