DES3

Swimming Pool Drown Detection and Rescue System

FYP Proposal

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DES3

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Declaration of Project Nature

This is a joint department project specially endorsed by the School of Engineering.

This crossed department project is submitted for fulfilment of both Mechanical and Aerospace Engineering Final Year Design Project (MECH 4900) and Computer Engineering (COMP 4981 or CPEG 4901). This project is also used to fulfil the Engineering School requirement on Integrated Final Year Project - First and Second Major (ENGG4901 and ENGG4902).

Thus, the grouping included:

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Executive Summary

Due to the noticeable lifeguard shortage in Hong Kong, the current lifeguards are overworked and may cause fatigue and the lifeguard's attention to drop [1] [2] [3]. This magnified the chance of drowning without being noticed immensely.

In response to the concern of drowning, there are some current systems that are mainly developed to alert and support the lifeguard to observe the drowning people under water. Poseidon is one of the examples that developed to the commercial level. However, these applications focus on the alert upon identifying victim who are already drowning.

Our Swimming Pool Drown Detection and Rescue System, on the other hand, focuses on the entire supporting architecture. In particular, we focus on identification of pre-drown [4] victim with an active rescue system. In our system, each swimmer will be given a wearable device to measure and detect any abnormal physical conditions by monitoring blood oxygen level and heartrate. When an abnormal signal is detected, the web application will alert the lifeguard and shoot a lifebuoy to the victim's location under the lifeguard's attention.

In our system, we would further focus on the indoor 25-meter training swimming pool setting. This venue selection not only enables a better focus of the rescue system on fundamental functionality but is also chosen for being the most common type of pool in Hong Kong's public swimming pool selected to maximum the possible usage.

Contents

1. Introduction

1.1 Background

In Hong Kong, lifeguard shortage is a yearly problem. During summer, the peak season of swimming, the frequency of insufficient lifeguards leading to the closure of swimming pools and beaches increases significantly (Local lifeguard union, 2019). In 2019, some swimming pools and beaches were closed due to a shortage of nearly half of the required number of lifeguards needed during peak season [5

Under the pandemic, the problem of lifeguard shortage had been worsened. The keen competition between the public and private sector with the opening of Water World Ocean Park exacerbated the lack of lifeguards. According to a report by the Standard in August 2021, there were no lifeguards at half of the beaches resulting in temporary close for some of them. Due to the closures, the training for newly recruited lifeguards and revalidation for qualified lifeguards were cancelled [6]. This reflects the seriousness and the impact of lifeguard shortage.

One of the lifeguard's main responsibilities is maintaining safety. However, without enough lifeguards at the swimming pool implies there will be not enough or even no people monitoring the safety of the pool users. Among the safety issues, drowning is the most severe. As shown in Figure 1, it is noteworthy that poolside drowns took up 13% of all drowning cases, with 8% in the private sector and the other 5% in public swimming pools [7].

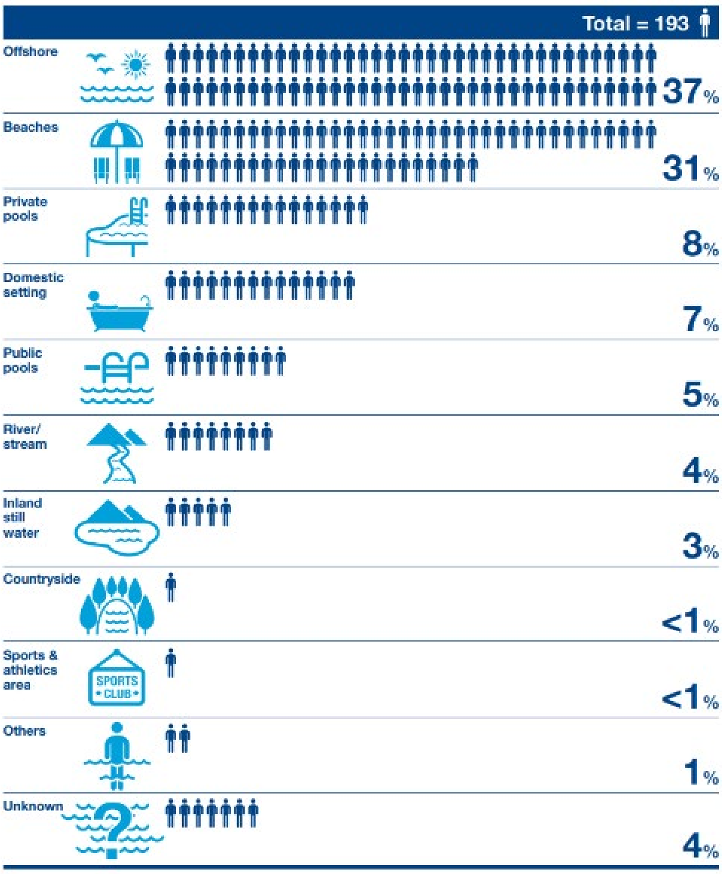

Figure 5. Drowning deaths by location, 2012-2016

Figure 1 Drowning Death by location in 2012-2016 [7]

Furthermore, even for swimming classes with a coach, there are occasionally cases of drowning for young swimmers. This increases the need for a better system. With the knowledge and concern mentioned earlier, improvement in drowning detection and rescue is imperative.

With the above considerations and case selection, to ease the lifeguard shortage pressure, a Swimming Pool Drown Detection and Rescue System is introduced to assist the lifeguard in efficiently identifying and saving the drowning victim.

Despite that there have been some developing drowning detecting systems, the current designs are mostly focused on drowning detection and warning. In our system, we would also include a follow-up action to shoot the lifebuoy to rescue the victim. With the drowning detection system, warning system, and lifebuoy throwing in one system, the signal transmission and reaction time can be further minimized. The rescue time can be shortened and become more automated. This aims to achieve a higher rescue rate since faster rescue means a higher chance of survival and fewer injuries experienced by the victim.

The drowning detection and warning sub-system is a combination of an electronic wearable device, a computer system for drowning alert trigger, a victim localization and a web application for the lifeguard to decide what to do when drowning is detected. Electronic components and computer programming will be utilized here.

The lifebuoy throwing sub-system consists of a robot that could move the mechanical parts such that it aims at the location of the drowning person and throws a lifebuoy for rescue. The throwing mechanism will be implemented by our Mechanical Engineering team[1] for the mechanical design and modification.

In the current development of our Final Year Project, we would focus our system on indoor swimming pool rescue for Olympic Pool Sized pools. In the future, the system may not be limited to indoor or outdoor swimming pools but also be used at beaches or the seaside.

[1] MECH FYDP team consists of Lok Yan Loreen LEUNG, Tsz Ho CHAN, Ka Hei LEE and Prof. Lok Wang Robin MA (Supervisor).

1.2 Objective of the Project

The aim of our project is to detect and rescue drowning victims in the pre-drown stage in a swimming pool. Although an IoT wearable device detection system will be developed to identify the victim, the lifeguard will also then be alerted through the Web application and is given a choice to decide whether to shoot or not. Once the choice to shoot has been made, the lifebuoy will be shot to the drowning victim's location to aid the victim's self-rescue capability and shorten the time needed for lifeguard rescue.

There are three parts in the system, namely (1) drown detection sub-system; (2) drown-alarming sub-system and (3) a lifebuoy throwing sub-system. Though a combination of the three systems, the rescue speed might be able to be further minimized.

With this aim in mind, we define the following project objectives:

Objective 1: To build a wearable device that identify potential drowning victims

The wearable device will be responsible for detecting the blood oxygen level and the heartbeat of the swimmer during swimming for every 30 seconds. The device will then send the signal to the web application control. Within the wearable device, some key abilities include:

1. Enhanced waterproofness to 5 BAR (only for swimming, but not suitable for water sports) [8] of the wearable device. This is used to support the sensor to function well for swimming in a swimming pool.
2. Accurate collection of sensor's data under water and during exercises.
3. Analysis of the data collected by the sensor to determine whether the situation is abnormal or has fallen into the drowning category
4. Transmitting the drowning message information from the swimming pool to the web application control system beside the swimming guard. The distance would be approximately 50m above water and 1m depth in water.

We will also explore the possibility of adopting a camera-based approach to locate the drowning swimmers who sunk with their heads in the water for 15 seconds as a hybrid approach to be able to identify the stage 2[2] drowning victim. In this approach, the camera would be mounted underwater inside the swimming pool to capture the swimmers' actions and moments.

Objective 2: To locate the drowning victim accurately with a subsystem

The location detection subsystem will be developed by in camera-based approach, where visible light detection by a camera system is used to identify the location of the possible drowning victim.

[2] Stage 2 means the victim chokes in water, and his/her vocal cord involuntary spasm to protect one's lung. The detail in 1.4.2 Related Research

When the victim's wearable device sensor detected abnormal readings or have reported drowning, the Arduino LED device on the wearable device will be lit up for the location system to detect the light. A camera mounted on the top of the swimming pool will be used for checking the location of the emitted light from the wearable device. This camera selection and location further enhances the identification of the location. The computation of the camera-light location system would be done by the external computer system due to the large processing power.

Objective 3: To build a user-friendly application to alert and assist the lifeguard in making drown and rescue decision

The aim of building an application is to allow the lifeguard to make the final decision making for the lifebuoy throwing mechanism operation. Since the lifeguard should be a professional judgment on rescue, the final decision making would be fall back on the lifeguard.

In order to allow the lifeguard to continue the regular routine checking while being aided by the system, there are three requirements. These requirements are set based on making the application easy and require minimal attention for the lifeguard to use.

The criteria include:

- User-friendliness for first time users. Since the lifeguard might not be professional in technology, it is suggested to have a simple and straight forward interface.
- Responsiveness of the application. Since rescue is a timely manner, the system should have a minimal delay, so the lifebuoy throwing system can be initiated once the confirm signal is sent.
- Clarity. The button and interface should be clear and easy to operate. Since rescue is a timely issue, it is not preferred to have the situation of wrong button pressing occur.

Node.js will be used to develop the web application to enhance compatibility. Different tablet computers and mobile devices may also use the application. This allows the flexibility of the management of the swimming pool. We will also simulate the swimming setting in the application to make the situation more manageable for the lifeguard to use.

Objective 4: To Integrate the Detection and Warning System with the Mechanical Lifebuoy Throwing System

For this objective, due to the immediate rescue aim, the signal transmission between the Detection and Warning system and the Mechanical Lifebuoy system should be fast. Thus, various signal transmission approaches will be explored, including but not limited to Wi-Fi transmission and cable transmission.

Moreover, the data transmitted from the detection and warning system, in particular the location and the basic sensor information, should be merely essential and sufficient data. This enables the focused resources on the operation of the Mechanical Lifebuoy system.

There may also be some mechanical lifebuoy throwing system data, including the current shooting stage, possible error message, and power status, transmitted back to the web application for error reporting and advanced monitoring of the Mechanical System for the lifeguard.

Objective 5: (MECH) To calculate and test the shooting distance and shooting angle

This part is responsible by the students from the MAE department.

A three-dimension shooting machine is used. A spherical polar coordinate system, as illustrated in Figure 2 is used to control the shooting distance. The magnitudes of two angles and the shooting velocity are calculated by using the data collected by the subsystem. By controlling these parameters, the life ring can be shot to different positions.

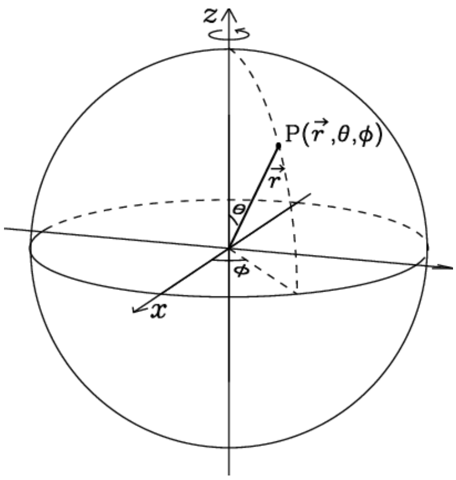

Figure 2 Figure illustrating the spherical polar coordinate system

Objective 6: (MECH) To shoot the life ring that to the potential drowning victim's location

This part is responsible by the students from the MAE department.

Air cannon and a wheel shooter are considered. For air cannon, air pressure is used to ignite the launching. For the wheel shooter, two wheels, which are driven by two motors, are used to accelerate the life ring in order to create a projectile motion. The shooting time is targeted to be smaller than 20 seconds.

1.3 Potential Challenges

After our investigation and research in the project, we can foresee that we need to overcome the following problems:

1. Wireless communication is unstable in our usage scenario as the common signal has great attenuation underwater.
2. Inaccurate measurement of heart rate and blood oxygen underwater.
3. Lack of empirical data in drowning.

1.3.1 Unstable wireless communication

Signal attenuation is one of the common problems in existing IoT drowning detection approaches. According to Figure 3, common communication protocol in IoT such as Wi-Fi, and Bluetooth has significant attenuation underwater. Those protocol does not work well in our use case. In [9], Researchers used URAT 433Mhz as their communication protocol. Although URAT 433MHZ is the second peak in resistance to signal attenuation, they still encounter loss of radio frequency signal between the wearable device and the monitoring hub. While losing signal is a problem, it is also an opportunity for detecting drowning, as the loss of connection is a sign that the user is downing deep underwater. In [5], they make use of signal loss as the last resort of downing detection. If the signal lost is more than a certain period, the user is classified as drowning.

To overcome this problem, our current idea is to make use of visible light, as visible light has the highest penetration depth underwater. By emitting visible light from the wearable device, we can overcome the signal attenuation problem. A camera can be used to capture the user's position, and notice the surrounding swimmers. However, we need further experiments to study its attenuation and limitation.

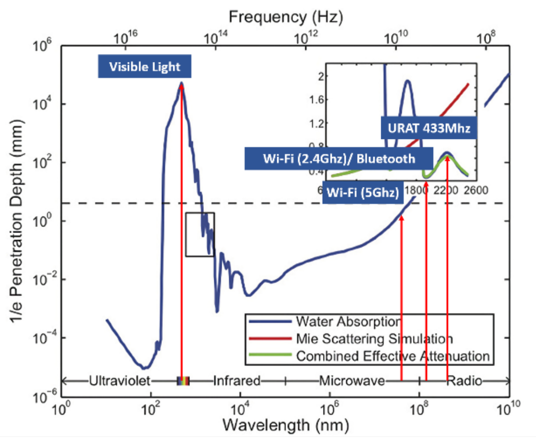

Figure 3 penetration depth of different wavelengths underwater, modified from [10]

Communication protocol	Wavelength (nm)
Wi-Fi (2.4Ghz)	1.2×10^8
Wi-Fi (5Ghz)	6×10^7
Bluetooth	1.2×10^8
URAT 433Mhz	6.93×10^8
Visible Light	380-700

Table 1 Wavelength of common communication protocol

1.3.2 Inaccurate measurements

Heart rate and blood oxygen measurements are likely inaccurate underwater. Existing commercial products (Samsung Watch) also state this limitation on their support page: “Its accuracy may vary due to physical factors that affect light absorption and reflection” [11

Now, we are conducting tests on the measuring sensor MAX30100, assessing heart rate and blood oxygen measurement accuracy in different situations like underwater and intense movement. If the measurement cannot be done underwater, we will build an additional water-sealing enclosure around the sensor and user’s skin, keeping it completely dry to eliminate errors introduced by the entry of water.

1.3.3 Lack of empirical data in drowning

Since it is unreasonable to literally use a drowning victim to obtain the movement, heart rate, and blood oxygen data, it is difficult to set up an accurate threshold for drowning detection and nearly impossible to put our device in a real test.

Our best effort will be estimating the threshold using the data from medical research on the physiological effect of a drowning person and do tests on simulation of drowning by holding breath and actively breathing more to trigger hyperventilation. Although our project will be infrastructure work of the drowning rescue system, the accuracy needs further investigation from the medical side, which is out of our project’s scope.

1.4 Literature Review

There are several drowning alert systems and drowning rescue robots that are used commercial use or being researched. We will investigate their approaches, and examine their advantages and disadvantages with different criteria.

1.4.1 Existing System

We have studied the following existing systems: EDDS [9], SwimTrack [12], Automated Underwater Lifeguard [13], Artificial Intelligence for Drowning Detection and Swimmer Performance Analysis System [14] [15], SwimEye [16]. The systems mentioned above all use different approaches and have different abilities, so a comparison table is listed after the detailed description to summarize the key points for clarity.

EDDS (Early Drowning Detection System) [9]

EDDS uses the PPG (photoplethysmogram) sensor to monitor the user's abnormal change in heartrate. Before the victim drowns, he will experience a panic situation, where the heartbeat may increase drastically due to hyperventilating. EDDS monitors heartbeat that drastically raises to detect victims before they drown. To continuously monitor the user's heartbeat, the sliding window technique is used. It counts the heartbeat samples of the first 10 seconds and multiplies by 6 to provide a heartbeat reading per minute (BPM) and continuously shifts for one second to give a new heartbeat reading. The accuracy of EDDS is good. In Figure 4, the area under the ROC curve is 0.94, where 1 is a perfect test, 0.5 is a useless test. However, the position of the victim is not collected in EDDS, which makes rescue less efficient.

In terms of the communication method, 433MHz Universal Asynchronous Receiver/Transmitter (UART) is used in EDDS as the wireless communication protocol due to the ability to establish long-range wireless transmission. Even though 433MHz has the second maximum ability to penetrate water, loss of radiofrequency signal still occurs.

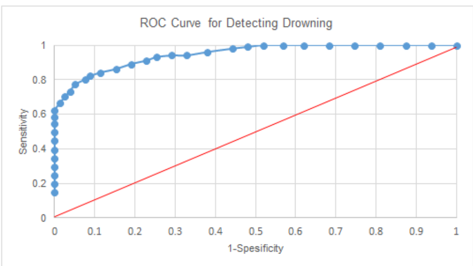

Figure 4 ROC Curve for Detecting Drowning [9]

Figure 5 Drowning Detection Device wear as a headband [9]

SwimTrack [12]

SwimTrack is a drown detection research utilizing the fact water will block RFID signals. In a swimming motion, the wearable RFID is detectable while the wrist is above water, indetectable while the wrist is underwater. By recording the "detectable/indetectable" frequency of swimming and drowning motions, they found that natural swimming strokes have a regular pattern but drown stokes have a random frequency. Therefore, drowning can be differentiated from swimming through the frequency at which motions of the RFID tag are detected.

Although the RFID approach is innovative, it fails to meet the needs for real-world application. When located beyond 2 meters, the RFID tag disappeared from the detection range of the antenna, which is unpractical to deploy in a 50m*20m swimming pool. Moreover, this research still incorrectly classified the state of drowning as it should require more empirical data to produce a decent error rate.

Automated Underwater Lifeguard [13]

Automated Underwater Lifeguard is an autonomous robot that uses computer vision with a haar cascade and convolution neural network to detect drowning victims in a swimming pool. The drowning location is obtained by an affine transforming the location of the victim into a map grid. Then the robot travels toward the XY coordinate and deploys a float to keep the victim afloat. This robot is one of few examples that has an active rescue procedure.

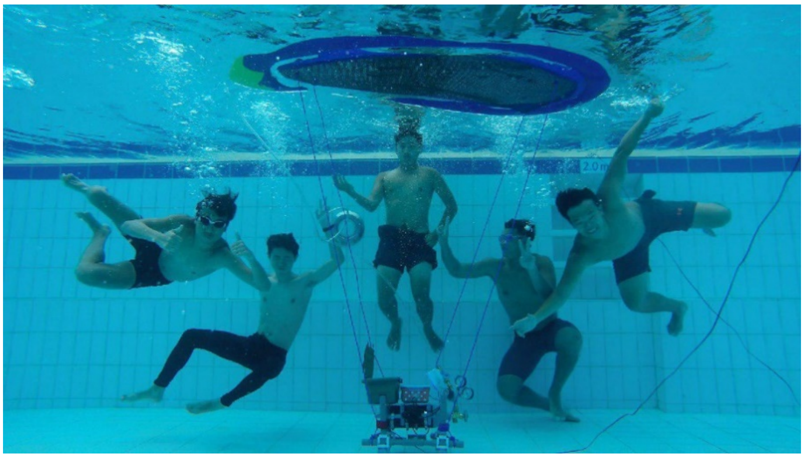

Figure 6 Photo of the Automated Underwater Lifeguard with the development team taken underwater [13]

Artificial Intelligence for Drowning Detection and Swimmer Performance Analysis System [14]

This project uses computer vision approach to detect drowning. A total of 16 cameras are placed around the pool, 12 at different points underwater and 4 in the ceiling. The footage captured is then labelled and fed into the computer to teach the AI about body parts and movements. Once the computer has accumulated enough data, it can monitor the movement in the pool.

When the threshold of drowning probability is reached, for instance in Figure 7, an audio alarm is triggered, and the location of the victim will display on the computer for the lifeguard. This system can process the image into body skeleton movement to analyse drowning without recording the swimmers.

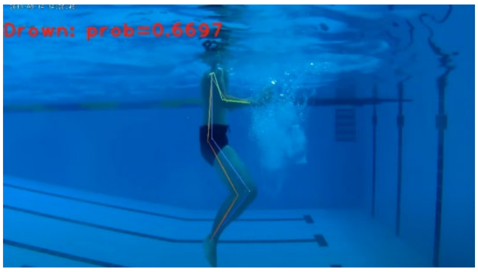

Figure 7 Drowning Detecting in Action [15]

SwimEye [16]

SwimEye has more than ten years of experience in the pool security system, currently used in 120+ swimming pools. This system places their underwater double camera houses between each other within 9 meters to create monitoring overlap and additional cameras to cover the dead zone. This camera configuration allows this system to monitor 100% of the pool basin area in most pools.

Footage from those cameras is automatically monitored by an object recognition software called state-of-the-art. When it detects a swimmer in distress on the bottom of the pool, it will raise an alert. At first, an early warning yellow alert will rise, which implies that a swimmer might be in the first stage of drowning, a yellow box will catch the attention of lifeguards to that camera, the lifeguard can click "reset" to stop the yellow alarm. If the alert lasts for more than 15 seconds, a red alert will raise with visuals and audio to alarm the lifeguard.

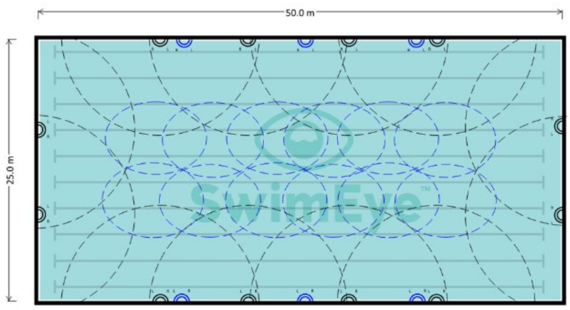

Figure 8 SwimEye's camera placement [16]

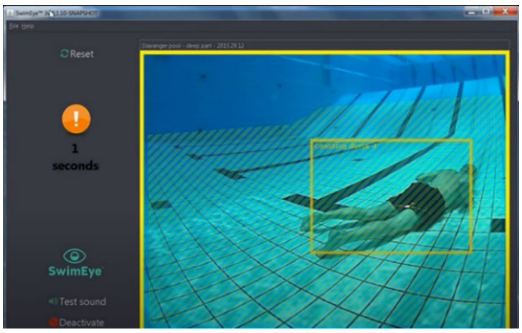

Figure 9 SwimEye detected a yellow alert situation [16]

Approaches	*EDDS*	*SwimTrack*	*Automated Underwater Lifeguard*	*AI for Drowning Detection*	*SwimEye*	*Our Design*
Active Rescue Method	N/A	N/A	Deploy a float by underwater robot	N/A	N/A	Shooting a float
Detect Method	Heart rate	RFID	Computer Vision	Computer Vision	Computer Vision	Heart rate
Positioning Method	No	No	Computer Vision	Computer Vision	Computer Vision	Computer Vision

Table 2 Comparison table of approaches of existing system

Criteria	*EDDS*	*SwimTrack*	*Automated Underwater Lifeguard*	*Drowning Detection with AI*	*SwimEye*	*Our Design*
Cover Area	Within signal	Very small	Robot's sight	Within camera	Within camera	Within camera + anywhere (Blink function only)
Detect time	Pre-drown	Drown	Drown	Drown	Sunk	Pre-drown
Accuracy	Good	inaccurate	Depends on the amount of data collected	Depends on the amount of data collected	Commercial grade	Similar to EDDS
Cost	$$ Wearable +Server	$ RFID+ Antenna	$$$ Underwater Robot	$$$ Cameras+ Powerful computer	$$$$ Commercial	$$ Wearable +Server
Active Rescue	No	No	Yes	No	No	Yes
Active Rescue Time	N/A	N/A	Take time to travel to under the victim.	N/A	N/A	Fast, within seconds

Table 3 Comparison table of pros and cons of existing system

From Table 2 those detecting systems can be divided into wearable approach and computer vision approach. While computer vision approaches can detect drowning victims, it is worth noting that their solutions rely on sufficient empirical drowning data. Moreover, computer vision approaches can only detect victims that are drowning or even sunk, while the wearable approach can detect the pre-drown period, which is important in the time-critical life-saving task. As the wearable approach does not rely on a large amount of empirical drowning data and has the advantage in detecting speed, EDDS is the model that our design base on.

Our design inherits most of the features from EDDS, on top of which provides positioning function, resolves the problem of signal loss, and an active rescuing system faster than Automated Underwater Lifeguard.

Compared to the computer vision approach, position function and signal attenuation under water are the weaknesses of the existing wearable approach. Our design can fill in those niches. As visible light has the highest penetrate-depth underwater, by making use of led integrated into the wearable device, we can position the user by the light emitted from the wearable device, avoid electromagnetic wave attenuation and as an additional function, it can alert swimmers nearby.

Furthermore, an active rescuing system is rarely implemented in existing works. The Automated Underwater Lifeguard is the only indoor example we found. The underwater robot travelling in a 25m by 11m standard swimming pool takes a significant amount of time. It will be meaningless if it is slower than a lifeguard, therefore we will try a new shooting approach that takes less than a few seconds to reach the victim.

1.4.2 Related Research

Physiological Effect of Drowning

Many may think drowning victims will scream and have rapid movement when drowning, but that is incorrect. According to the World Health Organization (WHO), the definition of drowning is “Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid.”, “Any submersion or immersion incident without evidence of respiratory impairment should be considered a water rescue and not a drowning.” [4].

In stage 1 pre-drowning, the victim will panic and react with violent struggling, while still being able to scream for help. Also, hyperventilating will occur, leading to a sudden rise in a heartbeat [9]. This stage will last for 20 to 60 seconds for adults, 10 to 60 seconds for a child [17].

In stage 2, when the victim aspirates water, it will trigger laryngospasm, which means the vocal cord will spasm to block the airway and stop water coming in to protect their lung. However, it also blocks the airway of breathing, which leads to brain hypoxia. In this stage, the victim can hardly be differentiated from a beginner swimmer as the victim is fatigued from the violent struggling and cannot yell for help due to laryngospasm [17] [18

In stage 3, laryngospasm stop due to brain hypoxia, aspiration of water continues. Hypoxemia quickly leads to loss of consciousness and apnea. The sequence of heart rhythm deterioration is usually tachycardia, then bradycardia, pulseless electrical activity, and finally cardiac arrest [4].

PPG (Photoplethysmogram)

PPG is an optical technique used to detect volume change and oxygen change of blood in the peripheral circulation. When infrared (IR) travel through human tissue, it gets absorbed by bones, skin pigments, and blood. To measure heart rate, PPG detects the reflected IR intensity change. Since blood absorbs more IR light, when blood volume gains, the IR intensity reflected will decrease, vices versa [19]. For blood oxygen, we detect the colour of light reflected. Blood with sufficient oxygen will absorb more infrared and reflect more red light, with less oxygen will absorb more red light, makes reflected light appear bluer [20].

A field that makes use of PPG is air safety. According to Air Safety Institute Safety Alert, when a pilot measured blood oxygen saturation is below 90%, his mental function begins to deteriorate, he should receive enough oxygen to function normally. Therefore, we may consider 90% of blood oxygen saturation is in a danger zone [21].

Although PPG is a cheap and easy way to measure heartrate and oxygen levels, it has its limitation. PPG is inaccurate in tracking the PPG signals during daily routine activities and light physical exercises because of Motion Artifact (MA) caused by hand movement [22].

As a counterargument, there are commercial wearable health devices such as Garmin Venu and Huawei Band 6 that does all-day monitor. Take ZOLL's R Series Pulse Oximeter (SpO-2) as an example, during the no-motion condition, its accuracy is within ±2%, and during motion conditions, it is within ±3%. The error range is acceptable, especially in extreme cases like hypoxia [23].

2. Methodology

2.1 Design

2.1.1 Design Philosophy

In order to maximize the ability of the system to rescue, there are a few design principles to be taken into account.

1) Responsiveness

   As an active rescue system, the response time has to be short to save time to rescue. Thus, the response and signal transmission between different system have to be minimal.

2) Modularity

   Having the system divided into sub-system, they are able to contribute individually to alert and thus support the drowned rescue decision making of the lifeguard. This also facilitates the debugging and easy maintenance of the system in the long run.

3) Optimised for the Swimming Pool Environment

   Being a computer system operated in a swimming pool, durability is very important. Since electronic components will be easily damage upon water contact, the material selection should be carefully made.

4) Minimal disturbance to the regular routine

   Being a rescue system supplementary to the lifeguard observation, the system is not designed with any purpose to replace lifeguard professionals. Thus, lifeguards should be not disturbed or are required to spend additional attention to observe the report from the system. The system should be mainly automated and have its own ability to alert the lifeguard instead. Additionally, the location and the installation of the system should not affect the regular operation of the swimming pool or

5) Safety

   Being used by the poolside and as a rescue system, the system aims to rescue instead of causing casualty. Thus, the insulation of electricity becomes crucial. Moreover, the system set up should not induce possible injury.

2.1.2 Design Workflow

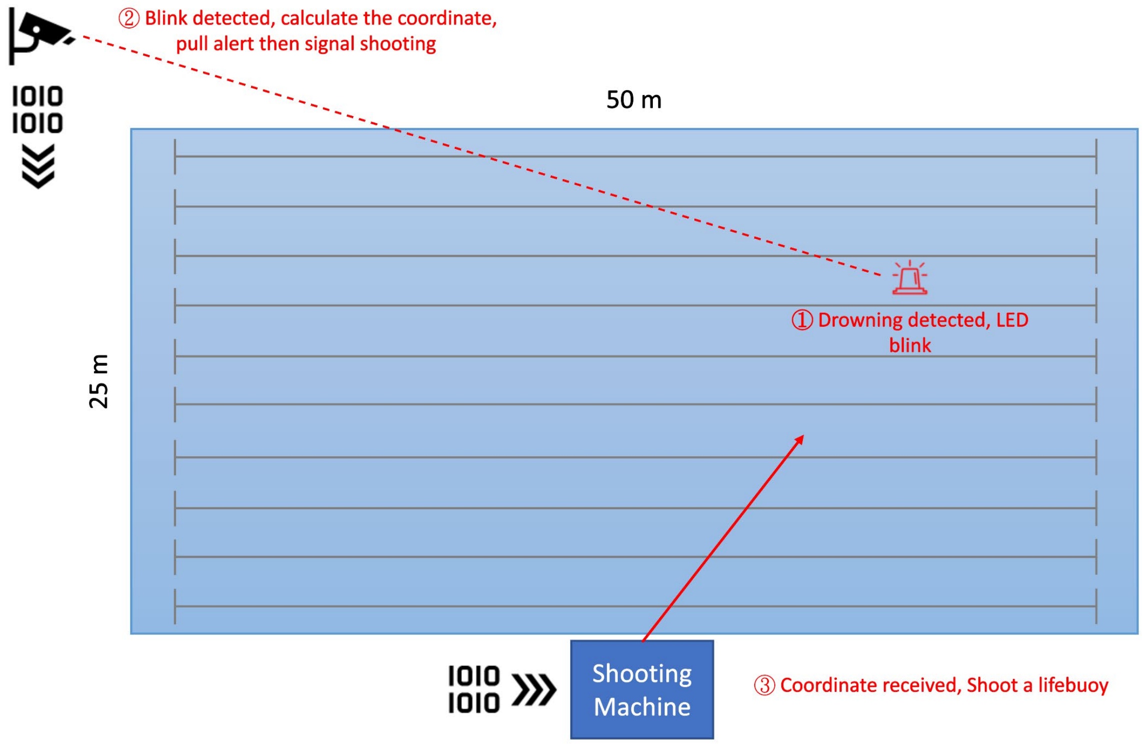

Figure 10 Drawing to illustrate the whole system [self-produced]

Our Swimming Pool Drown Detection and Rescue System consists of four main components interacting in real-time. They are the drown detection sub-system, drown location detection sub-system, drown-alarming subsystem and lifebuoy throwing sub-system.

2.1.3 Design Components for Drown Detection Sub-system

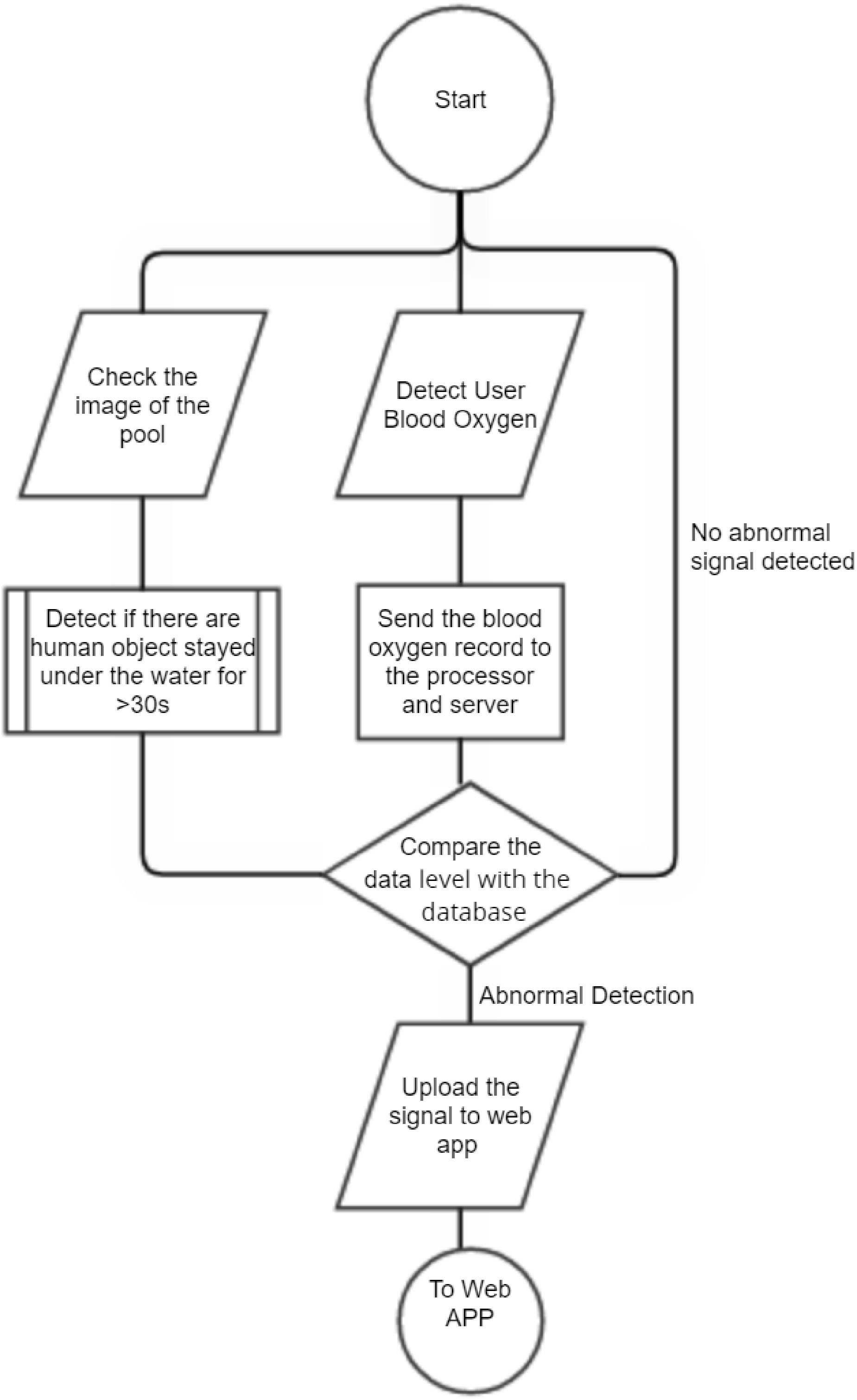

Figure 11 Flowchart representation of the drown detection sub-system

For the Drown Detection System, the main approach is using the MAX30100 blood oxygen and heart rate detection to monitor the user's data and information. As illustrated in Figure 11, after the user's data collection, the data is compared with the database. A threshold is currently planned to be collected by the medical review on drowning. However, we would also try to use breath-holding and daily monitoring of data to collect and get familiar with the data. If an error or abnormal signal is detected, the alert signal will be sent to the web application hold by the lifeguard.

In this current progress, several approaches will also be tested. We would also investigate the possibility of developing a hybrid approach of having an underwater camera to spot the drowned victim who stayed too long at the bottom of the pool. The approach will be further decided according to the development of the blood oxygen and heartbeat approach.

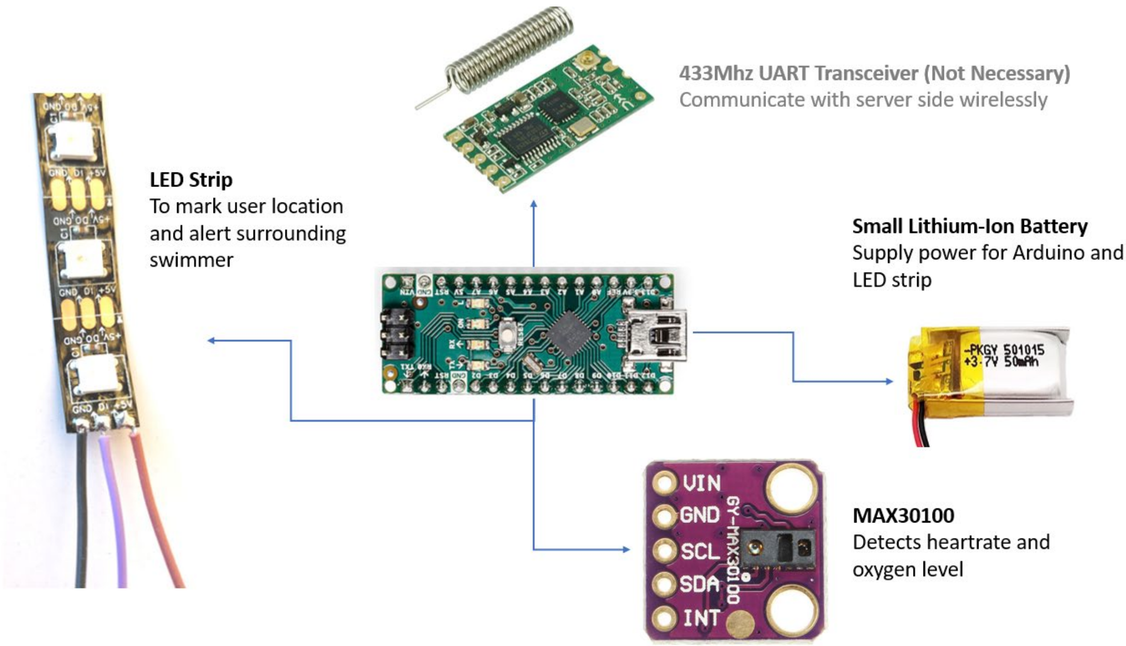

Figure 12 Hardware diagram Modified from [24] [25] [26] [27] [28]

As shown in Figure 12, the wearable device will consist of an Arduino, MAX30100, LED strip, small lithium-ion battery, and possibly 433Mhz UART Transceiver, and here are their functions:

1. The Arduino is the brain of the wearable device, used for processing the user's heart rate and blood oxygen level data, to decide if the user is drowning locally, and to control the LED blinking pattern and colour.
2. MAX30100 is the PPG sensor used to measure the user's heart rate and oxygen level.
3. The LED strip will blink if the user is in danger to mark the user's position in the camera. It can communicate with the server by visual light communication (VLC) for future needs.
4. The lithium-Ion battery is used to power the whole wearable, wired to LED separately.
5. 433Mhz UART Transceiver may use for wireless communication with the server to retrieve the data from MAX30100 for monitoring, need tests in signal performance.

C++ will run in Arduino since it is the widely used programming language in embedded systems, and C++ binaries have faster performance.

2.1.4 Design Components for Drown-Location Detection Sub-system

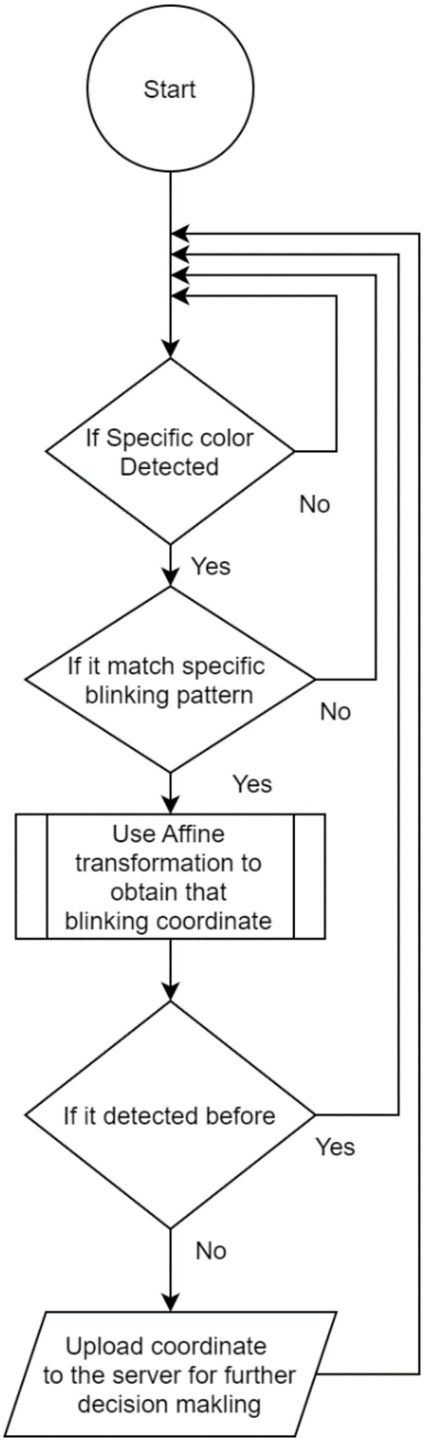

Figure 13 Flowchart representation of the drown-alarming subsystem

This system will detect if there is specific colour (e.g. red, yellow) blinking in a particular frequency, if the blink matches those requirements, it is a drowning alert. Then the system will use affine transformation to obtain the blinking location, check if it is a new victim. If it is a new victim, the system upload that coordinate to the server further decision making, else it keeps searches for other blinks.

2.1.5 Design Components for Drown-alarming Sub-system

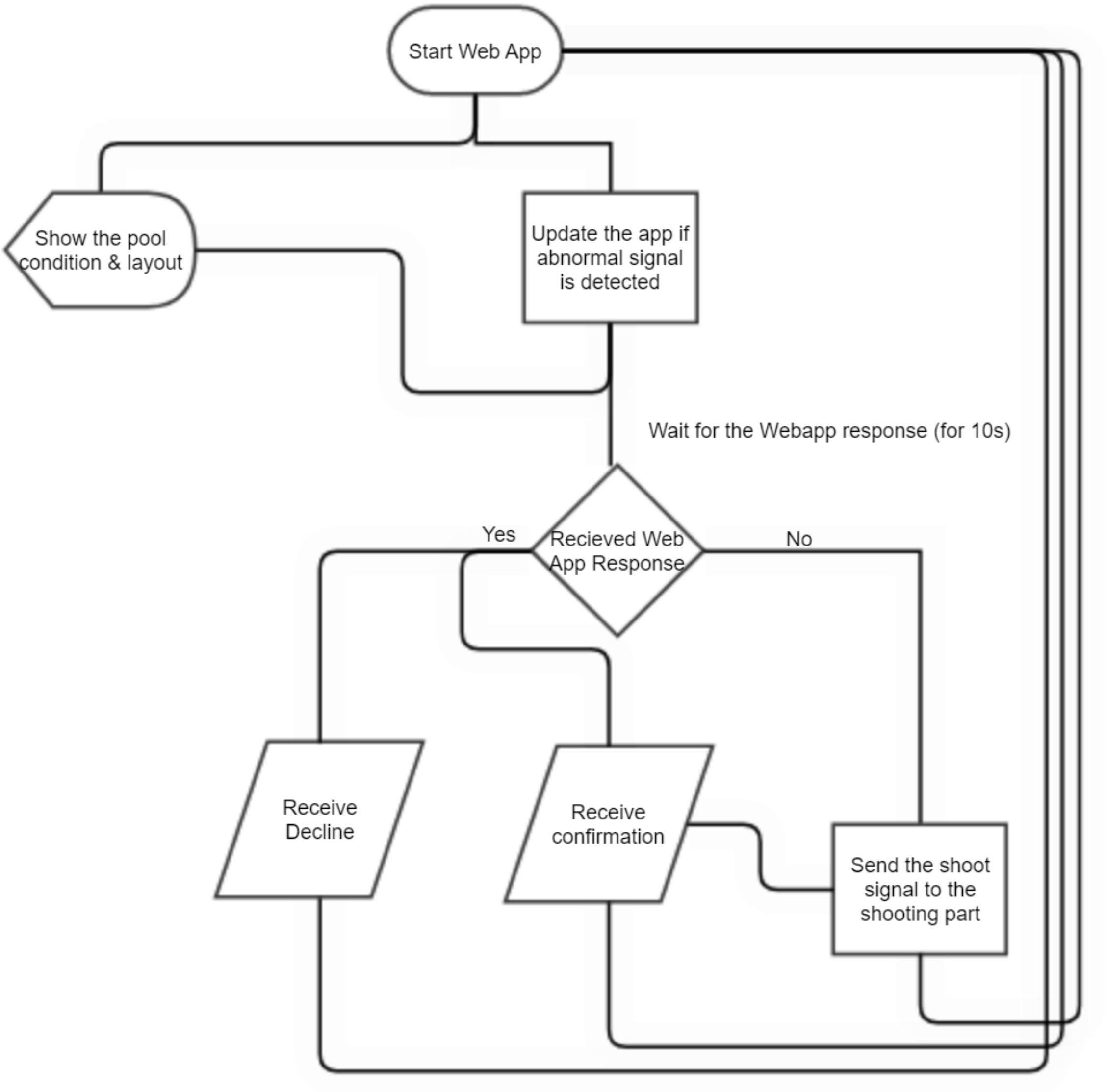

Figure 14 Flowchart representation of the drown-alarming subsystem

Figure 14 illustrates the flow of how the web application will function. Upon receiving the warning signal, the application will be updated with the victim's location and display on the screen. An alarm signal will also be sent out to catch the lifeguard attention.

Then, there will be a 10-second countdown for the lifeguard to confirm whether there is really a drowning detection. This would allow the lifeguard to make the professional decision. If the lifeguard has confirmed the drown condition OR no response is received within 10 seconds, the Lifebuoy throwing sub-system will follow up to throw the lifebuoy.

Moreover, there would also be an input system for the lifeguard to enter the location for the drowning case. This allows the lifeguard sitting on the lifeguard tower to be able to control the Lifebuoy Mechanism in case the detection system missed any drown victim, but the lifeguard is not able to reach the victim due to not being able to leave the lifeguard tower.

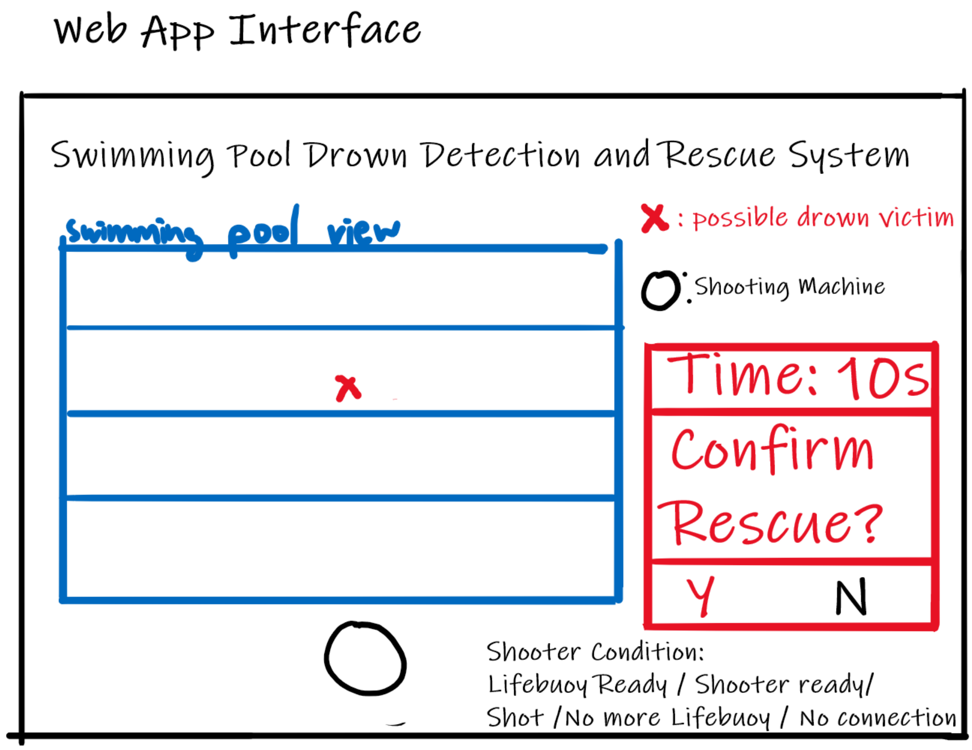

Figure 15 Preliminary UI Interface for the web application

For the web application, due to the design factor of being easy to use and not causing an additional burden for the lifeguard, a simplistic approach is taken. As shown in Figure 15 only the pool view, the location of the victim and the shooter stage (prepared, no lifebuoy, shoot) will be shown.

The monitoring webpage can access by smartphone, tablet, or laptop, but touch screen devices will be the main service platform. The user interface will design as touch screen friendly as it has a low learning slope and is intuitive to interact with.

The website will contain two webpages to serve different purposes:

1. Monitor Page: The footage capture will display here with notation of alert. The lifeguard can answer the prompt to stop the false alarm (depending on the setting), and touch the screen to do override shooting.
2. Setting Page: to set the pool size, pool edge, and config the alarm procedure.

2.1.6. Design Component for Lifebuoy Throwing Sub-system

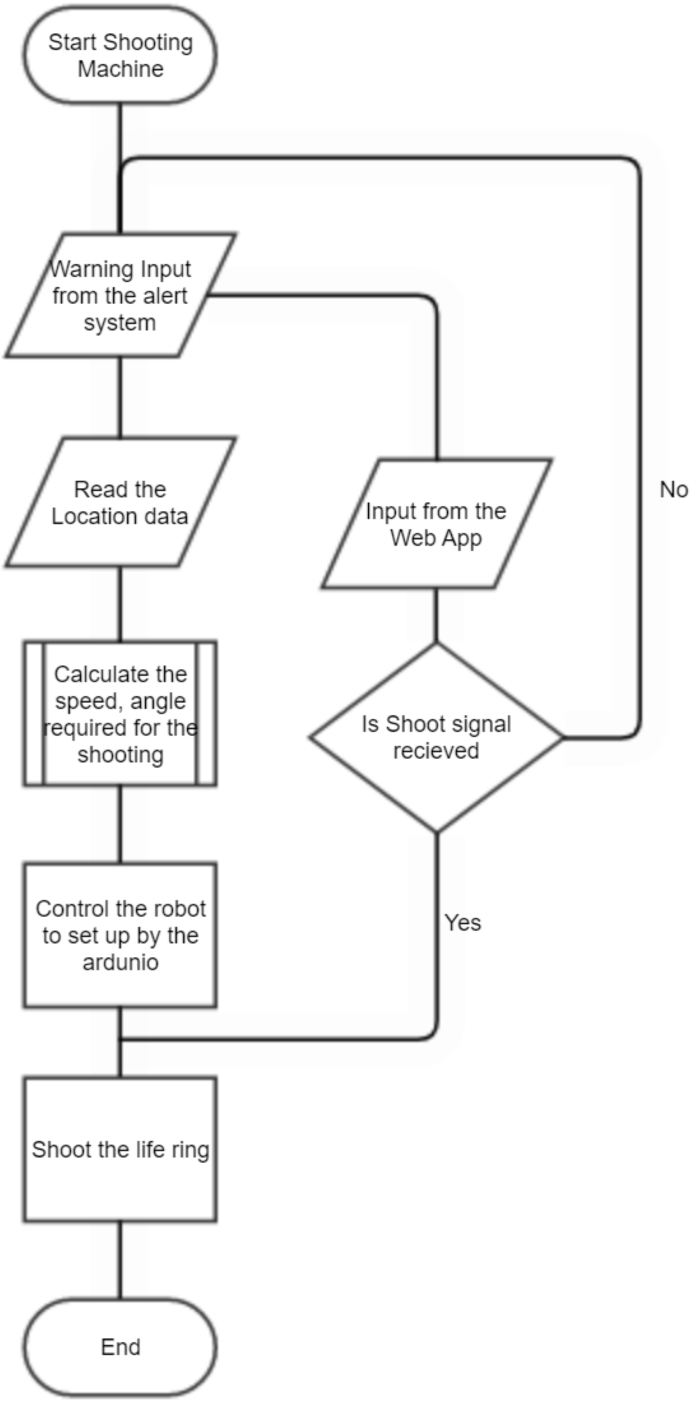

Figure 16 Flowchart representation of the lifebuoy throwing sub-system

Figure 16 flow chart illustrates the steps and mechanism of the lifebuoy throwing sub-system. The mechanism will be alerted with the victim's location once the victim is detected. This allows quick set-up while waiting for 10 seconds for the lifeguard confirmation of rescue. The mechanism can start the calculation of the speed of the angle, heigh and set up the station and get into "ready to shoot" condition as soon as possible. This allows quick response once confirmation from the lifeguard is received.

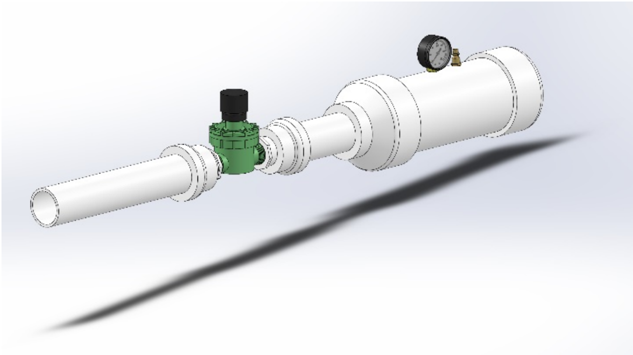

Figure 17 Solid work drawing of the Launcher Mechanism [Developed by the MECH Team]

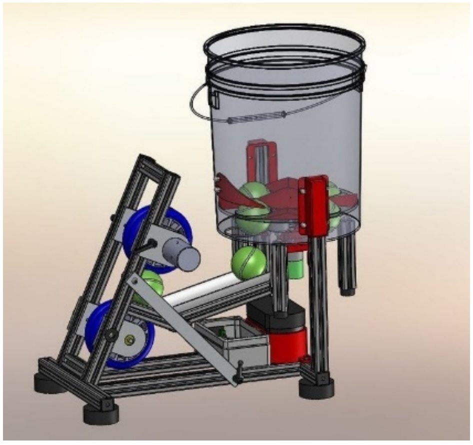

Figure 18 Mechanism for the wheel approach [29]

Figures 17 and 18 show the two mechanical designs, namely the air camber approach and the wheel approach, suggested by Mechanical Team. The purpose of these designs is to shoot the not yet inflated lifebuoy to the swimming pool. The lifebuoy will be inflated with 3-5 seconds upon contact with water.

2.2 Implementation

2.2.1 Wearable Device

The considerations of the hardware for the wearable device mainly consist of (1) Responsiveness, (2) Suitability for the Swimming Pool Environment and (3) cause Minimal Disturbance to the Regular Routine.

1. Arduino Nano

   Arduino Nano is chosen with the consideration of minimal disturbance to the regular routine for the swimmer, compatibility, and support to other electronic components. Comparing STM32 and Arduino Nano, Arduino Nano is smaller in size with less but sufficient functions. The smaller size helps to build the waterproof layer since this size is easier to control. Despite that both are written in C language, Arduino's platform consists of more library and support. The support further facilitates us to do some data collection from the sensor ahead for more accurate calibration.

   Comparing Micro-bit, a smaller size microcontroller, with Arduino Nano, Micro-bit is a more basic micro-controller. The customization and programming are comparatively limited due to the fact it was designed for academic purposes for the general public.

2. GY-MAX3010

   GY-MAX3010 is chosen with the design optimized for Arduino. Since the other model, RCWL-0530 has some design defects on the resistor connection. Figure 19 shows the resistors, R1, R2, R3, are pulled up to 1.8V and cause an incorrect "High" signal for the microcontroller. This defect creates various problems, for example, the sensor signal will not be detected. This is also one of the most popular asked questions on the MAX30100 discussion forum. There is a solution that desolders the three incorrect resistors, as labelled in Figure 20. and replaces them with some on an external breadboard. However, adding an external breadboard will make the circuit bulky which is not suitable for a wearable device for sports.

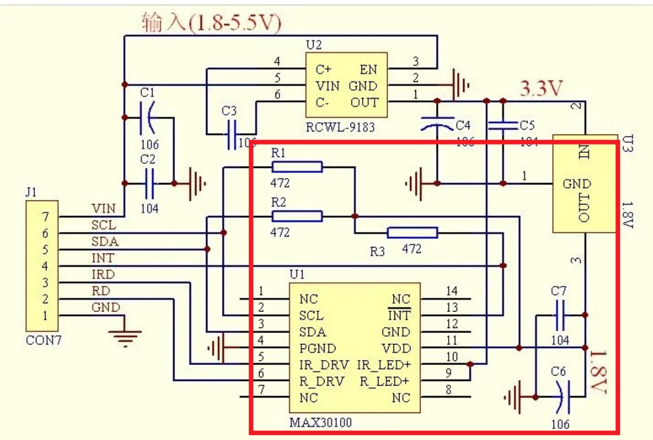

Figure 19 Schematic diagram for RCWL0530 [30]

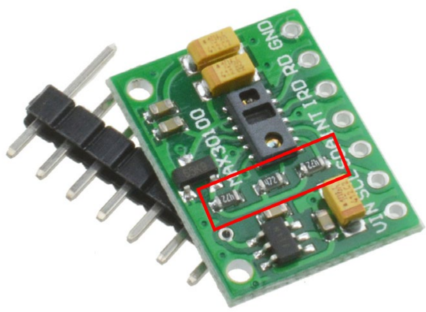
Figure 2120 Image for RCWL-0530

3. 3.7V lithium-Ion battery

The 3.7V lithium-Ion battery is chosen with consideration of rechargeability. Despite the option of using an AAA recharge battery, the 3.7V battery is chosen due to it being smaller and more compact for a wearable design than an AAA battery box.

4. 433Mhz UART Transceiver

As discussed in the Potential Challenges section (p.12 in this proposal), 433Mhz UART Transceiver has the second highest penetration. This is more suitable for our case that requires penetration through shallow water. This contrasts with the commonly used wireless communication mediums, Wi-Fi and Bluetooth, which are not as good as 433Mhz.

2.2.2 Positioning

A smartphone will be used as the camera for monitoring blinks from wearable LEDs via an application name "DroidCam". This app can turn the smartphone into a webcam input and transfer footage wired or wirelessly [31]. By making use of a cheap or old smartphone to substitute a traditional wired webcam or IP cam, our system cost can be lowered with ease if the site has Wi-Fi and a power supply.

The footage will monitor from the server-side, keeping track of blinks frequency and blink colour. Affine transformation algorithm will map the footage pixels to a 25*50m pool and obtain the X-Y coordinate of the blinking position.

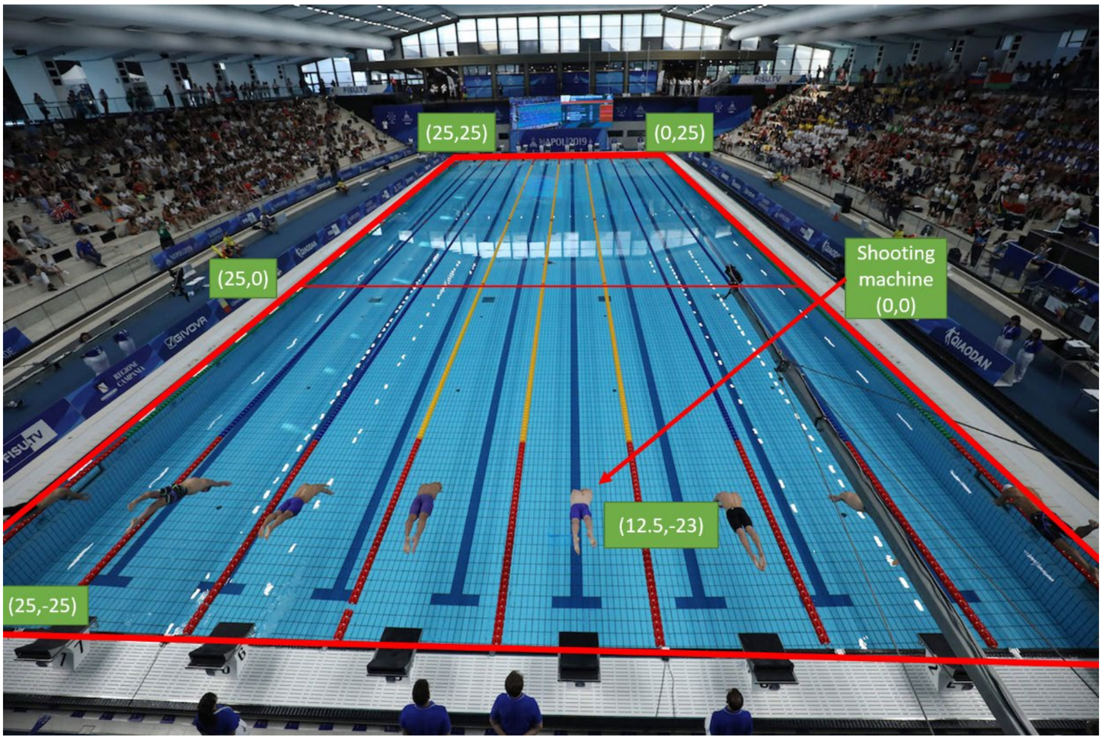

Figure 21 The schematic diagram for affine transformation Result, modified from [32]

2.2.3 Server Side

Node.js will be used as the webserver framework. JavaScript has good performance compared to Python and Java [33] as JavaScript runs on Google's V8 engine. Moreover, JavaScript is the same language as the frontend, which helps reduce the development workload. Node.js is also a better choice for mobile WebApp as its fast development time, ease of use and modularity of the "events" logic [34].

2.2.4 Frontend/Monitoring

The frontend will be implemented with HTML, JavaScript, CSS, and with the help of existing libraries jQuery and React. jQuery and React are widely used frontend frameworks [29] that provide powerful selector functions, delicate UI animation, and good compatibility across platforms.

In terms of processing speed, accessing the DOM tree is a computation heavy operation, React uses several clever techniques to minimize manipulation to the DOM tree. Therefore, using React is faster than using purely JavaScript [35].

2.3 Testing

With the divide and conquer approach, we will test the components separately before combination of the whole system. This can enhance the speed of debugging at the later progress. This approach is taken to avoid having multiple of the bug from different system to happen at once and become difficult to identify and solve.

After the individual sub-system testing, 4 combination sub-systems would be followed up before the final integration.

1) Drown detection sub-system & Drown location detection sub-system

2) Drown location detection sub-system & Drown-alarming subsystem

3) Drown-alarming subsystem & Lifebuoy throwing sub-system

4) Drown detection sub-system & Drown-alarming subsystem

The first testing targeted to identify whether trigger of the drown detection can spontaneously trigger the location sensing device. If time permits, testing between drown detection sub-system and drown-alarming sub-system may also be tested so as to ensure in case there are some issues happened in the location detection sub-system, the warning is still function and can alert the lifeguard to manually input location to command the throwing mechanism to shoot the lifebuoy.

The second testing focuses on feedback and showing the same location as sent by the location detection sub-system. With this combination, we are able to test the basic workflow of the computer system part.

The third test focuses on synchronization of the two systems. In particular, how the signal and command input by the alarming sub-system can be send to the lifebuoy throwing sub-system accurately. Upon data received, the throwing mechanism should react correspondingly within 5-10 second.

2.3.1 Testing for drown detection sub-system

We would conduct 3 test stages. They are waterproof functionality through water test, sensor accuracy under exercising, and lastly swimming. The first stage includes placing in device stationary in water basin for 30 minutes. The second stage will be data collection for both stationary and during exercise to observe the difference in behaviour. The third stage will then be water testing during swimming.

Then, the system will be test for the detection of abnormal signal. Due to the difficulty of obtaining dome real drown data, we would use a random function to generate some abnormal signal to test the response of the detection system.

2.3.2 Testing for drown location detection sub-system

The location detection will be first tested inside a room with about a quarter or less of the pool size. This testing is done to confirm the location system works. The second testing would focus on the range of the testing, how far can the sensor detect. The third testing would be having the sensor just below the pond surface to test the detection of the visible light under water. The purpose is to simulate the condition of the victim swimming or just drown.

2.3.3 Testing for drown-alarming subsystem

The user test concern user-friendliness, responsiveness, clarity[3] for the web application will be conducted with 5 invited lifeguards from varied technical background. Another test would be about the effectiveness of data retrieval and uploading from the web server.

2.3.4 Testing for lifebuoy throwing sub-system

The objective of the testing will be on ability of information retrieval of the location from the webserver. The test will be conducted by checking if the sub-system and retrieve the correct coordinate of the victim and perform the calculation of shooting angle and distance as expected. Moreover, shooting distance and accuracy is also taken into account with a range for 2m*2m for the mechanical team.

For the mechanical shooting test, it would be conducted separately beside poolside, such as the two water tanks outside LTJ. This testing will be done by the Mechanical team. The test below will be conducted:

1. Launcher test: Test shooting range and range accuracy, like maximum distance and if the if object landed as far as calculated by the system

2. Launcher test: X-axis accuracy, like we test if it misses left and right

3. Frame test: Accuracy of the control of the frame. Points 1 and 2 are, we need to check if that is accurate as well

4. Computation test: Accurate calculation of the data

5. Lifebuoy test: Test the speed and inflation of the lifebuoy

The first two test concerning the accuracy of the launcher, while the third refers to the frame that pans and tilts the launcher.

[3] The details criteria and description of these four terms are further defined in the objective section.

2.4 Evaluation

The fundamental purpose of this project is to develop a drown detection and rescue system. Thus, the ultimate testing would be sending a random abnormal heat beat externally to trigger the progress. Then test the progress time from the signal detected to the complete inflation of the lifebuoy to be within 1 minute. The choice of 1 minute is with reference to the golden rescue time for drowning of 2 minutes. We could also invite the general public to move the victim and change to a different location in the pool to test the calculation for the changed location. Additionally, we would also invite some additional suggestions and advice from 2 lifeguards during the progress to ensure some safety measure and swimming pool related matters are considered.

2.5 Discussion

1. If more than one possible drowning victim at the same time instance, how would our system handle it?

Solution: The system will first report all of the victims on the web application. Then the shooting mechanism will detect the furthest victim from the lifeguard location. The nearer victims will be saved by the lifeguard, and the furthest victim will be assisted by the lifebuoy.

2. If the lifeguard did not halt the alert?

Solution: The lifeguard may not halt the alert in an emergency. We should shoot a lifebuoy automatically after a configurable timer. Because there is no loss in shooting the lifebuoy, but there is a chance of saving people if the lifebuoy is shoot.

3. Project Planning

3.1 Project Work Plan

Year	Date	Task	Personal In Charge
2021	12 September	Internal Proposal Deadline	Loreen
	30 September	Collection for Detection Sensor Data	Don
	15 October	Functionality Testing for the Detection System	Loreen
	22 October	**Deadline for Individual Ethics Essay**	Loreen, Don
	29 October	**Deadline for Monthly Report**	Don
	30 October	Water Testing for the Detection System	Loreen
	30 October	Testing for the Positioning System	Don
	15 November	Functionality Testing for Web App	Loreen
	26 November	**Deadline for Monthly Report**	Don
	30 November	Functionality Testing for the Positioning System	Loreen
	30 December	Full Testing in Swimming Pool for Detection System	Don
2022	**12 January**	**Deadline for Monthly Report**	Loreen
	30 January	Seek User Opinion from Lifeguards for Web Application	Don
	15 February	Combined Testing for the Detection System & Positioning System	Loreen
	28 February	Combined Testing for the Positioning System & Lifebuoy Throwing System	Don
	1 February	Internal Deadline for Progress Report	Loreen
	14 February	**Deadline for Progress Report**	Don
	6 April	Internal Deadline for Final Report	Loreen
	20 April	**Deadline for Final Report & Self-Assessment Report**	Don
	1 May	Internal Deadline for Video	Loreen
	11 May	**Deadline for Video**	Don

Table 4 Project Work Plan

3.2 Human Resources

Name	Skills / Ability
LEUNG, Lok Yan Loreen	Stronger in have an overview in a problem, Have communication skills for different parties, Understand both skills in Computer Engineering and Mechanical Engineering, Interested in testing data collection and programming • Can help in project management • Can coordinate between different departments and resources • Can integrate the mechanical and computer system • Responsible for the drown detection system
CHAN Tsz Ho	Stronger in Language skills, Rich in hands on experience on Mechanical parts • Can proofread and become second reader for Computer Engineering Documents • Can direct and guide the progress of prototype building and testing
CHONG Shing Tung	Rich experience in electronic components and web programming, Swimming • Can initiate the electronic control and design the web application • Can support on-scene testing
LEE Ka Hei	Experienced at design and drawing, Thinks with a careful and detailed mind Patient • Responsible for the robot design and solid work drawing for Mechanical and gives suggestion for Computer UI design • Can give second option for the user experience • Responsible for the calibration and Mechanical Debugging

Table 5 Our skills and ability

3.3 Project Monitoring

We will be monitoring the project using the RACI method (Responsible, Accountable, Consulted, Informed).

Overall Version

Task/Name	LEUNG, Lok Yan Loreen	CHAN Tsz Ho	CHONG Shing Tung	LEE Ka Hei
Design and Research				
Communication Between Different Parties	R	A	I	C
Analyse on Different Topic	I	R	A	C
Defining Topic	C	R	I	A
Feasibility Study	R	C	A	I
Integration with CPEG/Mech Portion	A	I	R	C
Finalization				
Testing, Debugging, and Tunning	I	A	C	R
UI Improvements	C	I	R	A
Documentation				
Writing Proposal	A	C	R	I
Monthly Report	A	C	I	R
Progress Report	I	C	R	A
Writing Final Report	A	C	I	R
Preparing Presentation	C	I	A	R
Making Video Trailer	I	R	C	A

Table 6 Project Monitoring Table for the overall project (Both CPEG and MECH)

CPEG Version

Task/Name	LEUNG, Lok Yan Loreen	CHAN Tsz Ho	CHONG Shing Tung	LEE Ka Hei
Design and Research				
Study on ROS	A	C	R	I
Analyze on Different Approaches	R	C	A	I
Feasibility Study	R	C	A	I
Literature Review	A	C	R	I
Implementation				
Testing Electronic Component	R	C	A	I
Decide Detection Process of Drowning	R	I	A	C
Implement Detection System	R	C	A	I
Testing Positioning System	A	I	R	C
Implement Positioning System	A	I	R	C
Integration with Mech Portion	A	I	R	C
Web App Development	A	I	R	C
Finalization				
Implement Calibration System	R	I	A	C
Testing, Debugging, and Tunning	A	I	R	C
UI Improvements	C	I	R	A
Documentation				
Writing Proposal	A	C	R	I

Monthly Report	R	I	A	R
Progress Report	R	C	A	I
Writing Final Report	A	C	R	I
Preparing Presentation	R	C	A	I
Making Video Trailer	R	C	I	A

Table 7 Project Monitoring Table for the CPEG component of the project

MECH Version

Task/Name	LEUNG, Lok Yan Loreen	CHAN Tsz Ho	CHONG Shing Tung	LEE Ka Hei
Design and Research				
Feasibility Study	C	A	I	R
Built varies robot models	C	R	I	A
Literature Review	C	R	I	A
Analysis of Different Launching Approaches	R	C	I	A
Implementation				
Launcher 3D Modelling	C	A	I	R
Acquiring Launcher Parts	C	R	I	A
Implement first Launcher	C	R	I	A
Testing Different Launching Approaches	R	C	I	A
Acquring Pan Tilt Mechanism Parts	C	A	I	R
Testing Pan Tilt Mechanism	C	A	I	R
Integration with CPEG Portion	R	A	C	I
Finalization				
Testing, Debugging, and Tunning	C	R	I	A
Documentation				
Project Planning	R	C	I	A
Progress Report	C	R	I	A
Final Report	C	R	I	A
Making Video Trailer	C	R	I	A
Oral Presentation	R	C	I	A

Table 8 Project Monitoring Table for the MECH component of the project

3.4 Gannt Chart

Below are the two Gannt Charts for both Computer and the Mechanical Engineering part.

CPEG version

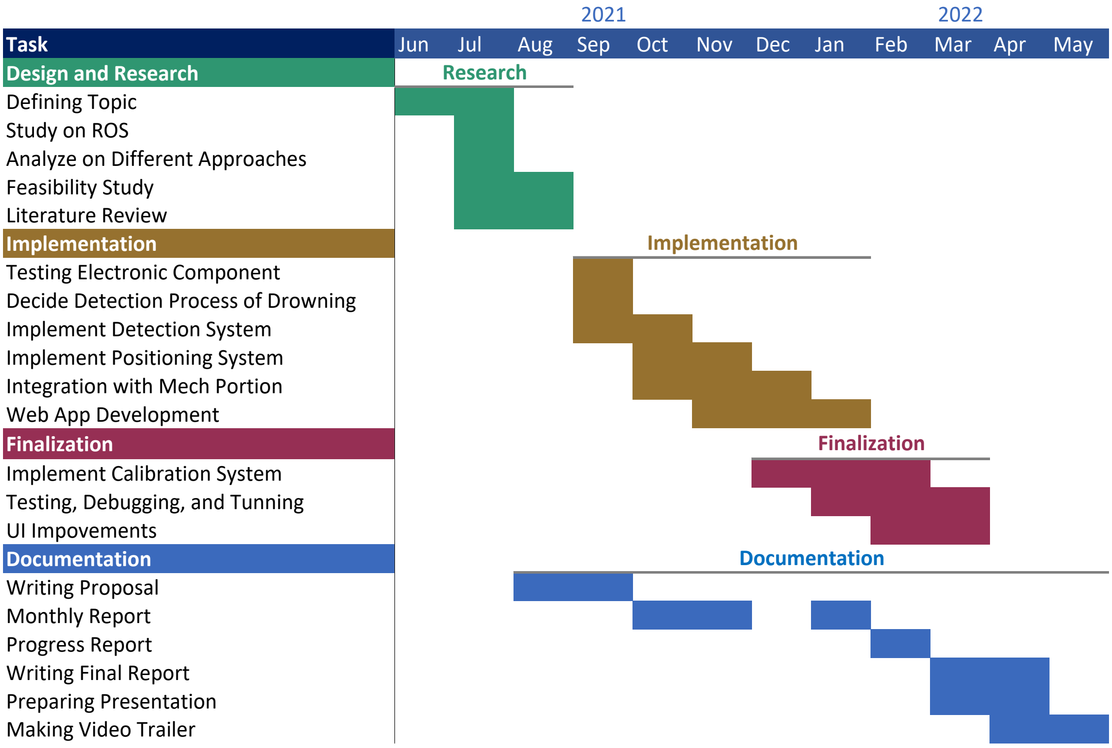

Table 9 Gannt Chart for the CPEG component of the project

MECH version

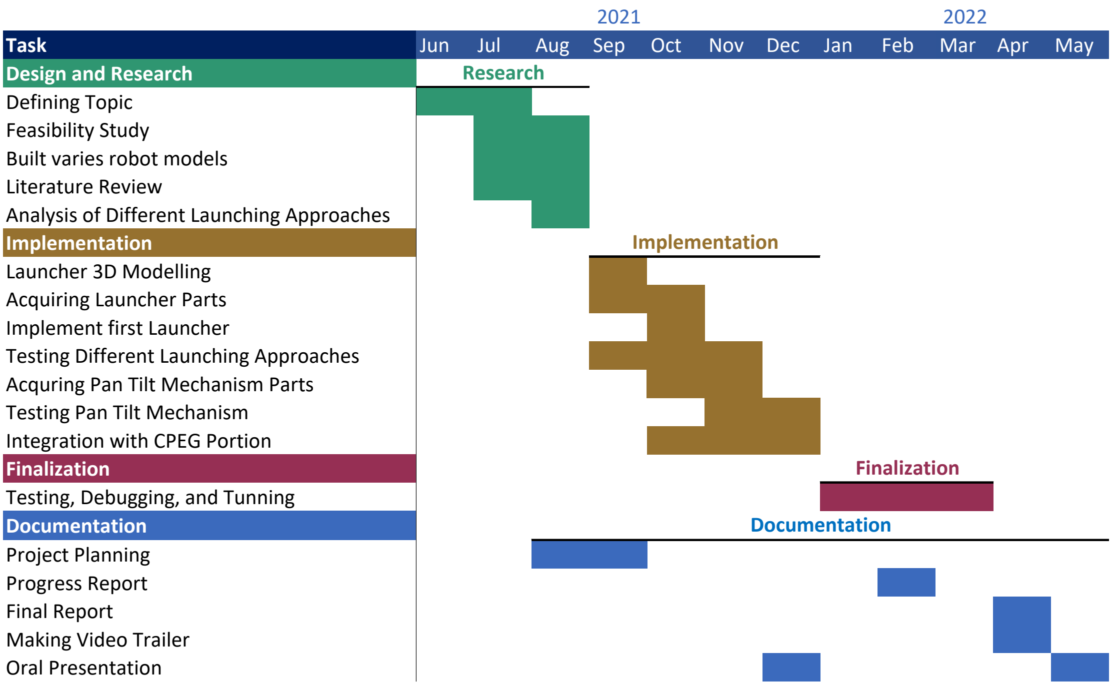

Table 10 Gannt Chart for the MECH component of the project

4. Required Hardware & Software

4.1 Hardware

Hardware	Usage	Price (HKD)	Quantity
Arduino Nano	Process data in the wearable	86.55	1
MAX30100	Monitor heartrate and blood oxygen level of user	19	1
Small Lithium Lon Battery	Power the whole wearable device	40	1
LED Strip	Positioning and alert nearby swimmers	8	1
Smart Phone	Webcam	1000	1
HKUST Server	Calculate position and host the webpage	Free	1

Table 11 List of details for the required hardware

4.2 Software

Software	Version	Usage	Price (HKD)
Arduino IDE	1.8.16	Program the Arduino	Free
Node.js	14.17.6 LTS	Server of Webpage	Free
React	17.0.2	Frontend UI	Free
Git	2.33.0.2	Share code	Free

Table 12 List of details for the required software

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6. Minutes

6.1 Minutes of 1st Project Meeting

Date: 10 June 2021 (Thur)

Time: 17:30 – 19:00

Present: Dr. Desmond Tsoi, Loreen, Fionn, Jackal, Don

To-do:

1. Research on SLAM, ROS, Printed PCB.
2. Terrain the robot will operate on.
3. Ask Mech Prof for advice on the terrain adaptability of the robot.
4. Try all peripherals before summer break ends.

Discussion:

1. General stuff to be aware
   i. We have two reports to submit (MECH and CPEG)
   ii. Think of how to test our robot
   iii. Setup "complete stages" of the project, to ensure to Project is "complete"
   iv. UI is a crucial element
   v. The project should Demo Oriented
2. Idea on robot
   i. The Robot should be overridable, as we cannot promise the bot to operate the way we want.
   ii. Which Sensor we may use: Thermal Camera, Gyro, GPS, Mic, LTE module
   iii. Form of Robot: Portable? 4-feet? Drone? Hybrid (4-feet + drone)?
   iv. Control of Robot: autonomous/with a human assist/Human control with an electronic assist(advice)
   v. What to do when it encounters patient: set up a communication channel to outside, Bring patient back to the main route.
3. We set up 4 Temporary "complete stages" for our Project

6.2 Minutes of 2nd Project Meeting

Date: 1 July 2021 (Thur)

Time: 22:00 – 00:30

Present: Dr. Desmond Tsoi, Loreen, Fionn, Jackal, Don

To-do:

1. Research on GPS accuracy
2. Ask Robin for a sample of FYP

Discussion:

1. Focus: The patients who cannot call for help, mostly solo and without preparation
2. Idea:
    i. Keep Track of the people, send out when needed
    ii. A wearable device, keep track of heart rate, etc
    iii. Trigger from outside to obtain patient's GPS location (PLBS?)
    iv. A drone that able to fly inside the forest
    v. Signal Approach: a drone that detects the common phone's communication frequency
3. Soft Robot This Unstoppable Robot Could Save Your Life
4. How to Find People who are not in range of signal
    i. 天災時代替基地台的無人機，可供方圓 10 公里手機同時使用 (A Drone that provides Mobile Phone Signal for phones within the range of 10KM)
    ii. 中華電信與雷虎科技合作展出「空中基地台系統」(Chunghwa Telecom Unmanned Air Systems; CHTUAS)

Useful Links:

- ☐ MOBILE NETWORK COVERAGE OF HIKING TRAILS IN COUNTRY PARKS
- ☐ Use fall detection with Apple Watch
- ☐ Hong Kong Frequency Allocation Chart
- ☐ WHY DRONES ARE THE FUTURE OF SEARCH AND RESCUE

6.3 Minutes of 3rd Project Meeting

Date: 7 June 2021 (Wed)

Time: 22:00 – 00:30

Present: Dr. Desmond Tsoi, Kris, Loreen, Fionn, Jackal, Don

To-do:

1. Try out different Wheel
2. Try out ROS
3. Feasibility study on Drone
4. Assemble and try belt drive in different terrain /w ROS

Discussion:

1. Idea
   - i. A drone saves people from heat stroke
     - I. Scenario:
       1. Heatstroke blackspots usually do not have many trees that can block the sunlight, which is suitable for the drone to operate
       2. According to AFCD and hobbies website, there is a place surrounded by 3-4 blackspots within 10km, set up a charging station and keep petrol around those blackspots
     - II. Stage 1: use a thermal sensor to identify patients, take advantage of the drone's propeller to fan the patient, and use a mechanical part to spray water to help heat dissipation.
     - III. Use an AirTag-ish cheap BLE, distribute at the entrance of the hiking trail, if the Tag is not returned within 2-days, we send out the drone to search for the patient
       1. Advice: use the deposit to increase the return rate, add a stamp on the tag, the user can return my putting the tag post-box
   - ii. Land-Base robot
     - I. Scenario: Following the rescue team, Petrol 24/7

II. Usage:

   1. Rescuer uses a phone to order the bot to search for an area
   2. Petrol blackspot with schedule
   3. If it meets the patient, build a communication channel to the rescuer, block sunlight, spray water, measure body temperature, heart rate

III. Appearance

   1. WALL-E like: https://youtu.be/ISznqY3kESI

iii. Limitation in outdoor: signal usually weak as it will not bounce back

2. Kris gives us some detail of using InnoLab
3. Note on Project

i. It is ok to change the project if it is justifiable

   I. e.g., What benefits that is better than original

ii. The report is a storytelling of the report: the journey of exploration, what option you encounter and why you did not choose them, compare their pros and cons

6.4 Minutes of 4th Project Meeting

Date: 31 June 2021 (Thur)

Time: 17:30 – 19:00

Present: Dr. Desmond Tsoi, Loreen, Fionn, Jackal, Don

To-do:

1. Ask Mech Prof for approval of the swimming pool robot
2. Research on how to detect drowning, and how to save a drowning person
3. Ready some questions for the swimming pool manager

Discussion:

1. Huge “human-eating” firefighting bot
    I. Hi-power Motor may be expensive, take advantage of gear ration
    II. Fire-proof material, we need to ensure the patient save inside the robot
    III. Can it substitute a firefighter? Maybe it can bring the patient out of the area, to free the firefighter to keep saving people.
    IV. Scale is huge and difficulty is high, we might not have enough time, 1:10 scale demo?
2. Swimming Pool Robot:
    I. Privacy problem (If we use computer vision approach), CCTV does exist in public swimming, but it is confidential, we may use a low-resolution camera/Infrared, but does infrared work with water?
    II. Wearable Device approach, measure position, blood oxygen, and heart rate to detect drowning
    III. Underwater robot approach, it is easier to reach the patient. Corrosion problem? Does not necessary to solve
    IV. Key Points: Is it fast enough? (30m to reach) Can it save a person?
3. Surveillance heat stroke
    I. We can have multi bot petrol together
4. If we encounter a situation where we do not have enough budget, we need to justify the user scenario

6.5 Minutes of 5th Project Meeting

Date: 5 Aug 2021 (Thur)

Time: 17:30 – 19:00

Present: Prof. Ma, Loreen, Fionn, Jackal, Don

To-do:

1. Gantt Chart
2. CS: Wearable Device, detect drawn, Locating
3. MECH: Release Mechanism
4. Ask Robin to get an FYP sample

Discussion:

1. Shooting approach is preferred than Spidercam approach, but we need to consider the safety issue as it might hit other swimmers.
2. Wrist band is feasible solution.
3. We need to consider the effect of water and movement toward the heart rate sensor.

6.6 Minutes of 6th Project Meeting

Date: 19 Aug 2021 (Thur)

Time: 17:30 – 19:00

Present: Dr. Desmond Tsoi, Loreen, Fionn, Jackal, Don

To-do:

1. Research and settle a detection method.
2. Draft report before/on 1/9, prove read till last mins.
3. Buy electronic parts and test.
4. Explore more papers about drowning detection, compare their feasibility, cost, and accuracy.
5. Ask Prof. Tim Woo for the question about the control system.

Discussion:

1. Resolution with Robin: 1. wrist band is recommended 2. A NO for spider cam approach, use shooting approach.
2. Backup System: We may give the decision part to the lifeguard to avoid error, Make it configurable for shooting
3. Calibration System: camera angle? Wind direction? we need a system for calibration to adapt to different swimming pools.
4. IoT communication method: visible Light, Radio wave, we should test one of it first.
5. Desmond gives the detail of writing the FYP report and Presentation

6.7 Minutes of 7th Project Meeting

Date: 25 Aug 2021 (Thur)

Time: 12:00 – 15:00

Present: Loreen, Fionn, Jackal, Don

To-do:

I. Buy heartbeat and Blood oxygen sensor.

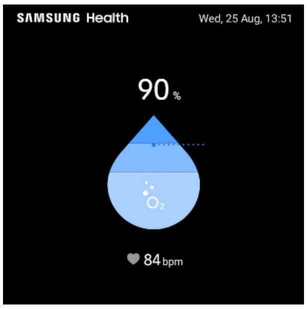
II. Try the exiting image approach on GitHub (Drown detection).

III. Begin in writing the proposal.

IV. Think of how our system communicates with the robot.

V. Ask for advice from Desmond to decide should we buy a commercial watch as a control data.

Discussion:



I. Tennis ball shooting approach and Air cannon shooting approach.

II. We can measure the drop of blood oxygen when we hold our breath, so our approach is promising.

III. We may make a complete seal to avoid water's effect on the blood Oxygen sensors. And use a watch clasp mechanism to ensure it fits.

IV. We draft the flowchart and Gantt chart of our project.

6.8 Minutes of 8th Project Meeting

Date: 26 Aug 2021 (Thur)

Time: 11:00 – 01:00

Present: Dr. Desmond Tsoi, Loreen, Fionn, Jackal, Don

To-do:

1. Read the Indoor Light positioning paper.
2. Buy max30100.
3. Read FYP sample "Vision and Graphic"
4. Ask Robin for the progress report and if Mech need a proposal

Discussion:

1. Desmond gives us detailed advice on writing the proposal. (From structure, to topic, so, literially, a lot)
2. Calibration System: Make a noddle that is equipped with our positioning system that shape and weight similar to our float, so it can measure position, making the calibration process easier.