A review paper on Design And Performance Evaluation Of Drowning Death Prevention System With various technologies.

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1.Abstract:

Drowning is most terrifying accident to most of the children and adult which prevent them from using swimming pools for recreation and fitness .The present article focuses on accuracy in drown predict ,notify and saving inventions .Comparison and short falls in research work done so for done .Research gaps were identified in available art work and proposed improvements .This review article focused mainly of drown safety related inventions and research articles in databases .The present study thrown light on how many technologies were being used to predict and avoid drown deaths .

Key words – IoT, Hydrophones ,blood-oxytometry ,swimming-pools , drown ,safety ,image processing ,thermal cameras , automatic-rescue ,embedded .

2. INTRODUCTION

As per the world health organization, drowning is the major cause of unintentional deaths across the deaths of healthy people while doing swimming in swimming pools. Several techniques are suggested by several research articles and patents.The present research is to study and suggest an improved method to save drowning victims. The present attempt try to suggest innovative robust methods to detect, alarm and make automatic attempts to save a drowning person. The present study may bring novel methods to avoid the fear of death in swimming pools both domestic as well as a public pool.

Drowning is a silent phenomenon where the victim will never show significant signs before or near-drowning incidents and silently lose a life. Since swimming is a healthy sport for cardiovascular and good for overall body fitness, and stress relieving exercise, everybody loves to use swimming pools. But a good amount is care is must to maintain these pools otherwise these pools will cause unintentional deaths to kids and elderly people.

3. Review of Literature

The following is a brief description of the work published by researchers on drowning prevent and avoid devices.

A. Roy [1] proposed wearable swimming goggles with a hydrophone, a buzzer is in outside water pool .Hydrophones were sending alert to buzzer outside water. Implemented using Proteus software and demonstrated practically. Ydrophones sound may be jammed by noise in public pools, and discomfort to the user to wear a mask type goggle.

J. Geetha Ramani[2] proposed wearable inflatable wrist band system where a sudden unusual moment of a swimmer is detected with an accelerometer and a manual switch, programmed in a PIC microcontroller. This will not cover most of the drowning cases. Limited to few cases of drowning are covered.

M. A. Hayat[3] proposes a technique to detect a drowning person in the swimming pool using video image frames. A-frame by frame difference VIBE algorithm is used to detect drowning persons is demonstrated used to determine the swimmer's position.

H. Liu [4] proposed an arrangement of underwater communication devices like Hydraulic Pressure Sensor, Ultrasonic Sensor to continuously monitor the location of the swimmer and learning the motion behavior of the swimmer is done. Hydraulic pressure is going to sense how deep the swimmer in submerged by 3D positioning of the swimmer. With the technique, the system is going to send a distress alarm signal to an outside system to turn alarm ON.

S. Sindhuja[5] has proposed an embedded system of the water pressure sensor and GPS system to send SMS alert to monitoring person and actuation of the airbag, an accelerometer is also used to detect unusual motion of swimmer in the event of suffocation. Its a wearable system where power supply and continuous pressure monitor in water and, gas level checking is needed ..Suffocated swimmer will not move so rapidly in all the cases and may fail to detect drowning. It is not useful in a person going sudden unconscious, breathing diseases in the event of failure of airbag failure.

Yaswanthkumar S K ; Praveen O K have proposed a device combining SONAR and thermal-detection sensors to automatically detect the location of a living person inside the water body. SONAR is an underwater communication signaling system including image processing techniques along with thermal imaging system with image processing system together used to track a human body under water is proposed.

Muhammad Ramdhan MS[1], Muhammad Ali[2] proposed a headband type wearable IoT device to detect a heartbeat pulsed from pulse-oxytomertic sensor .The sensor data is continuously detected by the controlling station outside swimming pool and transmitted to a mobile phone by internet protocols. The event of danger is detected by calculating absence of signal reception after 30 second to the out of pool control unit built by RASBERRYpi system meaning that water is abstracting signal since water does not allow RF signal transmission .It is merely a signal sending wearable device by which an alert to alarm system and mobile alert.

A. Kulkarni[8] has proposed a system which depends on a force sensor(piezoelectric), humidity/wet sensor and a muscular oxygen saturation detection device to evaluate early detection alarm of drowning accident using embedded processor.

Y. Nishida[9] proposed a spherical sensor setup to detect a baby fall into any water body. It is supposed to float on water and notify an abnormal wave pattern to recognize drowning accident. It is a wearable glass sphere and difficult to classify accidents from false alarms.

CAI Xiaoyang[10] proposed an image processing technique based on image restoration with a robust estimation method. Underwater video CC cameras were assumed in the article. A combination of image processing techniques helped to locate an underwater human body with all noise associated with water surroundings.

L. Fei, W. Xueli proposed a patented method, where a complex image processing technique used to evaluate a drowning accident. It was presently been used in several sports swimming pools. But always there is a need of a human observer and rescuers is found

Soren Bonderup Proposed an automatic surveillance system to trace floating ,accidental falling human in harbors and resue by using thermal cameras and image enhancement techniques like Kalman Filter and virtual trip-wire in combination with an optical flow algorithm which has gained 100 percent accuracy and 0.08 false positive case per hour.

Infrared cameras became commonly used in domestic and ocean coast guard to find any living person on top of the water.They can watch a floating object with some heat from 2000 meters distance.

Ahmad Ilham , [2]Sherly Prastica Della have proposed an autonomous underwater float and swim robot to rescue drowning victims in harbors in the event of failure of a large boat with several people struggling to swim for a longer duration. The proposed device is about 5Kgs weight and can carry a person upto96 kg, with an average speed underwater 0.95m/s .With image processing system with the Haar Cascade Algorithm ,the device is proposed to detect human hands, face from 3 to 4 meters distance in low light conditions.The paper reporting a remote control connectivity table showing successful remote connectivity below 700 meters only and afterwards there is a transmission error. The paper is showing an algorithm of motion of the proposed device autonomously above or underwater .

Wenmiao Lu proposed a complex image processing algorithm to learn and understand the motion behavior of swimmers and detect early detection of drowning incident by video surveillance camera output. It is also an article with a different approach of machine learning.

How-Lung Eng has proposed a complex image processing technique where underwater cross-section is monitored continuously by a high-resolution camera and every image frame is subtracted by a predefined image to locate anyone staying underwater stationery. The computer system will alert the security personnel immediately after detecting a victim.A rescue person is mandate to do a rescue operation. Watercolor should always transparent to operate this algorithm.

Comparison table of authors and their choice of technologies to predict and act on drowning accident.

S N o	Author Name	Image processing Techniques	Wireless SONAR (Acoustics) usage	Thermal Imaging	IoT	Automatic Rescue	Wearable	Signal to alarm
1	A. Roy & K. Srinivasan		Yes				Yes	

S No	Author	C1	C2	C3	C4	C5	C6	C7
2	J. G. Ramani, J. Gayathri					Yes	Yes	
3	M. A. Hayat, G. Yang	Yes			Yes		Yes	
4	H. Liu, M. B. H. Frej	Yes	Yes					Yes
5	S. Sindhuja				Yes	Yes	Yes	Yes
6	Yaswanth kumar S K	Yes	Yes	Yes				
7	Muhammad Ramdhan				Yes		Yes	Yes
8	A. Kulkarni				Yes		Yes	Yes
9	Y. Nishida						Yes	Yes
10	CAI Xiaoyang	Yes						Yes
11	L. Fei, W. Xueli	Yes						Yes
12	Soren Bonderup	Yes			Yes			Yes
13	Wikipedia		Yes					Yes
14	Ahmad Ilham	Yes			Yes	Yes		
15	Wenmiao Lu	Yes						Yes
16	How-Lung Eng	Yes						Yes

Google Patents granted on drown accident prediction and post drown actions

S No	Patent No	Title-description
1	CN103021135B	A kind of anti-drowning alarm
2	CN106428464A	Intelligent drowning-preventing rescue device and method
3	CN204965105U	Drowned monitored control system is prevented to children's intelligence
4	CN102324167A	Anti-drowning alarming method and device
5	WO2016141859A1	Anti-drowning system, method and swimming pool, and construction method and reconstruction method of swimming pool -
6	CN1162364A	Self-locating remote monitoring system
7	WO2016023138A1	Drowning help seeking apparatus for improving underwater electromagnetic wave communications
8	CN105923124A	Intelligent drowning prevention self-rescue device – (neck air bag)
9	CN104367312A	Human body drowning monitoring method and drowning-prevention auxiliary device –(wearable neck belt case enclosing airbag)
10	CN205177096U	Intelligence watch with drowned alarming function
11	WO2007/015088Al	A PORTABLE BATHER MONITORING DEVICE AND A WATERSIDE MONITORING SYSTEM
12	WO2002023501A1	Alarm apparatus (when contact with water ,gives alarm)
13	EP1872151A1	Salvage system for life jacket – (useful in marine swimmers,also pools)
14	EP1915747A1	A portable bather monitoring device and a waterside monitoring system - wristband device with alarm in it.
15	EP2701130A1	Drowning prevention system: helmet detect that a user is submerged in water for a long time.
16	US2942247	ALARM WARNING FOR SWIMMING FOOLS
17	US5049859	ALARM WARNING SYSTEM FOR SWIMMENG POOLS(sensors under pool pavement)
18	US5619187	ALARM TO PREVENT DROWNING-transmitter attached to the body

		, actuatable when submerged in water.
19	US5959534	SWIMMING POOLALARM-detects a sensor ,if anything falls in water.
20	US6064309	SWIMMING POOL DROWNING PREVENTION SYSTEM (wrist band)
21	US6127930	MOTION RESPONSIVE SWIMMING POOL SAFETY MAT-actuated by a dependable microwave pattern which is disrupted when a person falls into the pool.
22	US6133838	SYSTEM FOR MONITORING ASWIMMING POOL TO PREVENT DROWNING ACCIDENTS(triangulate human in water –motion behavior learning)
23	US7019649	POOL MONITORING-hydrophone generates a signal on pressure threshold.
24	US 7218235B1	MOTION RESPONSIVE SWIMMING POOL SAFETY DEVICE(perimeter laser)
25	US7642.921B2	ELECTRONIC SWIMMERMONITORING SYSTEM (heads are underwater for periods of time
26	US8164448	SECURITY FENCE FOR SWIMMING POOLS
27	US8659432B2	SECURITY SYSTEM FORAUTOMATICALLY DETECTING A PERSON OVERBOARD USING RFID tag
28	US9595178	WATER SAFETY MONITORING DEVICES, ALARM DEVICES AND RELATED METHODS.
29	US20080218332A1	PORTABLE BATHERMONITORING DEVICE AND A WATERSIDE MONITORING SYSTEM(wrist band)
30	US20080266118A1	PERSONAL EMERGENCY CONDITION DETECTION AND SAFETY SYSTEMS AND METHODS(wrist bands with balloon inflatable)
31	US20110068933A1	PERSONAL WATER SAFETY DEVICE(goggles with two electrical contacts by water entering between)
32	US20130106610A1	SENTNEL SURVEILLANCE SYSTEM WITH PRE-ALARMS TO AVERT DROWNING(mount cameras to observe unauthorized entry of pool)
33	US20160314675A1	SWIMMING AID TO PREVENT DROWNING(wearable Swimming aide having a plurality of wireless sensors including as an underwater depth transmit,, array of light and an array of underwater bubble generator.)
34	WO1999057696A1	*Swimmer location monitors (pressure sensor depth sensor emit alarm signal to central processors outside water.*
35	WO2009015060A3	ELECTRONIC SWIMMER MONITORING SYSTEM(wearable e-device communicate with underwater receiver)
36	WO2015019360A1	WEARABLE MULTI-SENSORY PERSONAL SAFETY AND TRACKING DEVICE(predicts danger by sensing changes in voice, pulse, emotions, impact, motion of the wearer and the device state)

4. Research Gaps

Based on various methods and devices, accuracy, reliability and comfort in usage are the main features lagging and the present study is focused to see/check accuracy, reliability and comfort in usability and suggest improvements.

Main importantly, IoT based swimming pool safety equipment is more vulnerable and might not work if there is a signal jammer which will give chances to criminal activities like planned murders or unresponsive in the event of internet network failure.

Almost all sensors used in the prior art were only appropriate to special situations like hospitals ,Intensive care units and old age homes where elderly patients monitored by skilled medical personals.

Some of the swimming pool security features are unacceptable for to swimmers due to short life span of device sensors, weight of wearable devices and discomfort in wearing on head.

In every invention, human intervention is observed and the present research is proposing unmanned methods/devices to save a drowning victim. There are fewer guarantees that a person is dedicated to monitor and save accidental drown -victim especially in domestic swimming pools.

5.Conclusion

More research work is needed in AI(Artificial Intelligence) and IoT used to prevent ,avoid accidental drown deaths. Efforts were needed invent more fail-proof methods in saving drowning victims. Nothing is going to replace the position of a dead person and only prevention of death is the only choice. Most vulnerable populations like old-age people, kids, and persons with seizures and fits disease are going to get more protection from unintentional accidental drowning. Most of the available drown prevention avoiding, alarm systems were needed more AI, sophistication, and simple to construct. As the device is a life saving equipment, accuracy and reliability should be taken care of first. IoT based systems were more vulnerable to hacking ,so sufficient care should be taken in the event of network security threat.

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