VirtualEye - Life Guard for Swimming Pools to Detect Active Drowning

A PROJECT REPORT

SUBMITTED BY

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TABLE OF CONTENTS

Abstract

Every year, many individuals, including kids under the age of 5 drown in the deeps of the swimming pool, and the lifeguards are not well trained enough to handle these situations. Thus arises the requirement for having a system that will consequently detect the drowning individuals and alarm the life guard at such risk. Swimming pool surveillance systems plays an essential role in safeguarding the premises. In this project differential pressure approach is used for detection of drowning incidents in swimming pools at the earliest possible stage. The children's life is saved during drowning incidents in the swimming pool by lifting the acrylic plate. The proposed approach consists of RF module, Pressure Sensor and Motor Driver. The demo system based on pressure sensor has an advantage of convenience, cost saving and simple algorithm

INTRODUCTION

Swimming is a kid's favorite aquatic sport and it's a great stress buster. But in the water, beginners often feel hard to breathe which causes choking actions, loss of balance and results in a drowning accident. Some special circumstances, such as cramps, collide with each other, disease or mental stress and so on may also cause swimmer to drown. Drowning is a leading cause of death and disability for children. Worldwide, drowning produces a higher mortality rate than any other cause of injury in children less than 15 years of age [3]. Younger kids underneath the age of five are at precise threat, suffering the very best drowning mortality rates international. According to the Centers for Disease Control and Prevention, approximately one thousand children
die from drowning annually in the world. In this project drowning accidents is avoided automatically by using the acrylic plate. The earliest swimming alarm system appears in the 1976, then there are some patent applications, but due to various reasons, these techniques are not popular[1]. In 2001, the French Vision IQ company produced the world's first set of drowning alarm system Poseidon; this is the first commercial promotion system. In 2003, Singapore Nan Yang, University of Technology design DEWS.

2. LITERATURE SURVEY

2.1 POSEIDON- Video based drowning detection system in the swimming pool

Swimming pool drowning monitoring system based on video technology is mostly reported in the literature. There are three kinds drowning monitoring system according to the different position of the camera. One is that the camera is mounted on the underwater swimming pool wall, then monitor underwater swimmer status. A limitation of this equipment is that if too many swimmers, the occlusion problem arises. The other is that the camera is mounted upon the water, and monitors the Swimmer posture change. The reflection and refraction of light in air-water interference will affect the image quality, and drowning man feature this method detected is not easy to distinguish swimmers and divers obviously. The third is a combination of the two, underwater camera and aerial camera matched, monitoring the swimmer posture. This system needs constant observation which is the main disadvantage.

2.2 Wearable devices for early monitoring and alarming for drowning incidents

The wearable drowning monitor device can detect drowning accident and alarm. The device has seven main modules, including microprocessor, power module, SD memory card module, LED warning module, acceleration sensor module, water pressure sensor module, and keys module. When swimming the human arm must constantly waving in the water, if drowning, arm motion of floating is significantly reduced, and if falling into the water, almost motionless. According to the physiological response of human drowning, it can detect drowning accident by recording arm motion real-time through wearable wrist accelerometer device. This accelerometer is packed with embedded functions with edible user programmable options, configurable to two interrupt pins. The pressure sensor is installed to judge whether the human body is in the water. The red LED is used for drowning warning. One blue LED is used to get the work status of the device which wills flash every few seconds in order to save the precious energy. Because LED lightemitting angle generally relatively small, 5 red LED lights of upward and around direction is installed to make LED alarm signal caller. Two keys are designed for the demo device.

One is the switch for power. The other is a self-help button. If drowning danger occurs, the swimmer can push the button and the blue LED will shine for help, and if a swimmer accidentally hit the button, he can push the button to cancel the alarm. If the swimmer lost

consciousness because of drowning, the device detects the drowning accident and will ON LED light to inform the lifeguard. The device is worn on the wrist and move in large amplitude along with the wrist when a human is swimming in the water, and the data acquired from accelerator will dramatically change. If a human is drowning in water, his or her wrist almost motionless, and the data acquired from accelerator will have only small changes due to water movement.

The drowning detection method uses threshold. First, data from a water pressure sensor is used to judge whether the human body in the water, if the body in the water, then start drowning judgment process. Then, analog signal obtained from the three axis acceleration sensor is converted to digital signal and three axis acceleration values are gained. Hanning filtering method and the moving average filtering are used to reduce noise error.

3. PROPOSED SYSTEM

The automated drowning detection system works on the principle of differential pressure. The system contains two fundamental modules: to begin with, the wristband consisting of pressure sensors on the transmitter side. Second, the receiver module at the swimming pool site. The children entering the pool territory should wear the wristband. The Pressure at underwater is different and greater than the pressure at the air - water interface. The pressure at a particular depth is measured and set as the threshold. Once the child gets into the pool, the pressure is continuously measured and monitored by the microcontroller. When the current value surpasses the threshold limit an alerting signal is sent to the receiver. The wireless transmission and reception of signals is done through RF module. On receiving the valid signal microcontroller sets the buzzer ON, turns ON the motor driver which in turn lifts the acrylic plate of the multi-floored swimming pool. The kid is brought to air-water interface, i.e. the top level of swimming pool by the acrylic plate.

3.1 Microcontroller

AVR microcontroller (Atmega32) is used here. The AVR microcontrollers depend on the propelled RISC design and comprise of
32 x 8-bit universally useful working registers. It is used to monitor the pressure values continuously. As the value exceeds the threshold limit an alerting signal is sent to receiver indicating drowning accident.

3.2 Pressure Sensor

The pressure sensor is used as an input here. The pressure sensor has 4 pins as shown above in figure. This system consists of a diaphragm with the crystal lattice circuit in it. The more the pressure, the more is the bending of the diaphragm and produces a corresponding voltage. This analog voltage is converted into digital and is inputted to the microcontroller.

4. METHODOLOGY

The system explained in this paper includes three main functions: detecting drowning victims, sending drones to victims, and detecting dangerous activities. The drowning detection component detects drowning victims through a custom CNN model, which detects drowning in three stages and immediately informs the user through an audio alert. The second component is the rescue drone, activated according to the drowning detection command and sent to the victim's location coordinates. This procedure uses a custom

configured x and y coordinate block system to link to ground GPS coordinates. At the same time, potentially dangerous activities, including running around the swimming pool and drinking, will be notified to authorized personnel in the premises through mobile alarms by the hazard detection component. This will prompt authorized personnel (including lifeguards) to make responsible decisions.

4. 1 Drowning Detection And Tracking

1. Creation of the data set: Due to the lack of an existing aquatic human body parts data set, a data set containing 5000 images were constructed. All images in the dataset contain at least one or more swimmers in the water • Image Collection: The primary source of data collection is the induction of actors and the collection of videos in real-time. The secondary source of data collection is the Internet, using specific keywords, such as "swimmer", "swimming", "drowning", "drowning in a swimming pool", • Image Labelling: LabelImg – a graphical tool implemented in Python, is used to mark the image. Each image is labelled by creating arbitrary bounding boxes and predefined labels in YOLO format. The predefined tags used in image annotation are "Not_drowning", "Drowning_stage_1", "Drowning_stage_2", and "Drowning_stage_3".
Model Creation: Use Google Colab to create and train models and get weight files every 100 iterations. The created model is then implemented on the NVIDIA Jetson Nano board, which runs on the Quad-core ARM CortexA57 processor. The main reason for using NVIDIA Jetson is to run multiple neural models parallel without complications and with a limited budget. First, swimmers in the pool are detected using an overhead camera and are kept track using the DeepSORT algorithm. YOLO is used to detect objects by locating one or more objects in the image and sorting each object. Yolo works well with a good resolution of entry compared to other models . Most of the problems in the detection and monitoring of swimming players are occlusal, scale changes, changes of appearance. These problems can be overcome using YOLO . The location of the tracked swimmer is also obtained using a predefined coordinate system. Initially, the detection of swimmers is tracked while using a predefined coordinate system to
obtain their position coordinates. At the same time, it will also check whether the swimmer has entered any drowning stage. If such an event is identified, the camera will track video clips in real-time to detect drowning victims. Using CNN, the human detection algorithm will use the image frames to identify the drowning person. Once the location block of the drowning victim is correctly identified, an audible alarm will sound to notify authorized personnel of the event. The images in the data set must include at least one drowning person to identify the chart as a drowning situation. A person's posture and movement can quickly identify a drowning victim. Although it is easy to recognize, one of the most common exercises is the "vertical ladder" exercise, which imitates the movement of a person climbing a ladder in a vertical movement
.Class
Features
Drowning_stage_1
Head is above the water
Drowning_stage_2
Half of the head is underwater, and hand gestures are in the climbing ladder motion
Drowning_stage_3
Head is underwater, and hand gestures are in the climbing ladder
Not_drowning
Regular swimming and floating motions

5. RESULTS AND DISCUSSION

Drowning Detection and Tracking Results The YOLO detection algorithm [19] uses 416 X 416 as its input dimensions. The drowning victims are detected in three stages using a YOLO-based detection technique. Even though the swimmer stayed underwater for an extended period, the DeepSORT algorithm [33] could keep track of them. The mentioned Fig.7 depicts the model's performance (False Positives and True Positives only) with 500 images.

Accuracy = (TP + TN) / (TP + TN + FP + FN)

TP - True Positives

FP - False Positives

TN - True Negatives

FN - False Negatives

ACCURACY VARIABLES

COUNT

TP

220

TN

208

FP

42

FN

30

TOTAL ACCURACY

85.6%

Hazardous Activities Because of the noise elimination via picture masking, the posture estimate accuracy was greatly improved. To allow the pose estimation algorithm to make more radical judgments, the default threshold value for the OpenPose body parts heat map was changed from 0.2 to 0.1. Although frame-by-frame identifications were only identified with a probability of 53% due to the threshold adjustment, the total system, which examined a frame in real-time, was able to identify a hazardous activity with much greater ease within 60 seconds, with a mean accuracy of 91.4 percent, after the threshold was changed. A close examination of the misclassified postures among the testing sets revealed that a posture was more prone to misclassification as it approached the far end of the camera, indicating the need for a secondary camera to improve accuracy and confirm the true positives from the primary camera, as shown in Table II. Although employing a higher quality camera to fix this problem is a good idea, the requisite hardware and the near-real-time CNN techniques used to detect further objects may not be up to standard at present.

6. CONCLUSIONS

Consistently numerous people, including kids, are suffocated or near suffocating in the deeps of the swimming pools, and the lifeguards are not prepared all around to deal with these issues. In this manner raises the necessities for having a framework that will thus recognize the suffocating people and alert the lifeguards at such hazard. It can be installed in International standardized schools where classes are held for training kids.