Swimming Self Coaching

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1 Introduction

1.1 Purpose of this document

The main purpose of this Software Requirements Specification document is to outline the requirements for Swimming Self Coaching: detect and analyze incorrect behaviors in the swimming movements. This is done with the aid of sensors such as accelerometer and gyroscope. This document will provide a detailed overview of our software product's parameters and goals and explain purpose and the features of Swimming Self-Coaching and describes its interfaces, hardware, software requirements and explains what the system will do. This software requirements specication (SRS) document defines how our stakeholder, team, and audience see the product and its functionality.

1.2 Scope of this document

This Software Requirements Specification (SRS) is the requirements work product that formally specifies Swimming Self Coaching system. This targets end users like sporting that would use swimming self coaching. It will also be beneficial and helpful for coaches and swimmers that may work on the Swimming Self Coaching system in the future.

1.3 Overview

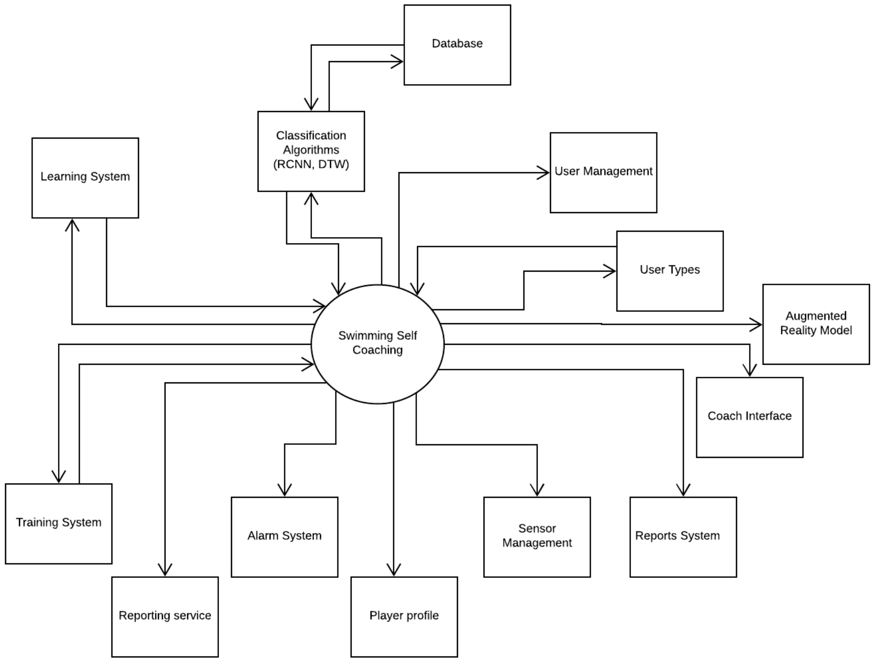

Figure 1: Context Diagram.

Real time Monitoring and analyzing of incorrect behaviors in the swimming movements to enhance the swimmer the swimmer's movements and techniques. The wearable systems of swimmers should always aim to provide swimmers with a trustworthy feedback, which also assists the coaches to obtain the incorrect movements of all swimmers who are monitored. This document proposes Swimming Self Coaching which is a system that performs detection and identification of a swimmer incorrect behaviour using sensors found in smart phones. Swimming Self Coaching will consist of a mobile application that will handle the real time data that will be collected from sensors(accelerometer and gyroscope), this data will be analyzed to create automatically generated analyzes that would be used by coaches to monitor each swimmer's incorrect movements.

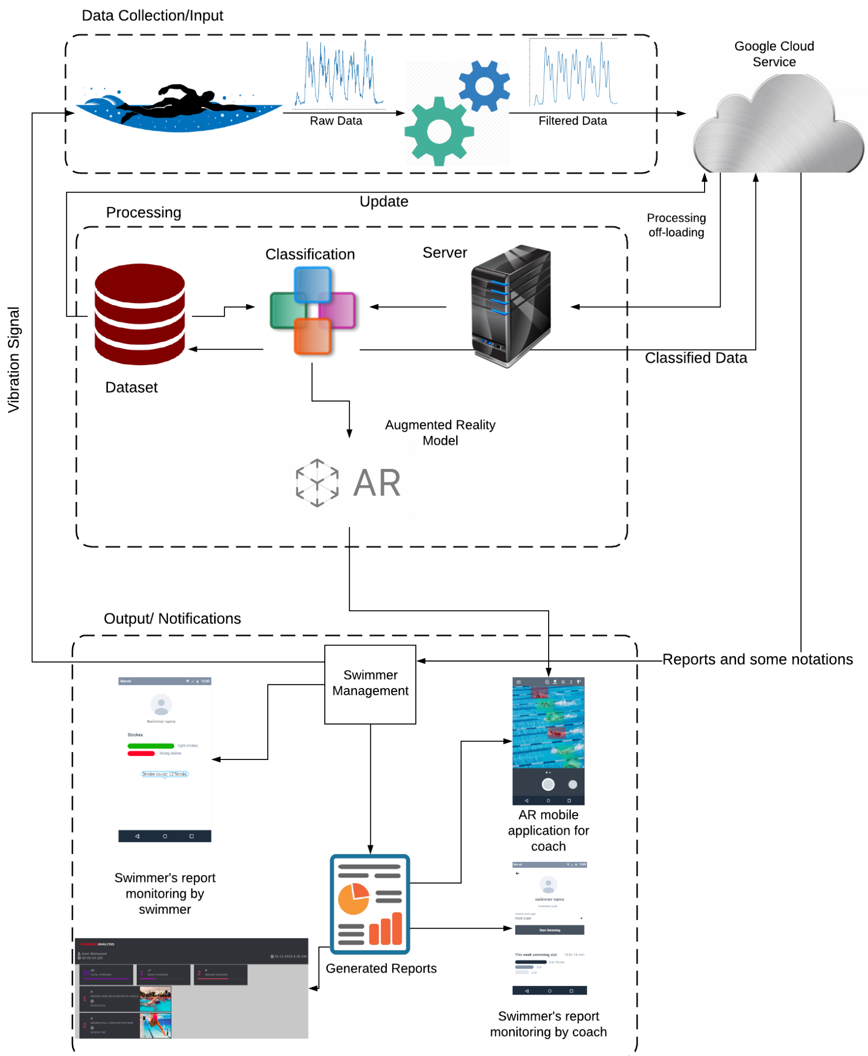

Figure 2: System overview.

The proposed system a Swimming Self-Coaching that uses sensors accelerometer and gyroscope to collect readings of swimming stroke. Thereafter, the collected readings is passed through a pre-processing phase that supposedly to get better results by using Kalman ltration. So, the ltered data is passed to the cloud data storage, which then takes the required data to the server side to get the required analysis to compare features and threshold using the feature extraction and classier algorithms such as DTW and RNN. After analyzing the data the incorrect behavior is obtained. Eventually, the analyzed data takes two ways, the rating data is always sent to data storage and vibration alert sent to the swimmer when detecting wrong behavior of the strokes. Also, the coach and sub coach can monitor the ratings of the swimmer by monitor the reports and the AR model that takes three steps which are rendering, motion capture and identication.

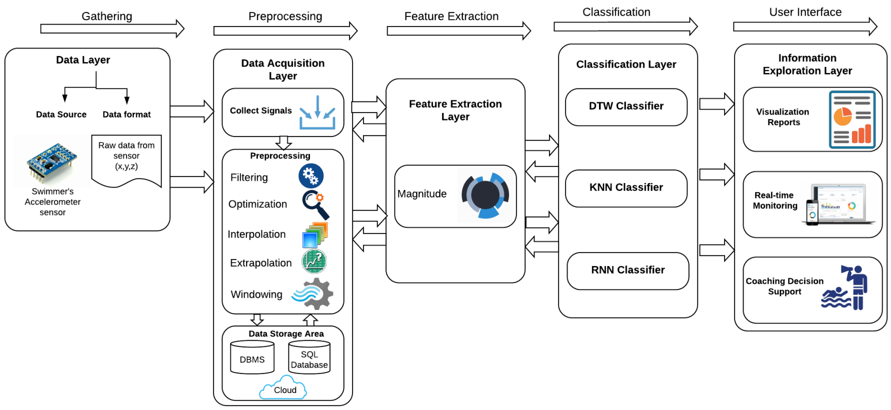

Figure 3: Block Diagram.

1.4 Business Context

Our work is motivated by both application domain and previous work. As the swimming plays a huge role in the performance of the players. Only 719 entries out of 2400 entries are qualified to enter the Junior competition of International Swimming Federation (FINA) World Championship (WC)[1]. Marc B achlin, Kilian F orster, and Gerhard Tr oster. [2] have developed a proposed system to assist the swimmer to achieve the desired goals. Pekka Siirtola, Perttu Laurinen, Juha Roning in [3] proposed study concentrates on tracking swimming exercises based on the data of 3D accelerometer they divide tracking of swimming exercise into three phases. Meanwhile, Rabee M. Hagem, Steven G. O'Keefe, Thomas Fickenscher, and David Victor Thiel r [4] presents a wrist mounted accelerometer and optical wireless communications to display goggles to give real time feedback to a swimmer during swimming. Huang, K.-C., Chu, C.-P., Chiu, T.-K., Chen, J.-C. set a study [5] to explore the eect of dierent detection of position on swimming stroke. The project idea was presented to many coaches and showing their interest and if it will be a successful project they will be a part of this project stakeholder team.

2 General Description

2.1 Product Functions

1. Coach can monitor the swimmers swimming behavior.
2. Coach can view the swimmers ratings.
3. System will have dierent users (coach, swimmer and sub coach).

4. System rates individual swimmers based on their average swimming behavior during all their training.

5. Sub-coach can plan and implement training program including water and based training schemes.

6. Alert to the swimmer if there is a wrong stroke.

2.2 Similar System Information

SwimMaster [2] is a system proposed to perform continuous swim performance evaluation. They used acceleration sensors with micro-controllers and feedback interface modules that swimmer wear while swimming. They detect some parameters such as time per lane, the swimming velocity and the number of the strokes per lane. SwimMaster assist the swimmer to achieve the desired exercise goals constantly monitoring his/her swim performance and providing the necessary feedback to achieve the desired workout goals. They used specic factors like body balance and body rotation to reduce the resistance and increase the propelling force. The system can dierentiate between a good and a bad body balance. The data read from the acceleration sensor is not yet processed online at this early stage but stored for o-line processing.

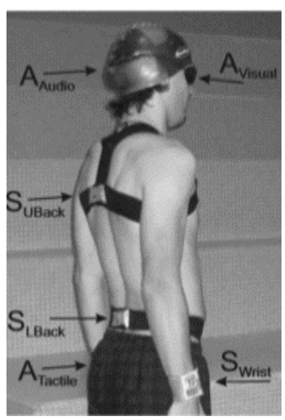

Figure 4: The SwimMaster system consisting of sensors and acutators as worn by a swimmer.

This paper [4] is self contained adaptable optical wireless communication system for stroke rate during swimming. Also presents a wrist mounted accelerometer and optical wireless communications to display goggles to give real time feedback to a swimmer during swimming. Experiments are conducted in air and under water for this system to optimize the link availability. Algorithms are used for nding the absolute maximum of the y-axis acceleration for each stroke cycle and the goggles display decision are implemented at the transmitter and the receiver.

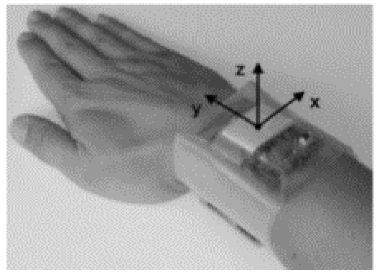

Figure 5: Placement of sensor.

2.3 User Characteristics

1. Coach:
    - Must have basic knowledge in using Android mobile devices and also with augmented reality application.
2. Swimmer:
    - Must have basic knowledge in using Android mobile devices.

2.4 User Problem Statement

Detection and improvement of classification accuracy of swimming incorrect movements and automatically generate reports monitored by the coach in real-time. So, coaches need to gain more information about the other who are not monitored.

2.5 User Objectives

By using Swimming Self-Coaching, the coach can view reports of the swimmer not only he is swimming wrong but also giving where is wrong of the movements.

2.6 General Constraints

One of the main constraints of the system is the connection under the water that the mobile could face. The mobile device process is mainly conducted under the water. In addition, the position of the mobile must be mounted horizontally in the right and left wrist. So the swimmer should consider that the mobile mounted in a right way and the mobile have a connection. Different problems would be challenging the system.

3 Functional Requirements

3.1 The Coach

3.1.1 FR1

Title	Register
Description	This function is for the coach register a new account
Input	Name , Email , Password , Telephone , Gender and User Type
Action	Check if all fields are filled
Output	Home Page and Acceptance message or error message
Precondition	None
Post-condition	Redirect to the home page and update the database with a new record
Dependencies	None

Table 1.

3.1.2 FR2

Title	Login
Description	This function is for the coach logging into an account
Input	Username and password
Action	Check if all fields are filled and compares data entered to the record in the database
Output	Home Page and Acceptance message or error message
Precondition	None
Post-condition	Redirect to the home page
Dependencies	FR1

Table 2.

3.1.3 FR3

Title	Adding a swimmer's record
Description	This function adds swimmer to the system
Input	Name , Email , Password , Telephone , Gender , National ID , Type of swimmer
Action	Check if all fields are filled and insert an object in a database.
Output	Acceptance message or error message
Precondition	Check if the swimmer exists
Post-condition	New swimmer is created
Dependencies	None

Table 3.

3.1.4 FR4

Title	Editing a swimmer's record
Description	This function edits the swimmer existing information to the system
Input	Name , Email , Password , Telephone , Gender , National ID , Type of swimmer
Action	Make sure that the record of the swimmer is updated.
Output	Acceptance message or error message
Precondition	Check if the swimmer exists
Post-condition	The record of the swimmer is updated into the database
Dependencies	FR1, FR2, FR3

Table 4.

3.1.5 FR5

Title	Deleting a swimmer's record
Description	This function deletes the swimmer's record
Input	Name
Action	Make sure that the record of the swimmer is deleted.
Output	Acceptance message or error message
Precondition	Check if the swimmer exists
Post-condition	The record of the swimmer is deleted from the database
Dependencies	FR1, FR2, FR3

Table 5.

3.1.6 FR6

Title	Listing all swimmers records
Description	This function listing the swimmers records
Input	Type of swimmer
Action	Retrieves information about the swimmers
Output	All swimmers information
Precondition	Check if the swimmer exists
Post-condition	None
Dependencies	FR1, FR2, FR3

Table 6.

3.1.7 FR7

Title	Searching for a swimmer record
Description	This function searching for a swimmer record
Input	Name
Action	Retrieves information about the swimmers
Output	Preview swimmer's record
Precondition	Check if the swimmer exists
Post-condition	None
Dependencies	FR1, FR2, FR3

Table 7.

3.2 The Swimmer

3.2.1 FR8

Title	View a swimmer's record
Description	This function searching for a swimmer record
Input	Name
Action	Retrieves information about the swimmer
Output	Preview swimmer's record
Precondition	Check if the swimmer exists
Post-condition	None
Dependencies	FR8, FR9

Table 8.

3.2.2 FR9

Title	Swimmer receives an alert
Description	This function receiving an alert for a swimmer during swimming
Input	Mobile ID, Stroke ID, Wrong Stroke ID, Threshold
Action	Receives vibration to the swimmer
Output	An alert and data classified to use in machine learning
Precondition	Get sensor readings to be classified
Post-condition	Sensor readings sent to be classified
Dependencies	FR12, FR13, FR14

Table 9.

3.3 Alert System

3.3.1 FR10

Title	Send vibration to swimmer
Description	This function sending an alert to swimmer during swimming
Input	Mobile ID, Stroke ID, Threshold
Action	Sends vibration to the swimmer
Output	An alert
Precondition	Clear array list of captured points
Post-condition	Array list of points start to be filled with filtered sensor readings
Dependencies	FR8, FR9, FR13, FR14

Table 10.

3.4 Classification

3.4.1 FR11

Title	Collecting Signals
Description	This function is for collecting sensor readings (x,y,z)
Input	Accelerometer and Gyroscope (x,y,z) and time stamp
Action	Remove gravity from z-axis and sending x,y,z readings into filtering method (Low pass and Kalman)
Output	Collection of Accelerometer and Gyroscope data
Precondition	Check if there is a duplicate of readings and time stamp
Post-condition	Calculate the magnitude of (x,y,z) and update into the database
Dependencies	None

Table 11.

3.4.2 FR12

Title	Filtering Signals
Description	This function is for filtering sensor readings (x,y,z) using low-pass and kalman
Input	Array of magnitude points
Action	Sending array into filtering method (Low pass)
Output	Data filtered
Precondition	Array to be cut into windows using thresholding
Post-condition	Array is updated into the database
Dependencies	FR11

Table 12.

3.4.3 FR13

Title	Cutting methods
Description	This function is for cutting the array into number windows to send to be classified
Input	Array of filtered points
Action	Sending array of (x,y,z) into filtering method (Low pass)
Output	Array of windows, each window is a stroke
Precondition	Data to be filtered
Post-condition	Array is updated into the database
Dependencies	FR11, FR12

Table 13.

3.4.4 FR14

Title	Optimization
Description	This function is for optimizing the array of windows
Input	Array of windows (x,y,z)
Action	Optimizing the array by include 20% number of points of the previous windows and 20% number of points of the next windows
Output	Optimized array of windows
Precondition	Array of cutting windows
Post-condition	Templates is updated into the database
Dependencies	FR11, FR12, FR13

Table 14.

3.4.5 FR15

Title	Interpolation
Description	This function is for interpolating the array of template
Input	Array of template (x,y,z)
Action	Interpolating the array by guessing data point between the range of dataset
Output	Interpolated array of template
Precondition	Array of magnitude templates
Post-condition	Templates is updated into the database and then classfication step
Dependencies	FR11, FR12, FR13, FR14

Table 15.

3.4.6 FR16

Title	Extrapolation
Description	This function is for extrapolating the array of template
Input	Array of template (x,y,z)
Action	Extrapolating the array by guessing data point from beyond the range of dataset
Output	Extrapolated array of template
Precondition	Array of magnitude templates
Post-condition	Templates is updated into the database and then classfication step
Dependencies	FR11, FR12, FR13, FR14

Table 16.

3.4.7 FR17

Title	Classification
Description	This function is for classifying the array of points with the matched templates
Input	Array of optimized windows (x,y,z)
Action	Array of templates, each template is a stroke
Output	Rating reports and alert to swimmer
Precondition	Array of cutting and optimized windows
Post-condition	Templates is updated into the database
Dependencies	FR11, FR12, FR13, FR14, FR15, FR16

Table 17.

4 Interface Requirements

4.1 User Interface

4.1.1 GUI

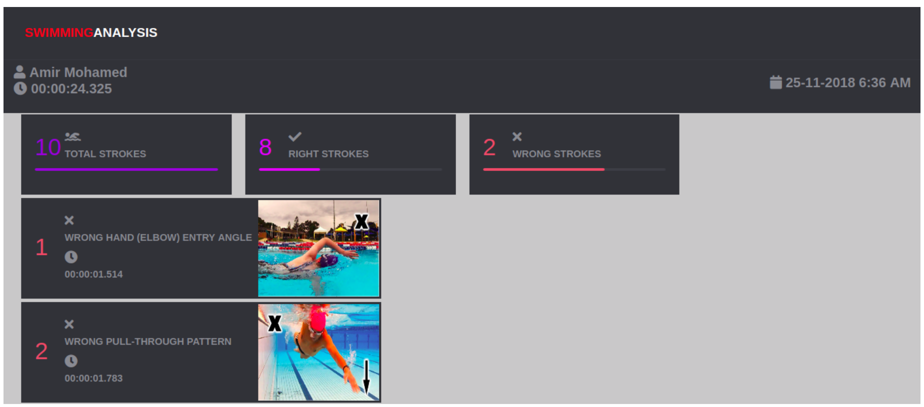

Figure 6: Coach's Web monitor Application.

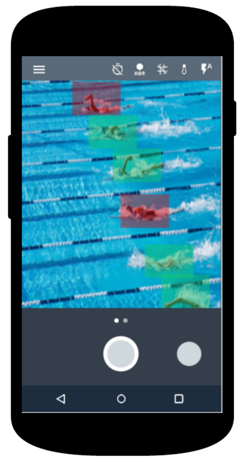

Figure 7: Coach's Mobile Application.

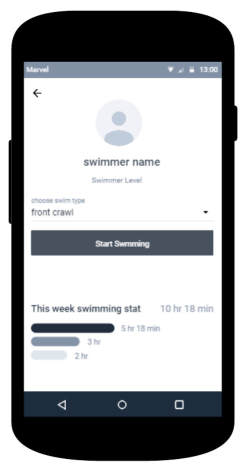

Figure 8: Swimmer's Mobile Application.

4.2 Communications Interfaces

The communication interface is one of the most important requirements of our software as it will need a connection to the internet or a local host connection.

5 Performance Requirements

For Swimming Self-Coaching, the system shall be able to process at least 150 point (x,y,z) per window. For model training, the system must be able to handle large training datasets to ensure model accuracy. Sample run times for different training datasets.

6 Design Constraints

Any smart mobile device that include the android operating system and must have the connection with the internet to deal with the real-time data transfer.

6.1 Hardware Limitations

Mobile device must have the accelerometer and gyroscope sensor.

7 Non Functional Requirements

7.1 Performance and Speed

The Swimming Self-Coaching must be interactive and the delays involved must be reduced. So in every action response of the Swimming Self-Coaching. Detection and classification must have no delays.

7.2 Reliability

The Swimming Self-Coaching is reliable. It must be make sure that the system is reliable in its operations. This would be mainly focusing on the detection and classification. As sensors readings should be accurate and error free. When a detected wrong movement is being classified, it is very important to identify the type of the wrong movement correctly with no errors and the user should be able to trust the Swimming Self-Coaching fail rate is almost 0 percent.

7.3 Scalability

The Swimming Self-Coaching is scalable. It should be easy to maintain to minimize the amount of changes that would be done to the code.

7.4 Usability

Proportion of functionalities or tasks mastered doesn't need time to be learned. Also, this system is easy to be memorized due to the small number of tasks the user will do.

8 Preliminary Object-Oriented Domain Analysis

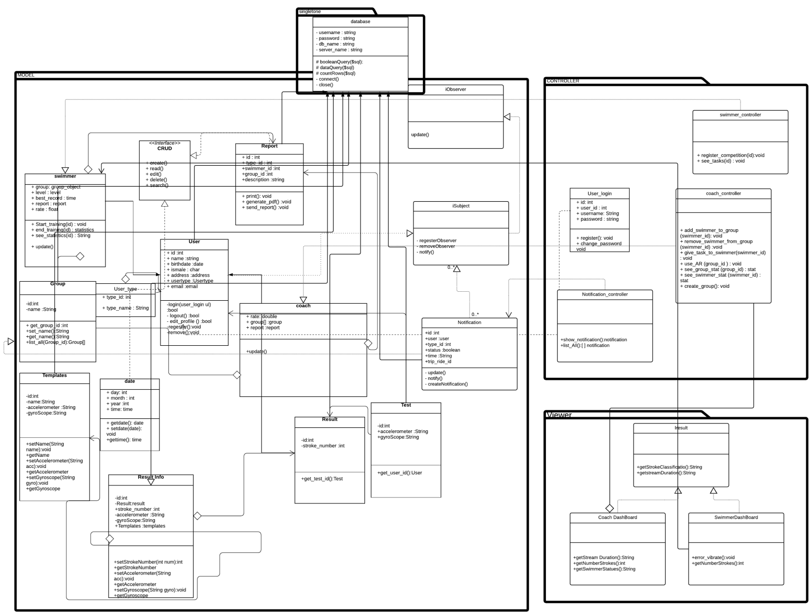

Figure 9: Class Diagram for System.

9 Operational Scenarios

9.1 Scenarios

9.1.1 Scenario 1: Swimming Process

The swimmer is working for this process and starts with swimming and the application starts to send the data to the system and analyzing the data into some generated rating reports.

9.1.2 Scenario 2: User Handling

The coach is the user that control this process. The coach is manipulating the swimmer in the system and includes:

1. Adding a swimmer.
2. Editing a swimmer's information.
3. Removing a swimmer.

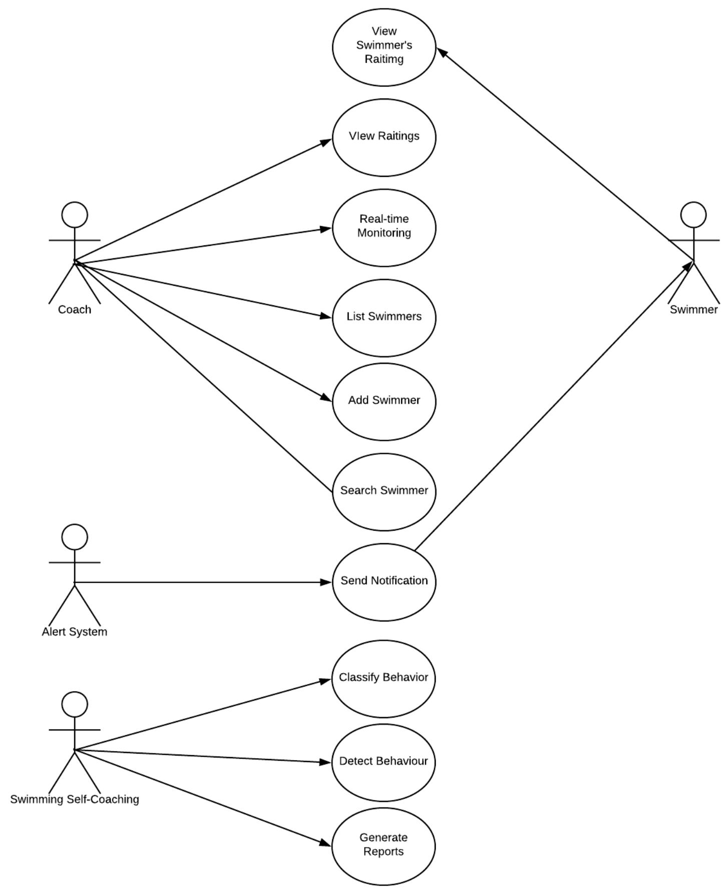

Figure 10: Use case Diagram for System.

4. Listing all swimmers and searching for a specific one.

9.1.3 Scenario 3: Swimming Self-Coaching Detecting and Classifying

These actions are done by the Swimming Self-Coaching system. When a swimmer goes into the water, the system will obtain if there's an incorrect movements was made by the swimmer by comparing the sensor's readings to the normal readings stored in predefined data set. Those readings that have been detected, and then compared against another predefined data set that consists of readings to classify the detecting readings.

10 Preliminary Schedule Adjusted

Task	Start Date	End Date
Idea discussion	26-7-2018	11-8-2018
Idea research	11-8-2018	11-9-2018
Survey and proposal	12-9-2018	26-9-2018
Proposal presentation	26-9-2018	26-9-2018
Implementing prototype	26-9-2018	30-9-2018
Designing application	30-9-2018	3-10-2018
Implementing GUI design	4-10-2018	7-10-2018
Designing database	8-10-2018	11-10-2018
Dataset collection	12-10-2018	17-10-2018
Dataset classification	17-10-2018	22-10-2018
SRS writing	22-10-2018	9-11-2018
SRS presentation	9-11-2018	9-11-2018
Implementing application	25-11-2018	22-12-2018
SDD writing	23-12-2018	16-1-2019
SDD presentation	19-1-2019	19-1-2019
Validation and testing	31-1-2019	27-3-2019
Writing paper	30-3-2019	10-4-2019
Deliver the paper	12-4-2019	12-4-2019
Writing thesis	21-4-2019	31-5-2019
Final presentation	26-6-2019	26-6-2019

Figure 11: Use case Diagram for System.

11 Preliminary Budget Adjusted

Item	Quantity	Cost
3 axis gyroscope and accelerometer	2	140
Amazon Cloud Drive	None	5GB for 11.99/*year*

Table 18.

References

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[2] Marc Bächlin, Kilian Förster, and Gerhard Tröster. Swimmaster: A wearable assistant for swimmer. *Proceedings of the 11th International Conference on Ubiquitous Computing*, 53(10):215–224, 2009.

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