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Automatic Waist Airbag Drowning Prevention System Based on Motion Information Measured by Memos Accelerometer and pressure

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ABSTRACT—

We propose an automatic airbag system helping evacuating swimmer who is motionless or spent abnormally long time underwater. The system is composed of a customized waist airbag and monitor equipped with pressure sensor and accelerometer. The monitoring system through Zigbee will try to define accurately the position of the swimmer's head the whether underwater or not by comparing the real-time measured pressure to an estimated value of over the water surface pressure. If the time-lapse spent by the swimmer exceeds a predefined maximum threshold or the measured accelerometer information shows that he has been motionless for long time period underwater, an on device alarm is triggered and a signal is sent to the servomotor connected to the deflation system of the airbag to trigger it and evacuate the swimmer.

1. INTRODUCTION

Drowning is the third cause of unintentionally injury death in the world. In United States it is considered the second cause of death among children under 12. Worldwide, children under 5 have the highest drowning mortality rate . Drowning accidents occurs even in swimming pool staffed with professional lifeguards. It is very hard for normal people to identify people drowning. Parents are required to watch permanently their children while they are swimming in the pool. However, this is practically difficult to ensure, as humans lose easily their attention.

Drowning is considered silent and rapid death. In less than one minute a person can drown silently without being able to call for help. There are few commercialized wearable drowning prevention system. SenTAG is a wrist band based system which triggers an alarm if the swimmer is motionless for twenty seconds under a certain depth. WAHOO is a head band based system which sends alarm if the swimmer spends a long period under water. These systems require the installation of equipments in the area where they are used. Which can make from the systems costly for private swimming pool as well as not suitable for large swimming area such sea? These systems also consider the presence of lifeguard nearby to respond to the alarm. In this research we aim to create an affordable drowning prevention system which can be flexibly used in various locations. For this we make use of the recent advancement in Smart phones equipped with pressure sensor and accelerometer which we attached at the swimmer's head level. We developed and application which can measure the motion and time spent by the swimmer underwater and compare it to a predefined maximum time-lapses threshold. So if an abnormal behavior is observed on device alarm is triggered and waist airbag is deflated to evacuate the victim.

2 . EXPERIMENTATION SETTING

2.1 The Waist Airbag

We use a manual waist inflatable PFD belt. Which is composed of nylon bag, a compact 24 gram CO2 gas bottle connected to a deflating system? Manually pulling the cable connected to the deflation system cause the airbag to deflate. PFD belts are mainly dedicated for boating or fishing activity to

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save the user who falls incidentally in water. However users without swimming ability are not able to pull the cable manually once they fall in water as they enter in a panic situation and keep fighting for breathing. So another variety of the system exist called automatic which include a water sensitive component. So when the victim fall in water the system deflate automatically. In this research we use the manual edition of PFD system as the automatic one is not suitable to be used during swimming. We connect to the deflation cable to a high torque servomotor which is controlled by a microcontroller (IOIO board),.

The servo motor deflates the system by pulling out the cable similarly to the human pulling action. The IOIO board can communicate with Monitor using USB cable or wirelessly using Bluetooth communication. As we are using the system in water we need to ensure the protection of the electronic components in the servomotor and IOIO board. For this, we use epoxy potting and gum dipping to protect water sensitive components .

3. SYSTEM DESCRIPTION

3.1 Mems Accelerometer:

Accelerometer is a sensor that measures the proper acceleration of an object. In this research we use it to measure the motion of the swimmer. For this we calculate acceleration square root accSQR:

$$accSQR = \frac{x^2 + y^2 + z^2}{g^2}$$

We calculate then maximum accSQR (max_accSQR) during a predefined time window W. We compare then accSQR with a predefined accSQR threshold (accSQRth) to check the swimmer motion.

3.2 Pressure sensor:

Pressure is the force per unit area applied in a direction perpendicular to the surface of an object. The measured pressure is sensitive to the environment where the sensor is located. We have conducted several experimentations in a water tank on the pressure sensor to identify the effect of waterproof case and swimming cap on the measured values (Fig.2).Pressure variation according to the pressure sensor location The results show that the measured pressure decrease by about 65 Pascal when the Electronic device is enclosed in the waterproof case. The pressure decrease again by about 42 Pascal when the Zigbee is inserted in the swimming cap. The current air atmospheric pressure value is very important as it is used to identify the whether the head position of the swimmer is inside or outside the water. As the pressure fluctuation is relatively important from one environment to another, it is important to ensure that the system defines properly the correct atmospheric pressure reference value at the beginning.

4. RESULTS

Fig.1: design without power supply

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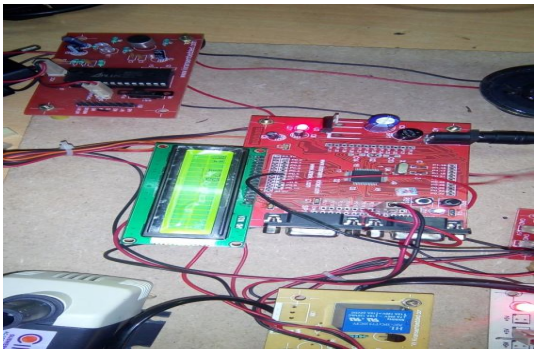

Fig .2 when measuring pressure and vibrations

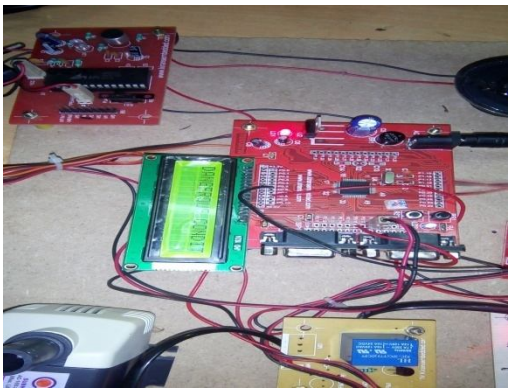

Fig .3 displays the dangers condition.

5.. CONCLUSION AND FUTURE WORK

In this research we show how we can use Zigbee as a platform for drowning alarm system, using the embedded device accelerometer and pressure sensors. We show also the efficiency of pressure sensor in detecting swimmer's head position: whether it is outside or inside water. When the swimmer submerge his head in water, we were able to measure a sensitive pressure changes at just one inch depth. Information from accelerometer was used to identify the case when the swimmer is motionless. So if an abnormal behavior is measured in either of these two cases an airbag is deflated. In the future we consider conducting further experimentation in order to define the appropriate parameters of the system which are necessary to reduce false positive alarms. We are also currently working on developing further more this system to detect the victim at early drowning stage by analyzing his physiological body changes .

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