Poster: Towards Edge-Intelligent Wearable for early Drowning Detection

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ABSTRACT

This research aims to develop a wearable monitoring system that can help in monitoring respiratory distress. Drowning-related accidents are 3rd leading cause of unintentional death. Among the victims most of them are children and world statistics state that there are 4000 fatalities per day in children due to drowning. In this research project, we propose a wearable system that can help in monitoring the heart rate, oxygen level, and body temperature variability, along with the accelerometer. Our proposed framework is designed as an anklet that can help detect drowning incidents early.

CCS CONCEPTS

• **Computer systems organization → Sensors and actuators**.

KEYWORDS

underwater wearable, drowning monitoring, submersibles, underwater edge intelligence

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1 INTRODUCTION

The fatal rate is increasing day by day due to drowning. Drowning is the 3rd leading cause of unintentional death worldwide. Among the victims most of them are children and world statistics state that there are 4000 fatalities per day in children due to drowning [5]. This project helps minimize the fatal rate due to drowning. Identification of a drowning individual still seems to be a challenge even for experienced lifeguards, especially the cases that occur among children and amateur swimmers, as there is no specific behavior expressed by all individuals in near-drowning experiences [6]. With the help of technological advancement, wearable devices for the reduction of drowning are rapidly emerging. Many systems are easily wearable and used for different types of anti-drowning that have already been put in place as listed below [7].

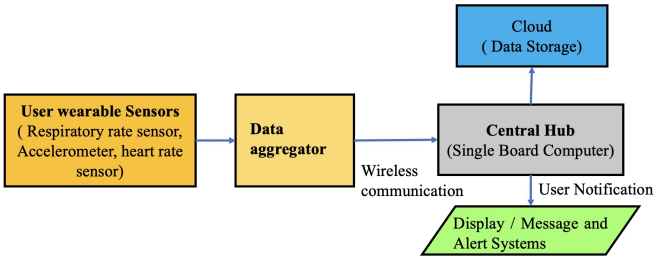

Figure 1: Overview of the proposed framework

- SENTAG: It is an anti-drowning system that offers a safety solution for swimming pools that helps to check individual swimmers via a wristband given to the individual, it is used to monitor the individual's depth in water, motion, and time. [8].
- WAHOOO: A headband is used to send an alarm to a receiver if a swimmer stays too long underwater. The system did not take into cognizance, the complexities of the near-drowning experience [9].
- SwimEye: It is a computer vision detection system for the prevention of drowning incidents in swimming pools. SwimEye works like an "extra lifeguard" under your pool's water. [10].
- AngelEye: It offers systems for drowning detection and prevention. [11].
- Poseidon: Poseidon Drowning Detection Technology is computer-aided vision technology that makes lifeguards more effective at keeping swimmers safe and preventing drownings in public and commercial pools. [12].

Edge-intelligent systems can help in collecting, processing, and caching the collected data at the wearable edge[1, 4]. In our proposed framework, we aim to develop a low-cost, lightweight edge-intelligent framework that can be used in underwater applications where connectivity might be an issue [2, 3]. In this project, multiple sensors are used to measure various parameters which can help in the early detection of drowning. Through this framework, we will collect the continuous heartbeat rate of the swimmer, which will allow us to monitor the current condition of the swimmer.

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2 PROPOSED EDGE-INTELLIGENT DROWNING DETECTION FRAMEWORK

In this research, numerous parameters that are thought to help detect drowning are measured using multiple sensors. Heart rate, oxygen saturation, body temperature, and respiratory monitoring are the variables that are measured. When a swimmer is drowning, their heart rate increases, oxygen level varies and body temperature is varied abnormally. These parameters are monitored with the threshold value and an alert and notification will be sent to the lifeguards and emergency contact persons. Figure 1 shows the overview of the proposed framework.

2.1 Hardware Prototype:

The sensors used in the proposed framework are listed as:

- Pulse Oximeter: The Oxygen saturation (SPO2) is continuously measured by pulse oximeters, which are inexpensive, non-invasive medical sensors. It shows what proportion of the blood is oxygenated. The differential absorption properties of oxygenated and deoxygenated hemoglobin provide the basis of the pulse oximetry theory.
- Respiration Sensor: The Respiration Sensor calculates the relative depth of thoracic or abdominal breathing as well as breathing rate. It comes with an elastic band that is simple to use and may be worn over clothing.
- Accelerometer: An accelerometer gauges a structure's vibration or acceleration of motion. The piezoelectric material is squeezed by the mass due to the force of vibration or a change in velocity (acceleration), which results in an electrical charge that is proportionate to the force applied to it.

2.2 Basic Working Principle

As a wearable system whenever someone wears it, the sensors will immediately start to collect the data from the swimmer and send it to the data aggregator which will be a lightweight microcontroller. In the ideal case i.e., when the swimmer is not drowning, all the parameter readings are not abnormal and they are within the limits. At that time, all the parameters will give some consistent values and there will be no huge fluctuation in the data. But when a swimmer is in danger of drowning, their heart rate increases, oxygen levels fluctuate, and body temperature changes rapidly. When these measurements are aberrant, such as when they are over or below the threshold value, the microcontroller detects the abnormality and triggers the alert system. The swimmer device works as a transmitter and the lifeguarding device (Central hub) works as a receiver. Figure **??** shows the Proof-of-concept of the proposed wearable sensor system.

In this project, all of the collected data is stored in the cloud for long-term analysis. This project uses an external Wi-Fi cloud connector to connect to the cloud.The microcontroller has different commands to connect to the cloud to transfer the data via Wi-Fi. Using HTTP requests on the cloud Arduino transmits the data to the IoT platform server. There are multiple approaches to connecting Arduino to the cloud.

There are many external connectors available and one of the most popular and suggested connectors is Nearbus. Nearbus is the cloud connector used to fully integrate Arduino into the cloud. This system maps the device memory into the cloud, and it is based on mirroring. It replicates a portion of microcontroller memory into cloud memory. The device is mapped to the cloud via the memory map process. To access this connector, the Nearbus connector has to be installed. Nearbus is simple, secure, and can easily connect the microcontroller to the cloud and it can be controlled using web services like REST API.

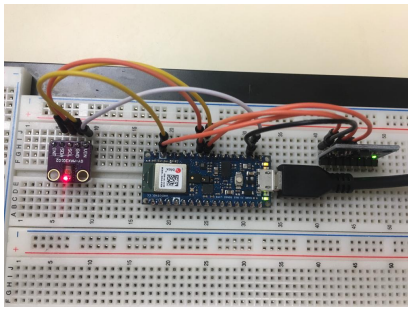

Figure 2: Proof-of-concept of the wearable sensor system

3 CONCLUSION AND FUTURE WORK

Currently, we are developing this prototype such that it can be integrated as an anklet. Our wearable will be developed as a standalone anklet that can help in monitoring the physiological signals for early detection of drowning. Our framework will be sealed with a soft flexible enclosure that can be worn by any user. As future research, we will integrate machine learning algorithms and train our system with relevant data of the vital signs of the swimmer to avoid getting a false alarm.

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