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Wearable Devices for Rescue Operation: A Review

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Abstract: In today's scenario, there are risks at every moment of our life. People rambling around are found insecure, especially at remote outdoor locations where there are no rescue services provided. One of these scenarios is an aquatic environment such as waterfalls, lakes, trekking, remote locations, water parks, swimming pools, beaches, etc. Many lives are at risks in spite of lifeguard resources. Therefore, to get rid of life's endangering situations at such scenarios there must be the wearable device which sends the immediate signal to the lifeguards to provide rescue service to the individuals in danger. Such a wearable device is a need for such scenarios. According to this context, the following review is undertaken.
Keywords: Wearable devices, biomedical sensors, rescue operations

I. INTRODUCTION

Fast development in the technology has increased the risk of intrusion. There are many safety, security, detection and tracking devices implemented for children, women's, environment, car tracking, houses, remote monitoring, etc. The World Health Organization (WHO) classifies drowning as the 3rd leading cause of unintentional injury worldwide after road traffic injury as the 2nd cause, while death due to heart attacks is the 1st. Every one admires playing at the beach, Water Park, love to travel, to trek, many go for picnic spots at remote locations; children's love to play and are great stress busters. But suddenly people might feel hard to breathe; there might be choking actions; loss of balance which may cause death. Some special circumstances, such as cramps, collide with each other, certain diseases or mental stress and so on may also lead to death. Frequently many deaths occur due to sudden body imbalance or organ failure such as brain damage, brain ham rage paralyses heart attack, etc. Thus automatically understanding events happening in such scenarios is the eventual goal of a surveillance system.

Thus there is a requirement for having a system that will consequently detect the individuals and alarm the caretaker at such risk. The people life is saved during by wearable device. As this system is based on health monitoring sensors, this has an advantage of convenience, lifesaving and real time. This paper investigates the challenges faced by automated surveillance systems operating in hostile conditions and demonstrates a developed wearable system that detects life-threatening situations of humans within highly dynamic environments. So let's take a brief review about life's endangering situations and its rescue systems.

II. LITERATURE SURVEY

One of the previous systems proposed by S.Hemalatha, P.Nandhini, J. Vimala, and V. Ramesh [1] was designed by using a light source of LDR and laser placed on the side of the wall to identify humans. The iron metal plate was placed in the floor of the swimming pool which was lifted automatically using the motor and motor drive. The laser source was allowed to spread over the swimming pool and the LDR to sense the laser light which produced the resistance value and when LDR value was constant, the alarm was activated. The resistance value was changed with respect to the human movement and message was send to the administrator by using the GSM service.

The second system designed by A Kanchana, Kavya G.R, Kavitha C, Soumyashree V, Salila Hegde [2] was especially for children. This automated drowning detection system worked on the principle of differential pressure. The system had two fundamental modules: to begin with, the wristband consisting of pressure sensors on the transmitter side which should be worn by every child entering the swimming pool and second is the receiver module at the swimming pool site. The Pressure at underwater is different and greater than the pressure at the air-water interface. The pressure at a particular depth was set as the threshold. When the current value transcends the threshold limit an alerting signal was sent to the receiver of the RF module. On receiving the valid signal, controller sets the buzzer ON, turns ON the motor driver which in turn lifts the acrylic plate of the multi-floored swimming pool and the kid is brought to air-water interface, i.e. the top level of swimming pool.

POSEIDON is a video-based drowning detection system reported in the literature survey by A Kanchana, Kavya G.R, Kavitha C, Soumyashree V, Salila Hegde [2]. This system has three kinds of drowning monitoring system according to the different position of the camera. One is camera mounted underwater; another camera is mounted upon the water while the third is a combination of the two. These cameras monitor the swimmer status and posture change. A limitation of this equipment is that if too many swimmers, occlusion problem will appear. The reaction and refraction of light and water wave interference will affect the image quality, and

drowning man feature this method detected is not easy to distinguish swimmers and divers obviously. This system needs constant observation, expensive installation costs which are the main disadvantage.

The system proposed by Johan Carlén, Jonas Larsson [3] had a wristband which consisted of several system components, which together form a network of sensors, processing units, alarm triggers, and wearable communication units and mainly were dependent on RFID-chip standards for supporting the Sen-tag system. The wristband senses pressure and triggers an acoustic signal in the water. For safety reasons, there was always two hydrophones one in visual contact with the wristband and other in the swimming pool. The wristband is equipped with an RFID chip so it can communicate with access points within the facility.

A prototype of wearable smart locator band was designed by Isha Goel and Dilip Kumar [4] which can be worn on the wrist of the children to monitor and keep an eye on them. The developed device includes an AVR microcontroller (ATmega8515), the global positioning system (GPS), global system for mobile (GSM), and switching unit and the monitoring unit includes Android mobile device in parent's hand with a web-based Android application as well as the location indicated on a Google Map. This development was very useful for senior people and individuals suffering from memory diseases. This device, hence, behaved as a communication interface between wearer and caregiver.

One of the works involved a wearable device for the safety and protection of women and girls proposed by Anand Jatti, Madhvi Kannan, Alisha RM, Vijayalakshmi P, and Shrestha Sinha [5]. This objective was achieved through the analysis of physiological signals in conjunction with body position. Real-time monitoring of data was achieved by wirelessly sending sensor data to an open source Cloud Platform. Analysis of the data was done on MATLAB simultaneously. This device was programmed to continuously monitor the subject's parameters and take action when any dangerous situation presents. It did so by detecting the change in the monitored signals, following which appropriate actions were taken by means of sending notifications/alerts to designated individuals. Acquisition of raw data was followed by activity recognition which was a process of employing a specialized machine learning algorithm.

One paper by Aida Kamišali´c, Iztok Fister, Jr., Muhamed Turkanovi´c, Sašo Karakati˘c [6] stated recent advances in the development of non-invasive wrist-wearable devices. The aim of the review was to analyze the current trends for sensors used in wrist-wearable devices. Research efforts are increased towards non-invasive sensors for human health monitoring. Devices, when commercially available, are known as Commercial-Off-The-Shelf wearables (COTS). They are used in a variety of domains, such as medicine, education, sports, office environment, industry and risky professions such as construction, firefighting, aviation, and military. Wrist-wearable devices using non-invasive sensors produce raw data of measurements, computers are used (integrated into a wearable device or external) for intelligent analysis of raw data obtained from sensors and monitors that visualize data obtained from sensors or results of the intelligent analysis.

The health status of a human body can be indicated by a variety of physiological parameters, which is stated by Yan Liu, Hai Wang, Wei Zhao, Min Zhang, Hongbo Qin and Yong Qian Xie [7]. The human parameters are evaluated and categorized as: (1) body motions, including hand, limb, foot, face, throat etc., (2) vital signs, including breath/heart rate, wrist pulse, ECG, blood pressure, skin temperature, SpO2, etc., These parameters have been detected by various wearable sensors as shown in Table 1 below.

TABLE I

INDICATORS OF HEALTH MONITORING

Indicator	Position
Motion	Hand Limb Foot Throat Face
Skin temperature	Whole body
Heart rate/ECG/pulse	Chest, wrist, neck, fingertip
Respiration	Chest Nostrils

The reliance on underwater cameras in one of the systems put forth by How-Lung Eng, Kar-Ann Toh, Alvin H. Kam, Junxian Wang and Wei-Yun Yau [8]. They summarized as,

1) Expensive installation costs

2) Drowning detection being constrained to victims who have sunk to the bottom of the pool. To circumvent these drawbacks, the proposed system is based on a network of highly mounted overhead cameras. This allows the detection of early drowning behavior from the onset of water crisis situation. Hence, any rescue effort could be initiated much earlier than those in water.

One paper by Mohamed Kharrat, Yuki Wakuda, Shinsuke Kobayashi, Noboru Koshizuka, Ken Sakamura [9] described a swimming cap that detects drowning situation as early as possible by analyzing the swimmer's physiological states. A person drowning tends to have a vertical body posture while struggling at the same location to ensure that the swimmer is in danger. The heart rate activity can be analyzed from ECG or PPG signals. For the body posture estimation, the vertical position can be detected using an accelerometer or gyroscope. The information will be processed in the cap and an alarm will be triggered if an abnormal behavior is detected. But one major technical challenge faced is to accurately detect and track swimmers within the noisy outdoor aquatic environments which are not feasible.

In paper [10] proposed by Nasrin Salehi, Maryam Keyvanara, Seyed Amirhassan Monadjemmi a method is provided to robust human tracking and semantic event detection within the context of video surveillance system capable of automatically detecting drowning incidents in a swimming pool. In the current work, an effective background detection that incorporates prior knowledge using HSV color space and contour detection enables swimmers to be reliably detected and tracked despite the significant presence of water ripples. The system has been tested on several instances of simulated water conditions such as water reflection, lightening condition, and false alarms. Our algorithm was able to detect all the drowning conditions along with the exact position of the drowning person in the swimming pool and had an average detection delay of 1.53 seconds, which is relatively low compared to the needed rescue time for a lifeguard operation. Our results show that the proposed method can be used as a reliable multimedia video-based surveillance system.

III.CONCLUSIONS

After review from the aforementioned source, it can be analysed that, every person want to be in a better and secure world. Thus a system to detect early drowning behaviour from the onset of water crisis situation is needed. Especially at beach sites, which is remained inattentive area until today. Hence, any rescue effort could be initiated much earlier than those in which includes developing a coherent framework for inferring semantic events involving beach where it is virtually impossible to track.

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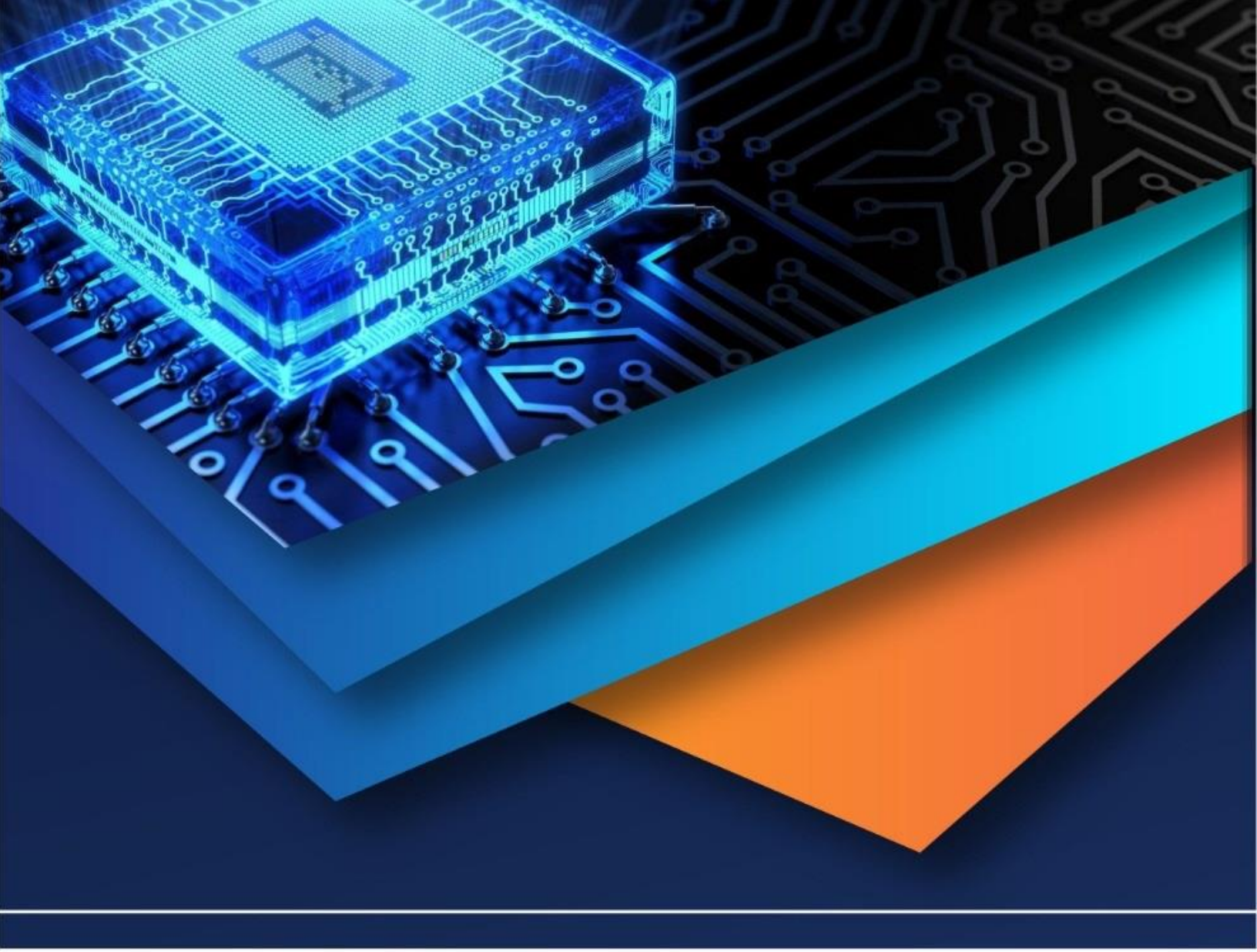

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