Drown prevention and flood detection monitoring system

(SmartGuardian)

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The supervisor/s should certify the proposal report with the following declaration

The above candidates are carrying out research for the undergraduate Dissertation under my supervision

Signature of the supervisor: Date:

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1. Introduction

1.1.Purpose

The purpose of the document is to give a detailed understanding about the wearable device and the user condition prediction algorithm which will be used in the *Smart Guardian*. And this document will explain the previous attempts done to overcome the problem addressed by Smart Guardian and development methodology. The main target of this document is the stakeholders of the research, research supervisors, team members and CDAP team.

1.2.Scope

This document covers how the wearable device will be designed and developed, the practicality of the wearable device, how it alerts the wearer and the other users of the Smart Guardian and how the user condition prediction algorithm works and the users get the alerts if someone using the wearable device in danger.

There are four main components in smart guardian, all of which have an essential part in delivering perfect results. This document is going to cover how the floating device is going to work as an intermediary communication device, and how it is going to receive data from the wearable device and read data from the floating device itself and sends data to the server.

1.3.Overview

The main objective of proposed product is introducing a full featured smart guardian system comprise with two devices which can be effective for ensure the people protection from aquatic environment. Identify the user condition and the flood prediction

In the Wearable device, it's main goal to measure the depth of front area and alert the wearer if he/she is going to a deeper area. The wearer will be alerted through a vibration sensor and the mobile app also will get notified. It also collects the pulse rate of the user to feed the algorithm to predict the user condition.

An algorithm to predict if user will be facing any difficulty will be implemented in the server. The pulse readings collected from the wearable device will be sent to the server using acoustic underwater communication and a GSM module placed in a floating device on the water (explained in another PPR of Floating Device and DD of Acoustic Underwater communication module)

2. Statement of the work

2.1. Background information and overview of previous work based on literature survey.

Speaking of safety in aquatic environments, the only step which was taken as a wearable device is the iSwimBand [1]. Which only capable of alerting parents if their children is drowning in the home pool.

But our proposed product, SmartGuardian demands the safety of in aquatic environments like rivers, lakes and oceans where children and elders might know how deep they are going to. So if they cannot swim and if they are reaching towards a deeper area they can take safety precautions before getting drowned.

Once somebody starts to drown, the end result is often fatal. not like different injuries, survival is determined virtually completely at the scene of the incident but there are many actions to prevent drowning and as well as the flooding. In here we are introducing a product which can help to survive from drowning and flooding. This product includes of two physical devices, a wearable device and a floating device. This document is going to cover the floating device is and its status. There are number of safety featured wearable devices that one can wear. But almost all of those can't communicate when they are inside water because the speed of the sound in determined by a combination of the mediums rigidity and its density, the more rigid the medium faster the speed of the sound, the speed of the sound in air is low because air is compressible, and because liquids and solids are very rigid it is very difficult to compress, the speed of sound in such area are generally greater than in gases,
So the floating device is there to overcome that problem by using acoustic waves to communicate between the wearable and the floating devices.

2.2.Identification and significance of the problem.

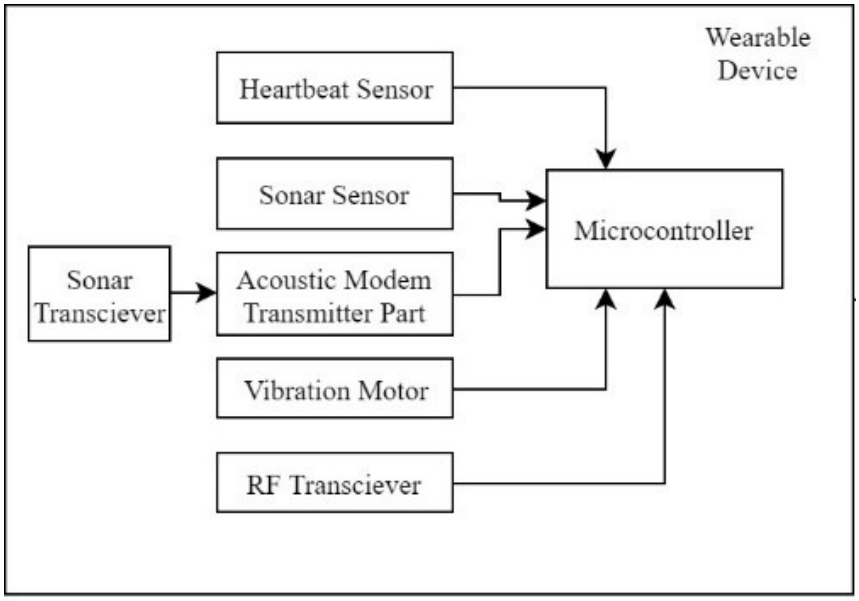
Aquatic safety is a critical matter that people should consider when they enjoy themselves in aquatic environments like rivers, lakes etc. But still there's only attention for children's safety on aquatic environments as well as swimming pools. Drowning is the major accident that may occur in aquatic environments and not only children, but also adults face accidents due to not being able to swim and not knowing their health conditions.

Also, there are rivers that occurs rapid floods so we can see that numerous lives have been lost because of rapid floods.

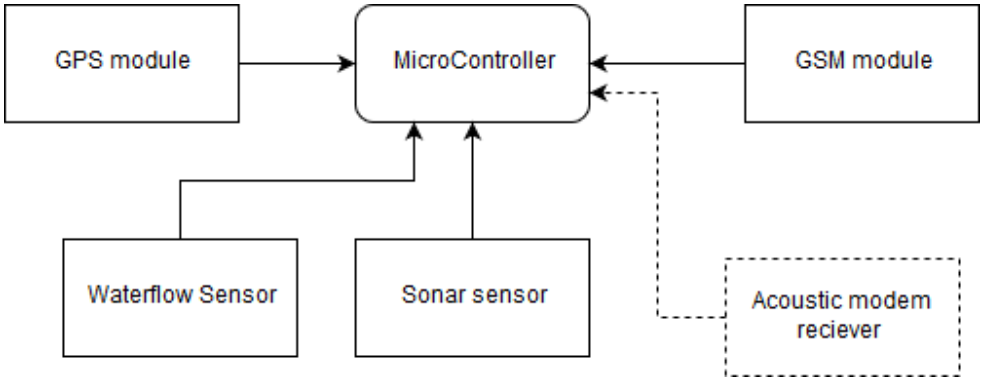
Sometimes people get helpless in water when they face sudden difficulties like breathing difficulties, muscle pains etc. and they even might get drowned.

2.3. Technical Objectives.

Wearable device will be based on Arduino Uno board because of its computational power. Also, the wearable device consists of Pulse Sensor, Sonar Sensor, Vibration motor, RF Transceiver.

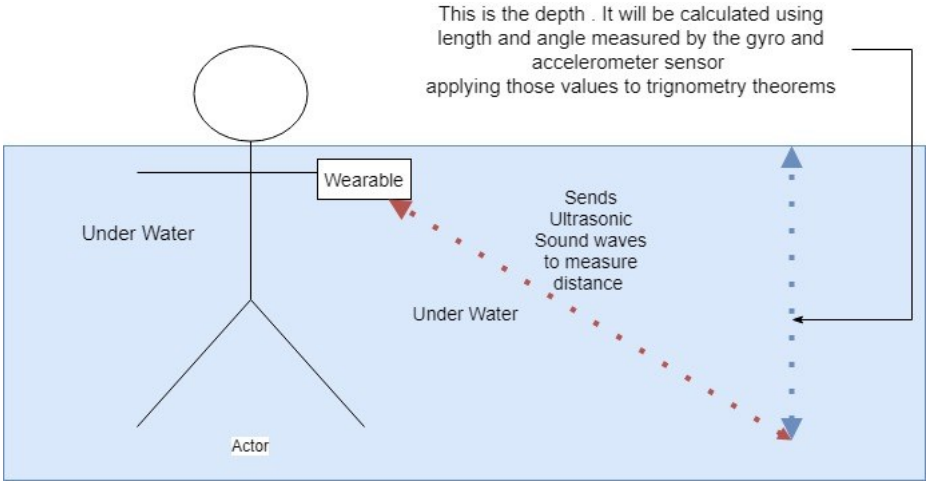


Floating device will be based on Arduino Uno board because of its computational power. Also, the floating device consists of GPS module, Sonar Sensor, water flow sensor, RF Transceiver, GSM module and an acoustic modem receiver.



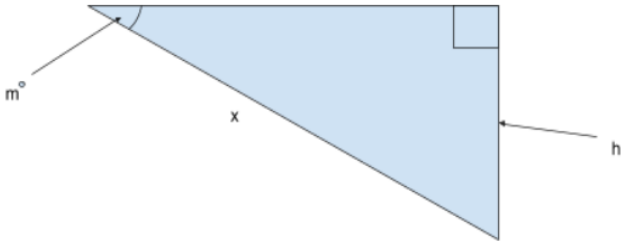
3. Research Methodology

3.1. Estimating the depth of water



Sonar Sensor is used to measure the distance from the wearable device.

Calculation of the depth of waterbody is done using trigonometry theorems.



Suppose that the angle of wearable device is *m* and the distance from riverbed to wearabale device is *x* and the depth is *h*

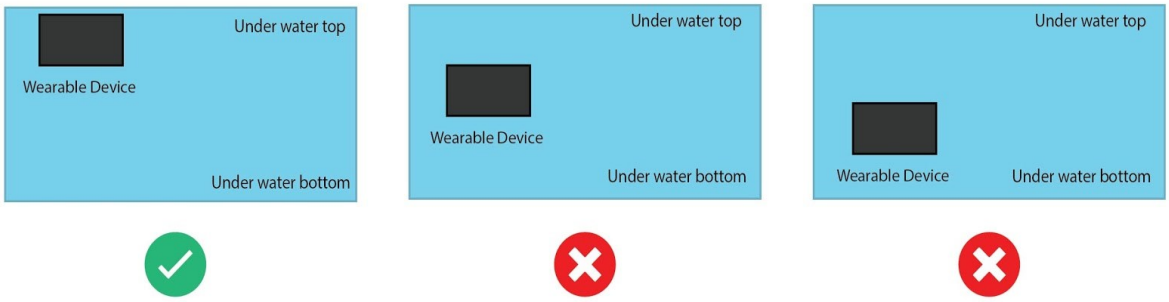
Degree of angle (m) is calculated by the Gyro and Accelerometer Sensor (MPU-6050).

Since we acquire the degree of angle and the slant (hypotenuse) using the respective sensors we can estimate the depth of the water (side opposite) according to trigonometry using below formula.

$$Sin(m) = h/x$$

$$Hence,\ h = x.Sin(m)$$

To measure the depth, the wearable device should be placed as follows.



Wearable device has a small screen to display the depth of the water and once the device identify the depth as dangerous it will vibrate the device according to the alert.

3.2. Predicting user condition

Pulse rate will be captured from the pulse sensor, and it will be transmitted to the server.

In server, an algorithm will be implemented to predict each user's condition using the change of pulse rate at each timestamp.

3.3. Design and development of Waterproof Wearable Device

Since wearable device will be used underwater and it consists of numerous electric components, one and each electric component should be placed inside a waterproof vessel. And also, the wearable device should be minimal in size as much as possible to be a proper wearable device. So, the vessel of the wearable device will be designed using 3D modeling tools and will be 3D printed. By doing that, all electric components can be placed using minimum space.

3.4.Floating Device

We implement this device because the server could not be able to communicate with the devices, which are in the water. The floating device in with a set of sensors for each task. To determine the depth of the water it has a sensor called depth-sensing sonar sensor and to determine the speed of the water flow it has a sensor called the water flow sensor. Floating device capture the data, which are received from the wearable device at the same time sends all data to the server.

This is not the only purpose of this device, which is capable of doing. If someone drowning, we trigger the alert to our mobile application. However, we need to locate the affected person. Therefore keeping track of a person in the underwater is an essential part of this process. To achieve this we follow a process as below that how we tackle this problem.

- A GPS tracker In the floating device so we'll know the exact location of each floating device.
- When a user data gets sent to the floating device a timestamp will also be included in the data file
- After receiving the data file, the timestamp will be converted to local time and compare with the time received and calculate how much time did it take the data to arrive.
- With this result, we are going to calculate an approximate value and show it in a radius respective to a floating device.

As mentioned earlier, the floating device has two communication modules to communicate with the wearable device, which is the underwater communication and RF communication to capture the data from the sensors in a wearable device to send data to the server.

3.4.1. Flood Data

To detect a flood the water level and pressure sensor will collect data and send that data to the back end for further calculations.

3.4.2. Detecting user location

When a user data gets sent to the floating device a timestamp will also be included in the data file. After receiving the data file, the timestamp will be converted to local time and compare with the time received and calculate how much time did it take the data to arrive. With this result, we are going to calculate an approximate value and show it in a radius respective to a floating device.

4. Test data & analysis

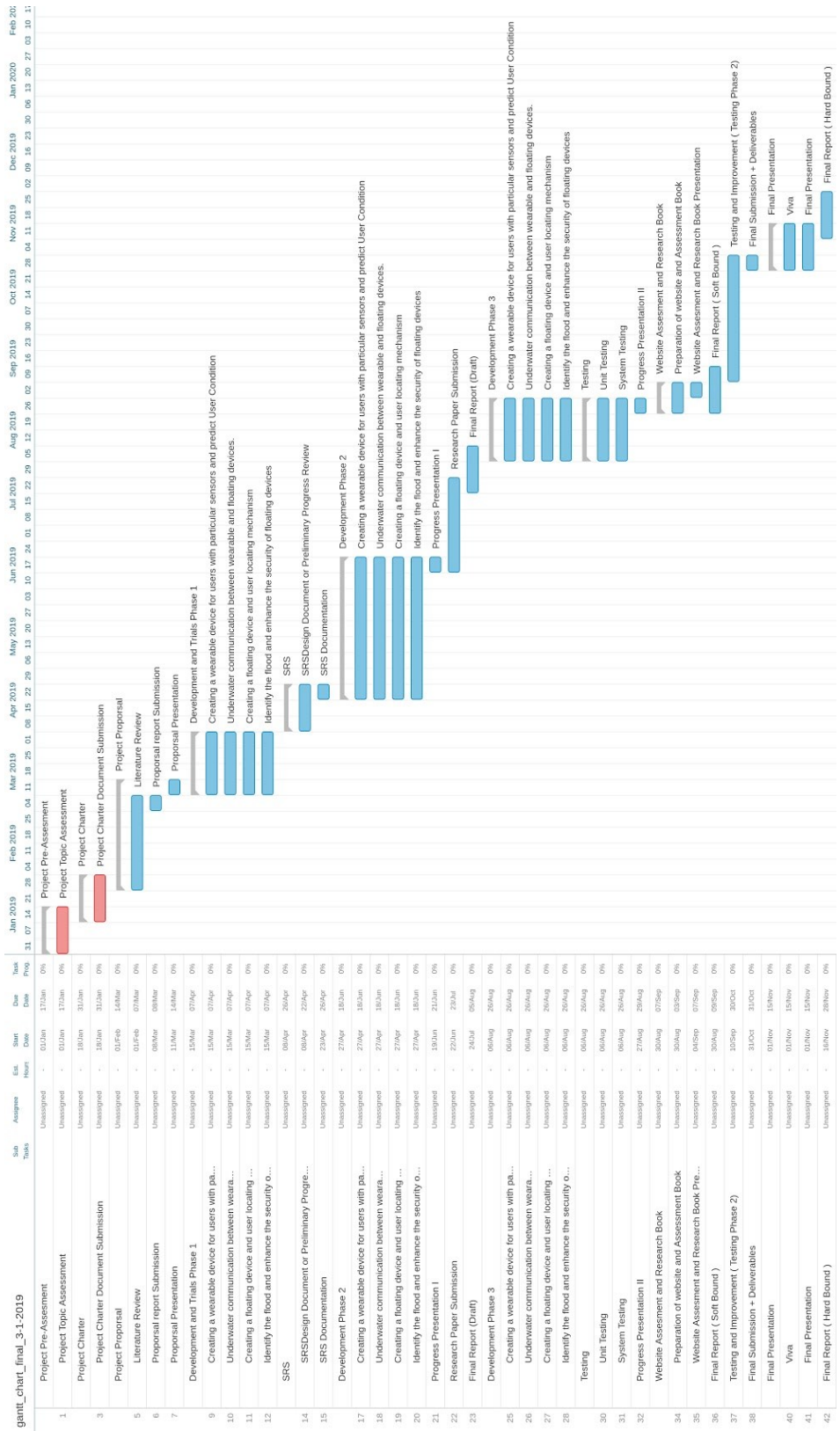
For the algorithm that predicts user condition, the pulse rate is collected from the wearable device and it will be transmitted to the server. The Pulse rate is captured from the pulse sensor and it will be wrapped with the timestamp and wearable device id.

For the algorithm that uses for the flood prediction, will get the data from the water level and pressure sensor

5. Anticipated benefits

- User of wearable device will be able to know he/she is going to a deeper area.
- Life saver / person who has the mobile app will be able to know that a person in water (if he/she is wearing the wearable device) is in a potential threat (Health / Environmental threat like rapid floods).
- Will be able to know before hand and alert authorities if there is a possibility of a flood.
- We will be able to locate the user wearing the wearable device.

6. Project Plan or schedule



7. Research Constrains

- As we were instructed, initially the device will be tested on a Swimming pool.
- Due to high-cost of underwater sonar sensors, low cost waterproof sonar sensors will be used.
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8. Specified deliverables

The final outcomes of the research component are,

- Wearable device to estimate the depth of water and collect user pulse data.
- Algorithm to predict the user condition using collected pulse data.
- A floating device to get data from the water, and act as an intermediary device

References

[1] Emarketer.com, 'Social Networking Reaches Nearly One in Four Around the World', 2014. [Online]. Available: https://www.digital.nyc/startups/iswimband. [Accessed: 24- Feb - 2019].