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Comprehensive Survey of Drowning Detection and Rescue Techniques

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ABSTRACT - *Being one of the leading causes of death drowning has become a severe problem since past few years. The paper focuses on comprehensive survey of drowning detection and prevention techniques. There are various methodologies put up in the domain of swimming pool safety using different intelligent control systems. Various methods have been adopted for drowning detection using the concepts of image processing, pressure and motion sensing, LASER-LDR mechanism and heartbeat sensing. The paper includes a scrutiny of these techniques and a blend which will be accurate and can be implemented easily as well. By studying and surveying this domain we also have mentioned the future scope of the topic which can be implemented in domestic swimming pools. A novel technique that can be implemented for domestic swimming pools is also proposed.*

KEYWORDS: Drowning, Automatic drowning detection, rescue, swimming pool safety.

INTRODUCTION:

Over the years, unintentional injury deaths resulted by drowning have been on a rise. In fact, it accounts to be the third major cause with respect to the same, and 7% of all deaths that are injury-related. It is speculated that about 372,000 people round the globe per annum lose their lives as a result of drowning. To put it in facts, about 42 drowning deaths occur on a per hour per day basis [7].

In general, it is seen that in the primary stages of the drowning process, there is relatively meagre water that enters into the lungs due to which a small amount of water enters the trachea resulting in a muscular spasm. Consequently, the airway is sealed while preventing the imperative path for both air and water till the time person becomes unconscious. Thereby, an individual who is drowning would not be able to shout or to make a call for rescue. Non interruption of the process leads to loss of consciousness resulting from hypoxia which is quite quickly followed by cardiac arrest.

However, at this point of time, the aforesaid process can still be reversed on account of immediate and efficient rescue. The duration of immersion is strongly concerned to the rate of survival of an individual. Thereby, if an individual who is undergoing drowning is brought back to the floor within a stipulated time, the eventual death can be averted.

RELATED WORK:

This survey in the domain of 'Drowning detection and prevention' through this document analyzes various proposed methods. After scrutinizing the current solutions comparisons are made based on various points. This involves complexity of design coupled with accuracy of design. This also involves Cost efficiency and feasibility. On site performance, success rate, maintenance required & reliability of the solution are the other aspects to be considered.

Authors of the paper, Automated Drowning Detection and Security in Swimming Pool [1], propose the system in which the drowning detection is done with the help of two fundamental modules: The wristband module and Base station module. Pressure sensor and RF transmitter are incorporated in the wristband which is worn by the swimmer whereas base station includes RF receiver, motor driver module, buzzer and LCD. An acrylic plate is mounted at the base of the swimming pool which can be lifted up by motor module bringing the swimmer to the surface. Motor module comprises of a motor driver IC L293D Dual H-Bridge and a high torque motor. The wristband continuously measures and compares the current value of pressure with the predefined threshold value. When the threshold is surpassed an alarm signal is sent by microcontroller through wireless RF communication to base station unit. The buzzer is turned on after receiving distress signal and motor driver IC turns the motor on lifting up the acrylic plate hence bringing the drowning person to the surface. Use of only one sensor in the wristband gives the proposed system advantage of convenience, cost saving and simple algorithm but the acrylic plate mechanism restricts its use at large water reservoirs such as lakes, rivers or sea.

Authors of the paper, ADRS (Automatic Drowning Rescue System For Human Using RFID)[2], propose the idea of drowning detection and rescue with help of RFID. Human Sensors equipped with RFID are responsible to detect the

presence of an under-water human. Identification of location of the person is done using GPS; while GSM is used for sending an SMS about person's location to a boat's receiver. Out of Tag and Reader, the two parts of RFID, the volatile locations of the body are equipped with RFID reader, which produces RF signals all the time; while the person's hand is attached with RFID tag. The Reader gets activated upon coming near to the RFID Tag and a unique serial number is sent to it using antenna. The Tag is identified based on program dumped in PIC Microcontroller. This is followed by activation of GPS that sends the location signals to the PIC MC, which are conveyed to a boat with help of GSM. Location of the person is then retraced leading to his rescue. The most important advantage of this system is the automatic identification of drowning person and resultant rescue with considerably less time. The normal RFID reader operating at a frequency of 125KHz has a range of about 10cm instead of which a 3m range RFID module is being used.

Authors of the paper, Anti Drowning System With Remote Alert Using Zigbee[3], propose the idea of saving the life of a person drowning in water by informing the rate of heartbeat of any under-water individual to a lifeguard using ZigBee. The heartbeat rate is continuously monitored and transmitted using the ZigBee coordinates. The transmission circuit is under water with an individual swimmer and range of transmission that under water is around 2-4 meters. At the transmitting end, an LCD is interfaced to AVR family microcontroller. A lifeguard is equipped with receiver circuit that informs it about the heartbeat rate of person. The receiver circuit also makes use of AVR family microcontroller. Initially, a heartbeat sensor is used to measure the heartbeat of a person. It is mounted upon the head or hand of a person under water. At the receiver end, an LED and a buzzer is present. When the heartbeat rate of a person aggravates or if it becomes too low, LED is turned ON, and accordingly, buzzer is driven. This leads to informing the lifeguard about drowning of the person upon substantially reduced heartbeat levels and rescue of the person. Consequently, irrespective of the lifeguard being or not being near the person who is drowning, the buzzer system will allow the rescue operation to take course.

Authors of the paper, An Automatic Video-based Drowning Detection System for Swimming Pools Using Active Contours[4], propose a real time drowning detection method based on analysis of HSV color space, which makes use of prior knowledge of the video sequences for the purpose of setting the best value for the color channels. The use of HSV thresholding mechanism in addition to detection of contour for the purpose of detecting the region of interest for video sequences with respect to each frame is done in this method. The person who is drowning in indoor swimming pools is detected by the software and an alarm is sent to the lifeguards, in case that a person detected previously is seen missing for a considerable amount of time. The number of false alarms generated in this system is minimal while the maximum alarm delay reported by the system is 2.6 sec, which is found to be quite reliable as against the time for rescue and remedial efforts. For this notion to be established, the system algorithm has been tested on several video sequences recorded in swimming pools on existing actual conditions, while the high accuracy results with a high individual tracking capability are obtained. This prompts the system to be used a reliable multimedia video based surveillance system.

Authors of the paper, Automated Drowning Detection and Security in Swimming Pool[5], propose the system which is actually a swimming pool surveillance system in which LASER and LDR mechanism is used for drowning detection. LASERs and LDRs are mounted on the side walls of the swimming pool and an iron plate is placed with motor drive at the bottom of the pool. When the light emitted by the LASER falls on the LDR its resistance decreases. Variable amount of light falling on the LDR will cause continuous fluctuations in the resistance offered by it. This principle is used in the system for detecting the movement of the swimmer. As the swimmer continues to swim his movements cause small ripples in the water in the pool which will deflect the light falling on the LDR hence changing its resistance. From fluctuations in the resistance it can be inferred that the swimmer is swimming continuously. If he is motionless then there won't be any changes in the resistance and distress condition will be detected by the microcontroller. If the condition continues for more than 30 seconds then an alarm is activated and a message is sent to the administration by the GSM module. Also the microcontroller sends control signals to the motor drive lifting up the plate hence bringing the swimmer to the surface.

Authors of the paper, Automatic Waist Airbag Drowning Prevention System Based on Motion Information Measured by Memos Accelerometer and pressure[6], propose an idea of automatic airbag system which monitors the position of the swimmer as well as rescues him after distress detection. The proposed system is composed of a customized waist airbag and monitor which is equipped with pressure sensor and accelerometer. The pressure sensor kept in the cap of the user keeps the track of water pressure through zigbee and hence using it the position of swimmer's head is calculated. The accelerometer monitors the movements of the swimmer and checks whether he is motionless. If the user spends more amount of time underwater than the predefined threshold or is found motionless for a long time then an alarm is triggered and a controlling signal is sent to the servomotor by the microcontroller. A high torque motor pulls the cable of the PFD belt hence causing the CO2 gas stored in the 24g cylinder to inflate the airbag and brings the user to the surface. Water sensitive components of the device are ensured water protection by epoxy coating and gum dipping. The proposed system not only raises the alarm but also protects the user from drowning separating it from other drowning detection-only methods available.

COMPARISON:

Paper Title	Sensing Method	Mode of Action	System Complexity	Cost Efficiency	Reliability
Automatic Waist Airbag Drowning Prevention System	Accelerometer And Pressure Sensor	Detection and Rescue	Moderate	Moderate	High
Automatic Video-Based Drowning Detection System	Image Processing	Detection and Alarm	High	Low	High
Automated Drowning Detection And Security In Swimming Pool	Pressure Sensor	Detection and Rescue	Low	High	Low
Anti- Drowning System With Remote Alert Using Zigbee	Heartbeat Sensor	Detection and Alarm	Moderate	High	Moderate
Automated Drowning Detection And Security In Swimming Pool	LASER And LDR Mechanism	Detection and Rescue	Moderate	High	Low
Automatic Drowning Rescue System For Human Using RFID	RFID	Detection And Alarm	Low	Moderate	High

TERMINOLOGIES:

- LCD : A Liquid Crystal Display is a flat panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals
- HSV : It is named such for three values : Hue, Saturation and Value. It describes colors in terms of their shades and their brightness.
- Global Positioning System (GPS): GPS is a system of global navigational satellites that provides geo-positional information to a receiver anywhere on the earth.
- Global System for Mobile communication (GSM): GSM is a standard developed by European Telecommunication Standard Institute (ETSI) to describe the protocols for second generation digital cellular network, used by mobile phones.
- Radio Frequency Identification (RFID): RFID refers to a small electronic module elongated with an antenna which is typically capable of carrying 2000 bytes of data.
- Personal Flotation Device (PFD): Personal flotation device, a device designed to keep a wearer afloat in water.
- LASER: A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation.
- LDR: Light-Dependent Resistor or photo-conductive cell is a light-controlled variable resistor.

FUTURE SCOPE:

Through the thorough scrutiny of the work put up in the domain of 'Anti-Drowning Systems' domain, we remark that the domain is integral part of Human Safety and Security and it contributes its enormous share in the development of smart systems intended to provide rescue for humans under the threat of drowning. The work done till date, though focused primarily on detection and intimidation about drowning instances, is quite below the levels that can need to be reached. Hence a system can be developed which detects the incidence of drowning, takes the corrective measure so as to result in rescue of an individual and record such happenings while conveying the information about the same to the concerned entities. A mobile app can be developed to assist the underwater wearable for customizing every swim event and for providing real time data to surface. Services of GPS/GSM can be availed in order to convey geographical location information of site where drowning incidence has taken place, to the nearby costal guards so as to have the professional aid along with registration of such incidences.

This can bring about a drastic change in the contemporary anti-drowning systems and thereby in the domain of Human Safety and Security. The increase in annual death rate due to incidences of drowning might well be reduced considerably with the help of this dynamic system, which should be an integral part of the diving and swimming related activities in days to come.

CONCLUSION:

The comparative and comprehensive study of various drowning detection and rescue systems showed a wide range of available ideas differing in their accuracy, complexity and reliability. Detection using image processing gives better accuracy but requires large cost price whereas LASER-LDR gives cost efficiency but lacks in accuracy. Use of pressure sensing and RF transmission method can rescue a drowning person in the pool but it is not suitable for large water bodies. On the other hand RFID technology can be used at large water bodies but it only generates an alarm signal. Providing both detection and rescue automatic waist airbag is found to be the most suitable, cost effective and reliable solution of all the available methods.

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