MJIT 2019 Malaysian Journal of Industrial Technology

DEVELOPMENT OF ATHLETE FITNESS MONITORING AND TRAINING LIGHT SYSTEM WITH IOT

M. S. H. Anuar [1, a], M. I. Yusof [2,b] , A. R. Asari [3,c]

[123] Instrumentation and Control Engineering Section, Universiti Kuala Lumpur Malaysian Institute of Industrial Technology (MITEC), Jalan Persiaran Sinaran Ilmu, Bandar Seri Alam, 81750, Masai, Johor

[a]shahrul.anuar@s.unikl.edu.my, [b]mohdismaily@unikl.edu.my, [c]ashraf@unikl.edu.my

*Corresponding author's email: shahrul.anuar@s.unikl.edu.my

Abstract

Nowadays, there are several issues or accident happened to the athletes in Malaysia and also around the world during tournament or training. Plus, lack of awareness during match or game could also could become one of the issues that could lead to the injuries also losing the match or competition. Those factors could be determined by the lack of technology to monitor andmeasure the athlete's fitness and their reflexes towards their surroundings. Therefore, the idea of proposing a monitoring device that could be used by the trainer or coach to monitor their athletes were developed. This project was used to monitor the athlete's fitness status and test their reaction time by using wireless communication based on embedded technology. This project was designed to record and monitor data set of player heart rate, body temperature while checking their reaction time to stimulation and transmit it wirelessly by using compact embedded sensor and microprocessor as the main device. Multiple sensors were used to monitor the heart rate, current body temperature and athlete's reaction time. The device will be included with Arduino as a main microprocessor unit and medium for data transferring and receiving before it being transmitted to the monitoring platform and also several node microcontroller unit for the training light system. The results obtained from the first andsecond prototype shows that readings from three different types of sport during data collection were different. The data from the prototype were also influenced by the play pattern of the sport itself which require a different athlete performance. As for theconclusion, the result data were illustrated on graph for all the parameters. Therefore, it is required to use a better high specification sensor and monitoring platform as a future improvements.

Keywords: Athlete fitness; Heart rate; Body temperature; Reaction time; Training light; Wearable technology; Internet of Things

1.0 INTRODUCTION

Over the decades, sports and healthy lifestyle has played an important roles in human life. The number of humans participating in all organised athletic activities worldwide is also increasing yearsby years. However, physical fitness level among the athlete are sometimes are below expectation due to certain circumstances. The decreased preparedness for sports participation has led to a chronic sport injuries and poor performance. Also, there are lack of technologies that can be used to monitor the amateur athlete performance and fitness in some institutions nowadays except for a professional organization whom specialized in sports industry. It mainly because the organization or institutions does not want to invest a huge amount of money into the sports technology in order to ensure the athlete were in best state and well performed before the competition. Therefore, it is required to develop much efficient, low-cost and reliable device to make sure the athlete in good fitness level and highly focused before performing in any athletic activities and ensuring the athlete health in perfect conditions.

By doing some research, the materials required were being taking priority to ensure the device works. The monitoring device is being monitored by sending a signal from the device which are connected to the Wi-Fi module to the user in order to keep tracking ofthe player performance based on the athlete's bodyheat temperature, heart pulse and reaction time. This parameter will helps the user or the trainer to assumethe athlete's stamina and focus level of athlete during the training simulation. The process of the device involve a several phase of parameter tracking, then it will send the analog signal through Wi-Fi to the main electronics device which is smartphone or PC as a monitoring platform and convert the signal into some kind of digital value toindicate the current reading.

1.2 Problem Statement

Nowadays, athlete's performance in various sports isa big deal during tournament or event. Athlete's fitness and performance are really crucial to keep them in good pace and perform well. Therefore, without any devices or technology to sense the athlete's heart rate, body temperature and reflexes towards the surrounding, this surely can cause a problem for the trainer or coach to determine whether the athlete can still keep up the pace or not since each of the players have a different capability.

Usually, athletes such as football players, martial arts, tennis players and so on are lying about own actual energy level. Athlete tend to lie because of the eagerness to play the game much longer and proves his or her talent to the coach or trainer. Littledid the athlete know, this can cause a poor performance when could not keep up with the opposing team performance later and lose the match easily if not performed well during the match. Plus, it will also affect the health of the athlete since human's body need to cool down and rest otherwiseit will cause an injury to the athletes themselves. Therefore, the idea of developing a prototype were produced to overcome this problem. The data gathered from the devices can be used by the trainer to make any adjustment to the training regime.

1.3 Project Objectives

The main project objectives were:

- To design the athlete fitness monitoring and training light system prototype.
- To monitor the data based on the three parameter which are heart beat per minutes, body temperature, and athlete's reaction time.
- To implement the IoT concept into the prototype development.

2.0 LITERATURE REVIEW

2.1 Introduction

The main objectives of this chapter is to focus on the primary points of the current knowledge and all possible methodologies approaches in order for this project to work perfectly. There are few features included and implemented into this project which are heart rate and body temperature reading. Therefore, a research on pulse sensor, body temperature sensor, ultrasonic sensor has been done, reviewed and summarized. All those literature reviews that being highlighted are secondary sources and do not represent any original work.

2.2 Fitness Monitoring

Fitness are one of the most important aspect in sports that must be prioritize. The fitness of the athletes are considered as the main weapon in certain sports tournaments the athlete were participating. Therefore, there are various of technologies are made not only focusing on sports but also in other field such as medical, agriculture and more. According to Ka Yiu Sham (2017), the fitness level of the certain athletes are decreasing when the age increase. Therefore, to see if the athlete still capable to keep up the pace on the training session, this is where the technology play its parts.

In addition, Abbey Lunney (2016) said there were several alternative has been made by the society to keep tracking the user or individual fitness.The world has become more and more advanced from humans expectation and so do the technologies. Those alternatives have become part of the sport player to make sure the athlete still updated towards the fitness level and health.

As mentioned by Perikles Simon (2006), fitness of the sports players are important because some of the athletes tend to take an illegal drugs. The numbers of unreported cases are in the peak spot where there are lack of technology that can be used to sense the possibility of the athletes taking a steroid that may affect the athlete own health and performance during competition. Usually, athletes tend to take illegal drug to make them keeping up the pace during training sessions.

Furthermore, according to A.W.S Watson (1984), there are sports injuries happened to the Irish schoolchildren during their training and one of the factor is lack of fitness besides illegal play, foul and defects in sport area. There are no method tomonitor the children as there were no technologiesdeveloped to sense the children's fitness level.

Figure 2.1: Heart Rate Monitoring

2.3 Athlete Reflexes

In certain area of sports, athletes are required to be fully aware during the match. This can be determined whether the athlete will win or lose the game if not focusing on the current gameplay objectives. Therefore, the athlete reflexes on the main objectives point are really worth to keep them focus and move fast.

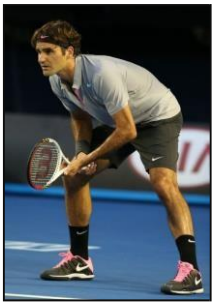

Figure 2.2: Athlete focusing in game

According to NeuroTracker Team (2016), the athlete's reaction time could mean a thing between who wins and loses a game. Though some sports required a certain degree of quick reaction time while some sports are more heavily dependent on this factor then others. It stated, reaction time to stimulus is one of things that can be difficult to be trained for, but is an area in most all sports that requires attention. The fact is also pointed out that reaction time is a crucial part of many sports such as tennis.

As mentioned by Tulin Atan and Pelin Akyol (2013), all athlete who involved in a team sports have several advantages in motor skills that can be improved in training. The reflex time also could be improves regarding the strength, agility, endurance, flexibility and balance. Those factors are used consecutively in aerobics and anaerobic system which will affect the performance of the players.

Based on Royal H. Burpe and Wellington Stroll (2013), the reaction time has been tested in several ways which are tapping with a stylus method, the verneer chronoscope, etc. The purposes of this test is to classify athlete's abilities in sports and for the research. The speed of tapping has been used frequently as a measurement of reaction time for research purposes. It require the athlete to tap as quickly as possible with stylus. In this method of study, the time is also measured which elapsed between the presentation of stimulus and the response.

Furthermore, according to Caserta, R. J., & Singer, R. N. (2007), there are difference between both amateur and professional athletes reaction time in certain sports. For example, the professional soccer player athletes are required to predict any actions made by the opponents in match and had to move faster to obtain certain objectives to score a point.

Also, in training situation awareness, there are majority of studies that have been conducted to perform a simulation training techniques to improve several specific anticipation like the ability of the player to identify the visual or postural cues from the opponents rather focusing only on the situational awareness. However, the results and effects of this program on the experts and older athletes are likely unknown.

2.4 Pulse Sensor

Nowadays, pulse sensor are used in various field, type of application, devices and machines. Plus, the usage of pulse sensor are quite trending on medical and sport science field. The purposes of pulse sensor in medical field is to measure the patient's or athlete's heart rate per minutes and checking for any abnormality that would affect the health. In addition, there are lot of application of pulse sensor in this modern technology that could be made to be a wearable devices such as fitness vestor smart health watch. The device will alert the user if the heart rate exceeded certain value or showing any abnormalities that would danger or effecting own performance and health. However, every pulse sensor have its own range depending on the types of sensor used.

Generally, the most common pulse sensor which are being used in sports field is the pulse sensor module. It can be easily incorporate live heart-rate data that can be used for monitoring purposes. It is an integrated optical amplifying circuit and noise eliminating circuit sensor. The sensor are usually being clipped on the finger or body for recording and measuring purposes.

2.5 Temperature Sensor

In this days, the temperature sensor has also been used in various types of application, machines and devices. In fact, temperature sensors are also could be found in surroundings such as house's appliances for example dryer and air conditioner. Moreover, there are lot of application of temperature sensors in today's modern technologies such as temperature sensor in smart phones or laptop to alert the users if the body temperature is exceeding normal temperature. Every temperature sensor have its own temperature range and it depends on the

types of the sensors itself. As stated by Qimin Yang (2011), in order for the temperature sensors to produce effectively and independently, the processors need to stay at its temperature range.

Generally, LM-35 is analog sensor which is a precision integrated-circuit temperature sensors, which having an output voltage is nearly proportional to the Celsius temperature. The LM-35operates at -55° to +120°C which are suitable for measuring a human body temperature. As stated by Kaushik. S (2018), the LM-35 is a low cost temperature sensor which using a semiconductor and an electrical phenomenon to live an encompassing air to produce a signal on the information pin of the sensor.

As mentioned by Bogdan (2016), the LM-35 able to measure the body temperature on human body. The temperature sensor consist of three pins which are power input, ground and signal pin. The signal pin can be connected to any analog pin on Arduino board. The voltage supply for the sensor should be between 3.3V to 6V (the most recommended voltage is 5V).

2.6 Ultrasonic Sensor

Ultrasonic sensor has also been used and could be found anywhere in human daily life. Ultrasonic sensor are being used widely in automotive, medical, industrial, etc. This sensor is commonly used to detect or sense the presence of an object to trigger the input value when it reached at certain distance. There are variety of ultrasonic sensor that could be found in technologies and marketplace. Every different parts of ultrasonic sensor have its own range and capability.

HC-SR04 is one of ultrasonic sensor. This sensor is very popular sensor that are been used in many application when measuring distance or sensing an object. This module has a two eyes like projects in the front which would forms the ultrasonic transmitter and receiver. The formula that been used by this sensor are as Equation 2.1:-

$$\text{Distance} = \text{Speed} \times \text{Time} \qquad (2.1)$$

Its transmitter transmits an ultrasonic wave which this wave travels in air and when it get objected by any material, the wave will reflected back towards the sensor and being observed by the ultrasonic receiver.

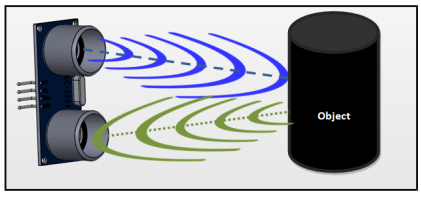

Figure 2.3: Ultrasonic sensor working principle

2.7 Previous Technology

Figure 2.4: Smart fitness watch

According to Sarah Silbert (2018), this smart fitness watch is one of the portable device that being designed to worn on a wrist. It has a variety of function that can even sense the fitness level on the people who worn it. As for the athletes or sport's player, this watch is quite common and well known for its capability and advantages to sense the athlete performance and achievement during sports play. Since this device can track the wearer fitness level and have many function besides fitness tracking suchas receiving call, alarm, GPS tracking etc. The price of one of this devices are much expensive compared with the normal watch and the data is only limited to the wearer access only.

3.0 RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, it propose the progress of this project which includes the result and graph obtained from the prototype. The output system which is the athlete fitness monitoring and training light system is to monitor the fitness level and reaction time of the athlete by using the pulse sensor, temperature sensor and ultrasonic sensor. The system used ThingSpeak and web server to monitor the data wirelessly. The pulse sensor and LM-35 temperature sensor has beenused to monitor the athlete's heart rate and body temperature because it is a small electronics components that can be attached on athlete's body and obtain the data from them. As for the ultrasonic sensor, it has been used to detect the athlete's tap in order to gather how fast the athlete's reaction time. Therefore, it can be concluded that all the data which is heart rate, body temperature and reaction or reaction time are interrelated with each other during the result analysis.

3.2 Research Plan

This section will discuss on the overall planning regarding the project flow which includes the Final Year Project 1 and Final Year Project 2. The flow chart for this process flow of Final Year Project has been illustrated to provide a better understanding as well to make it easier to conduct the project. According to the illustration, during FYP1,the study are focused on determining the project idea, brainstorming the concept of project, reviewing related study by past researcher anddocumentation for Chapter 1, Chapter 2 and Chapter 3 which includes introduction, literature review and methodology of the project. Meanwhile,during FYP2, the study has been highlight on obtaining and collecting the result as well as data logging for the project. All the result obtained will be recorded and document in order to complete the full documentation for Final Year Project.

As to evaluate this project, the methodology used are also based on System Development and Life Cycle (SDLC). By referring to Figure 3.1, it being divided into three major steps which is planning, implementing and analysis.

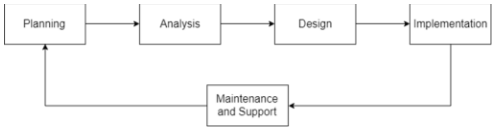

Figure 3.1: System development life cycle Based

on Figure 3.2, it describes the work flow of the project from the beginning until the end.For the first step, the title defend presentation by the students has been conducted by coordinator of final year project one in order to approve the project idea and assign to specialized supervisor and co-supervisor. Next, after the final year project title has been decided, the work flow moving on to the hardware and software implementation and development. At this phase, the prototype of the project and the coding has been develop before it is being tested. For the system integration, the system is being test to identify the error and troubleshooting before the system can fully functional to collect data. At the end, the data is collect and record for documentation.

Figure 3.2: Project process flow chart

3.3 Project Block Diagram

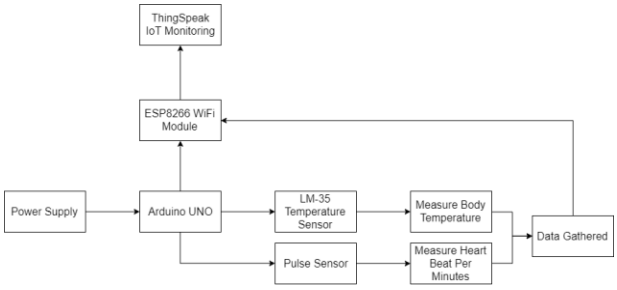

Figure 3.3: Fitness monitoring block diagram

Referring to Figure 3.3, the block diagram illustrates the process flow of the fitness monitoring project. There are power supply which is 9V battery are being used to power up the Arduino UNO board as the main microcontroller for athlete fitness monitoring prototype. On this project, the Arduino UNO will activate the pulse sensor which connected on A0 pin on Arduino UNO board while the LM-35 temperature sensor connected on A1 pin.

Thus, the pulse sensor will sense the athlete's heart rate when it being attached to the athlete's body. As for LM-35 temperature sensor, the sensor will sense the current ambient heat on the athlete's body and send the data to the Arduino for recording purposes. When the data from both sensor are gathered, the ESP8266 Wi-Fi module will transmit the data from Arduino board to the open source monitoring platform which is ThingSpeak and produce the live monitoring graph.

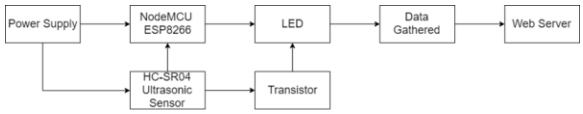

Figure 3.4: Training light system block diagram

As for Figure 3.4, the block diagram illustrates the process flow of training light system. There are power supply to gives power to the main microcontroller which is NodeMCU and ultrasonic sensor. The sensor VCC pin are connected to the 6V battery and connector pin on the transistor. While the trigger pin of the sensor were connected to the D1 port on NodeMCU board and echo pin were connected to D2 port. The function of the transistor is to amplify or switch the electronic signals and electrical power. The data or time interval for this device to work could be manually set by the user based on own preferences. There will be three training light system kit that react as the client and the data gathered from the client will be transmitted to the primary NodeMCU which will react as the server itself (the Wi-Fi hotspot). Then, the server will create a web server user interface which is 192.168.4.1 for monitoring purposes.

3.4 Hardware Block Diagram

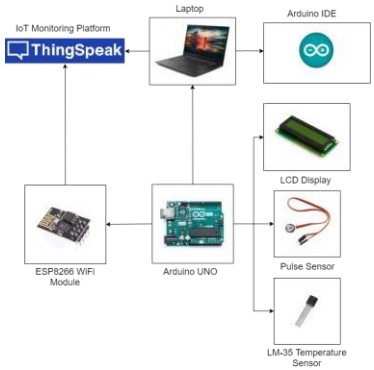

Figure 3.5: Fitness monitoring hardware block diagram

Figure 3.5 above shows the main component used for fitness monitoring which consist of ESP8266 Wi-Fi Module, Arduino UNO, pulse sensor, LM-35 temperature sensor, a computer and LCD display. The pulse sensor and LM-35 temperature sensor will obtain reading of relative heart rate and body temperature of athlete's body. Then, the data obtained will be display on the LCD as the non-IoT data so that the athlete can view the data manually without accessing the internet platform. The ESP8266 Wi-Fi module will act as the bridge to connect the Arduino board with IoT so that the data can be accessed wirelessly through laptop by the secondary user or trainer. As for the Arduino IDE, it being used to create the coding to implement in the Arduino UNO board.

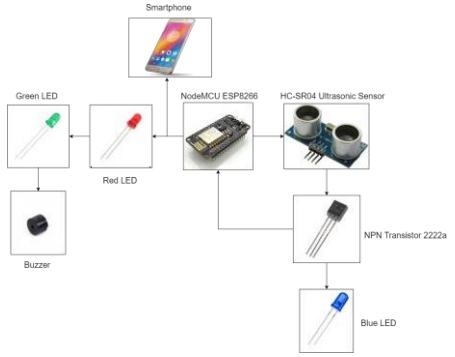

Figure 3.6: Training light system hardware block diagram

Figure 3.6 above shows the main components used for training light system which consist of NodeMCU, HC-SR04 ultrasonic sensor, 2222A NPN transistor, red LED, blue LED, green LED and a smartphone. The hardware of this training light system will be divided into main three light system that will act as slave or client in the system. There will be one NodeMCU that will be act as the master or server in order to connect all three client in one system. Hence, the master NodeMCU will create a Wi-Fi hotspot in order to let the phones to be connected to web server for monitoring for all the client data. The monitoring platform can be access when the master have the power supply connected and it will automatically create the web server. All the settings can be adjust on the smartphone to match the user preferences.

3.5 Software Block Diagram

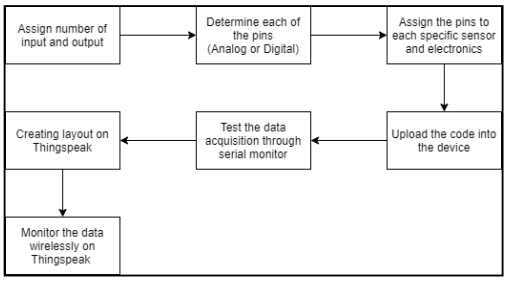

Figure 3.7: Fitness monitoring software block diagram In

this fitness monitoring project, the main software that used as compiler is Arduino IDE. According to the block diagram on Figure 3.7, it is shown that the fitness monitoring prototype are being set by using Arduino IDE software. In order to compile the coding into the Arduino UNO, several phases must be go through before it can be uploaded. First of all, the input and output that were being used are need to be assigned. In this fitness monitoring prototype, the number of input were being used was two which is pulse sensor and temperature sensor. Plus, the output of this device is

also two output which is the heart rate per minute and temperature in °C. After all the variables were declared and all pins have been determined, the code have to be uploaded into Arduino IDE before it can be monitored through serial monitor. Next, the layout on the ThingSpeak need to be set up before the data can be monitored on the private channel via PC.

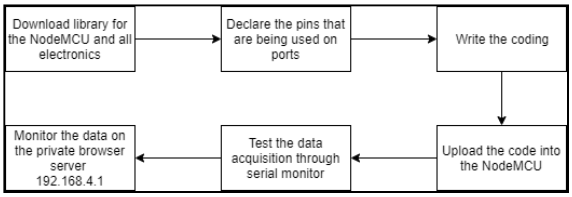

Figure 3.8: Training light system software block diagram

In Arduino IDE, it is required to select a correct type of Arduino board in order to allow compilation into hardware without any error. In this training light system project, the Arduino IDE must beable to interface with the NodeMCU ESP8266 to allow the communication between itself such as read andwrite the connection of the sensor. Besides, the Arduino IDE also allow the data obtained by the sensor to be send to the browser for analyzing the athlete's reaction time simulation and the time taken.

When the construction of the block is done, it needs to be build and deploy to the Arduino board. After the block is successfully built and deployed into the hardware, the simulation can be run accordingly throughout the browser. Based on the coding, the IP address for the web browser is 192.168.4.1. Therefore, the user must access it through the smartphone in order to execute the simulation process.

3.6 Project Flow Chart

Figure 3.9 explains about the flow of the athlete fitness monitoring prototype with IoT. In this sub project, the system will be obtain themeasurement of heart rate per minute and currentbody temperature from the athlete by using the pulse and temperature sensor. The value obtain from both sensor will be analyze by the Arduino. This is where the readings and measurement takes place in order to obtain the current data reading of the athlete's fitness level. The readings from actual sensorthrough the Arduino will be display on the LCD for direct visual monitoring and then the data are also displayed on the online monitoring platform which isThingSpeak via ESP8266 Wi-Fi module. Moreover, theThingSpeak will also produce the graph as for live monitoring purposes. The data from the graph can be used by the user for analysis and gain information on the player fitness.

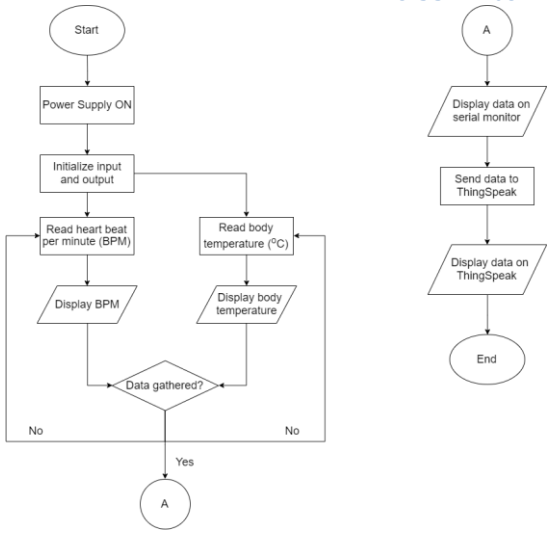

Figure 3.9: Athlete fitness monitoring flow chart Figure

3.10 shows training light server process flow chart. In this second sub project the system will obtain the reading of the athlete's reaction time by using the ultrasonic sensor and NodeMCU. It shows the server that are being created to connect all the clients via Wi-Fi network that are being established bythe server itself. Whenever the server is powered up, it will create a Wi-Fi hotspot and search for the client's connection. After the client (the training light and smartphone) are connected, the user must log on into the web browser which is 192.168.4.1 and usercan control the interface based on own training session preferences. The data obtained from the user smartphone will be transmitted to the server and itwill communicate with all the lights client to follow the protocol. The data then will be shown to the user smartphone for monitoring purposes.

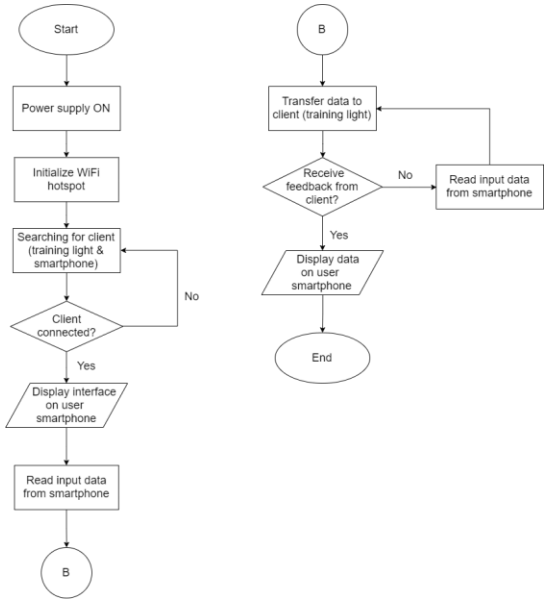

Figure 3.10: Training light system server flow chart

Figure 3.11 shows the training light client process flow chart. There will be three clients that are connected to the server. These lights were suppliedby the 6V battery to power up and it will initialize the Wi-Fi connection to the server. During the attempt to connect to the server, the green LED and buzzer will also be power up until the Wi-Fi connection are establish to the server. Then, the blue LED will automatically light up to signify the clients light working process. Whenever the ultrasonic sensor sense the presence of object or athlete's body, it will trigger the green LED and buzzer for 2 second. The data will be transmitted to the server and user can see the data for "points" increasing. If the ultrasonic sensor unable to detect any object or athlete's body, the red LED will be light up for 2 second and the data will be transmitted to the server. The user can see the "error" data are being display on the smartphone. The training light settings can be select by the user based on own preferences on how the trainer want the athlete to alert towards the surroundings.

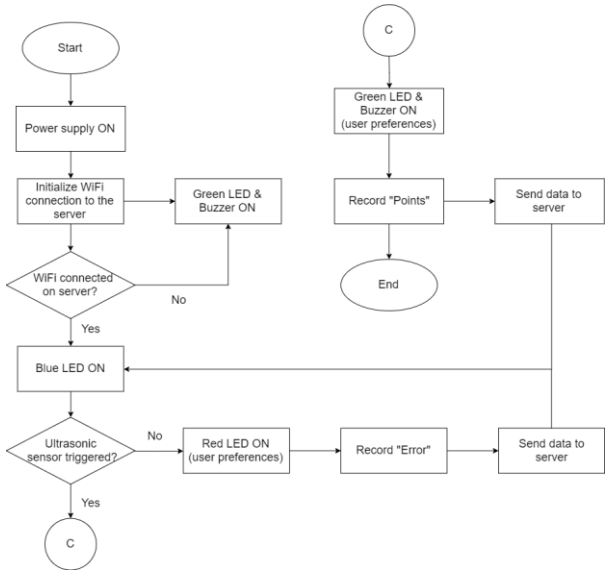

Figure 3.11: Training light system client flow chart

3.7 Schematic Diagram

This section will describes the connection for each components related to the fitness monitoring prototype and training light system. The purpose ofthis schematic diagram is to ensure the connectionof the components is being connected properly andto ease up the troubleshooting when it required.

As for the schematic diagram, the Fritzing software are used to ensure the drawing is clearly drawn.

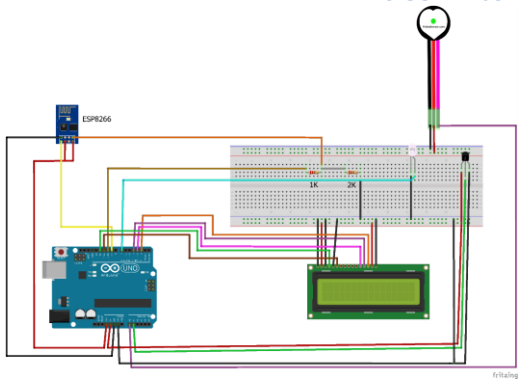

Figure 3.12: Fitness monitoring prototype schematic diagram

As for training light system, the following schematic diagram are used to connect all the components in order to ensure the device works perfectly.

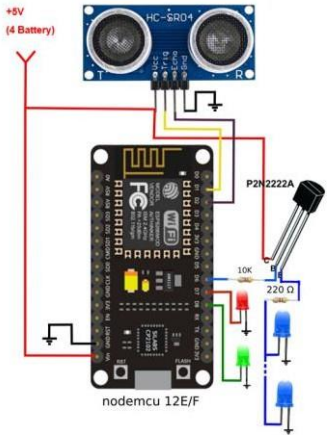

Figure 3.13: Training light system schematic diagram

Based on Figure 3.12, it shows the connection for the athlete fitness monitoring prototype. Basically,the connection for this system includes the Arduino UNO, a breadboard, power supply, pulse sensor, LM-35 temperature sensor, ESP8266 Wi-Fi module, 16x2 LCD display, 2K and 1K resistor and white LED. All this components were interfaced with the Arduino UNO. Each of the components is installed to the Arduino with specific pin. The Arduino board are connected to port 3 computer, the pulse sensor andtemperature sensor connected to pin A0 and A1 on Arduino Board respectively.

Based on Figure 3.13, it shows the connectionfor the training light system. As for the connections, itusually includes the NodeMCU ESP8266, a breadboard, HC-SR04 ultrasonic sensor, a NPN transistor, 10k and 220 ohm resistor, blue, red and green LED, and a power supply. Therefore, each of the components are also being installed to the NodeMCU with its respective pins. As for the NodeMCU, it was a standalone microcontroller, the ultrasonic sensor trigger pin were connected to D1

and echo pin connected to D2 while the supply connected to the battery and collector terminal of the transistor. The base terminal of the transistor connected to pin D6 with 10K ohm resistor while the emitter terminal were connected to the 220 ohm resistor with several blue LED. For pin D7 were connected with red LED and for pin D8 will be connected with green LED.

3.9 Prototype Design

Figure 3.14 shows the completedevelopment of athlete fitness monitoring and training light system with IoT prototype. These prototypes was used to measure the parameters that have been stated in the project objectives.

Figure 3.14: Fully development of athlete fitness monitoring and training light system with IoTprototype

Figure 3.15: Athlete fitness monitoring prototype

4.0 RESULT AND DISCUSSION

4.1 Introduction

In this chapter, it propose the progress of this project which includes the result and graph obtained from the prototype. The output system which is the athlete fitness monitoring and training light system is to monitor the fitness level and reaction time of the athlete by using the pulse sensor, temperature sensor and ultrasonic sensor. The system used ThingSpeak and web server to monitor the data wirelessly. The pulse sensor and LM-35 temperature sensor has beenused to monitor the athlete's heart rate and body temperature because it is a small electronics components that can be attached on athlete's body and obtain the data from them. As for the ultrasonic sensor, it has been used to detect the athlete's tap in order to gather how fast the athlete's reaction time. Therefore, it can be concluded that all the data which is heart rate, body temperature and reaction or reaction time are interrelated with each other during the result analysis.

4.2 Project Result

Result of this project includes the result obtained by using the ThingSpeak, web server for real time monitoring and Arduino IDE for IoT. In order for comparison of the system, all the matters below were taken and Microsoft Excel are used to produce the graph from the data obtained from both prototype. The individual for this project are required to wear the prototype during the fitness and reaction simulation while performing all three sport activities.

Figure 4.1: Field simulation testing

4.2.1 Data Analysis between Different Types of Sports.

From the experiments, data were compared from the same individual performing three different activities using the prototypes. For all the parameters measurement, there were three different activities which were playing a badminton, football and frisbee that have been taken. The data of the system were being taken and saved in Microsoft Excelformat manually for further reference. The stored

data are then observed and compared to produce a graphical figures.

The experiments were held for atleast five minutes for each sport activities in three different days in order to monitor the heart rate, body temperature and reaction time activity of the athlete from time to time.

The purpose of this data analysis was to determine which sports influencing the mentioned parameters most. The initial of the heart rate and body temperature was not specific during each sport activities before testing as the simulation were held in three different place, days and time. For the data comparison of heart rate, body temperature and reaction time between three types of sports, the graph used was bar chart. Meanwhile, a line chart was used for the difference between all those three types of sports activity.

4.2.2 Athlete Fitness Monitoring Result

Table 4.1 shows the heart rate data of the athlete performing three different activity. Table 4.2 shows the difference of body temperature between three activities. These data and graph were representing the fitness monitoring prototype. All the data from these prototype were taken during the simulation and being recorded.

Table 4.1: Athlete heart rate data

Time Taken (h/m/s)	Heart Rate Parameter in Beats Per Minute (BPM)					
	Badminton (A)	Football (B)	Frisbee (C)	Difference (BPM) |A-B|	Difference (BPM) |A-C|	Difference (BPM) |B-C|
00.00.30	62	64	60	2	2	4
00.01.00	65	69	60	4	5	9
00.01.30	81	95	68	14	13	27
00.02.00	94	110	66	16	28	44
00.02.30	103	141	70	38	33	71
00.03.00	98	145	73	47	25	72
00.03.30	86	119	71	33	15	48
00.04.00	88	87	68	1	20	19
00.04.30	80	67	73	13	7	6
00.05.00	93	64	69	29	24	5

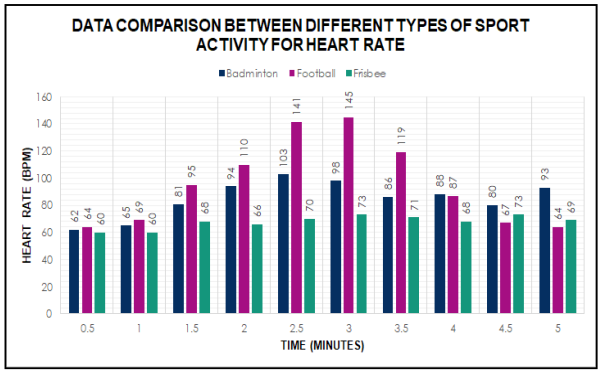

Figure 4.2: Data comparison between different typesof sport activity for heart rate

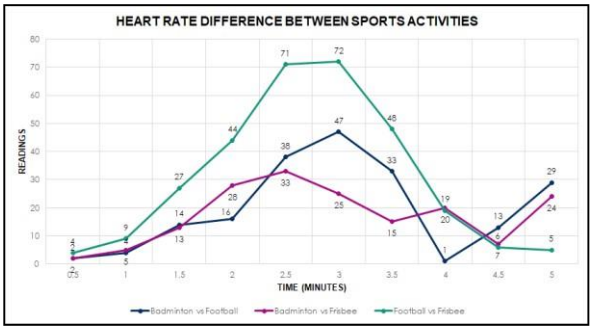

Figure 4.3: Heart rate difference between sport activities

As for the athlete's body temperature, the results areshown as in Table 4.2

Table 4.2: Athlete body temperature data

Time Taken (h/m/s)	Body Temperature Parameter in Degree Celcius (°C)					
	Badminton (A)	Football (B)	Frisbee (C)	Difference (°C) |A-B|	Difference (°C) |A-C|	Difference (°C) |B-C|
00.00.30	35.12	33.17	33.22	1.95	1.9	0.05
00.01.00	35.38	33.28	33.43	2.1	1.95	0.15
00.01.30	36.04	33.54	33.63	2.5	2.41	0.09
00.02.00	34.60	34.12	33.72	0.48	0.88	0.4
00.02.30	35.82	34.34	33.64	1.48	2.18	0.7
00.03.00	36.01	35.39	33.59	0.62	2.42	1.8
00.03.30	36.44	34.94	33.86	1.5	2.58	1.08
00.04.00	35.68	34.64	34.02	1.04	1.66	0.62
00.04.30	35.73	34.60	33.95	1.13	1.78	0.65
00.05.00	36.05	34.52	33.89	1.53	2.16	0.63

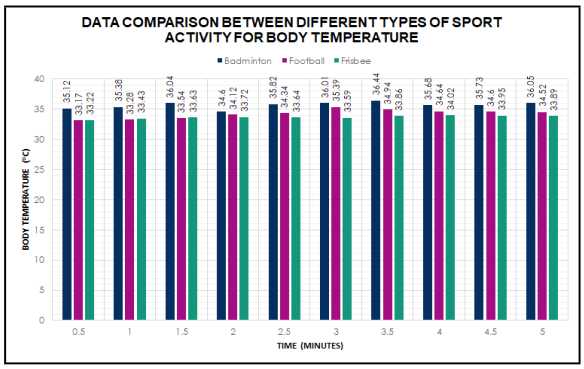

Figure 4.4: Data comparison between differenttypes of sport activity for body temperature

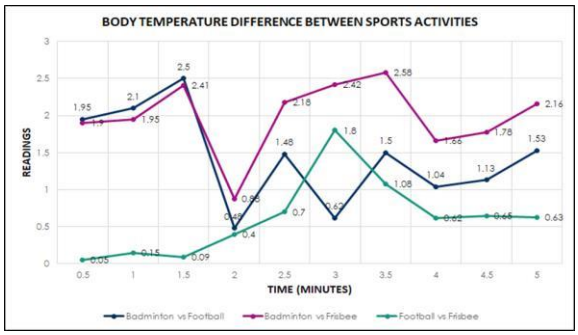

Figure 4.5: Body temperature difference between sport activities

Data taken from three different sports by using athlete fitness monitoring prototype were being compared. The result showed that this development prototype were capable to monitor the data from a distance and produce a result. Figure 4.1 interprets that the heart rate of athlete when playing football were much higher compared to badminton and frisbee. This is because in football sport, the athlete had to cover larger area of field and required them to move frequently compared to badminton and frisbee which only cover a small scale within the court area. The highest heart rate was took on 3rd minutes which was 145 BPM. The difference between badminton and football were around 47 BPM while the difference between football and frisbee were around 72 BPM.

The reason why the heart rate of an athlete when playing football were decreasing on 3rd and half minutes until the final 5th minutes of simulation because the athlete were taking a break and slow down his pace during the experiment. As for the badminton sport, the athlete was required to do the simulation without a break for five minutes therefore the heart rate data for badminton game were much stable around 80 BPM to 100 BPM average. As for frisbee, the athlete does not move a lot and rather to stayed stationary for five minutes during the simulation process.

For body temperature data, it recorded the highest 36.44 °C on the 3rd and half minutes. It was much higher compared to football and frisbee mainly because it was an indoor sports. Therefore, there was no air flow inside the badminton hall to cool down the athlete's body temperature and this became a factor for body fast heating process. For the difference between these three different sports, it showed a small gap of difference values between the badminton and football while a large gap of difference values between badminton and frisbee. It was mainly because there were some aspect which influencing these data during simulation such as stationary movements and the place of simulation.

4.2.3 Training Light System Result

As for training light system, it was also conducted together with the athlete fitness monitoring prototype. This was because both prototype were correlated with each other. In some cases, the fitness of the athlete were influencing the reaction time of the athlete. Therefore, these data were taken using the training light system to monitor how long the athlete could keep up the pace, focus and react during the simulation period of five minutes. The default setting for this system were 3.5 seconds for athlete to trigger the sensor and 2 second delay for each light system trigger after sensor pop out.

Table 4.3: Athlete reaction time data

Time Taken (h/m/s)	Reaction Time Parameter in Millis (ms)					
	Badminton (A)	Football (B)	Frisbee (C)	Difference (ms) |A-B|	Difference (ms) |A-C|	Difference (ms) |B-C|
00.00.30	2759	3120	2951	361	192	169
00.01.00	2437	2945	2699	508	262	246
00.01.30	2153	2765	2391	612	238	374
00.02.00	1757	2611	2462	854	705	149
00.02.30	1880	2484	2551	604	671	67
00.03.00	2056	2597	2487	541	431	110
00.03.30	1943	2681	2353	736	410	328
00.04.00	1896	2652	2249	756	353	403
00.04.30	1966	2703	2358	737	392	345
00.05.00	1954	2687	2442	733	488	245

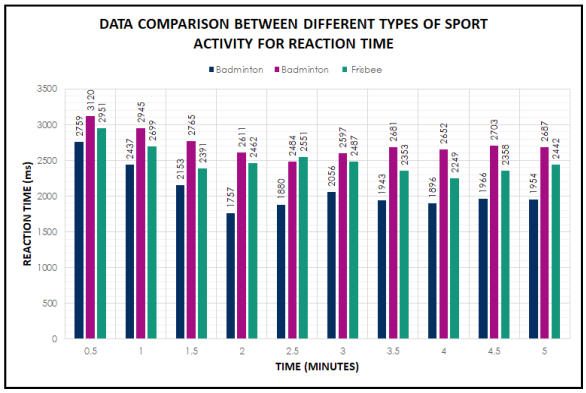

Figure 4.5: Data comparison between different types of sport activity for reaction time

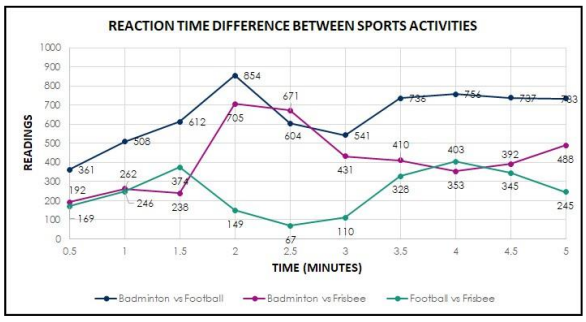

Figure 4.6: Reaction time difference between sport activities

As for the athlete's reaction time, the data are shown as in Table 4.3 for all three different types of sports activity. The graph of this data obtained were interpret as bar chart and line chart on Figure 4.6 and Figure 4.7.

The highest reaction time recorded based on three types of sports was on the first 30 seconds of simulation. It was probably because of the athlete does not prepared well before the simulation started and try to learn the light pattern. For football, it was recorded as the highest among all sports which was 3.12 seconds. The data was followed by frisbee which was 2.951 seconds and lastly badminton which was 2.759 seconds.

The reaction time for football were slowly increasing up until two and half minutes during simulation and increasing until the end of the simulation. While as for the badminton, the reaction time of the athlete were drastically increasing until minutes of two of the simulation. The main probability of this were because in badminton sport, it require the athlete to react fast during simulation and it only cover a small scale of the simulation field of test. Therefore, the reaction would be much faster compared to football which require the athlete to cover a large area of simulation field of test and it makes the athlete become much tired on the half of the simulation period. As for the frisbee, the data were average compared to both football and badminton since the athlete only need to stay stationary and cover only small scale of simulation field of test.

Therefore, as to compare the difference between all sports activity. The line chart have been developed. As mentioned, the data difference for badminton and football were high because the covering area and sport play pattern factors. There were slight difference between badminton and frisbee mainly also cause by the sport gameplay pattern while there not so much differences between football and frisbee. Thus, it can be concluded that badminton required a high reaction, respond time and pace from the athlete compared to football and the frisbee.

5.0 CONCLUSION

5.1 Introduction

In this section, the findings of athlete fitness monitoring and training light system using IoT are summarized. The monitoring and training light system of athlete are able to be developed by using the Arduino, NodeMCU and ThingSpeak. Besides, the development of this project able to achieve all the project objectives that have been made at the beginning of this thesis. This project are meant to design a system for monitoring purposes of athlete heart rate, body temperature and reaction or reaction time using Arduino ATmega328P and NodeMCU ESP8266 as the microcontroller. There are three types of health parameters have been chosen for monitoring which are heart rate and body temperature using the pulse sensor module and LM-35 temperature sensor while the reaction or reaction time using the ultrasonic sensor. Besides, the findings of the project and future recommendation are includes in this chapter and being further discussed.

5.2 Findings

After the development of this project comes to an end, there are several major findings that are need to be highlighted. By using the ThingSpeak software, the monitoring of athlete fitness can be illustrates in real-time which mean the heart rate and body temperature can be monitored through a real-time graph. This software can be very useful for monitoring through a distance for the trainer towards the athlete fitness statistics. Also, as for the training light system, it helps the athlete to become more alert towards every situations and surroundings. It can improve the athlete concentration and reaction time based from time to time when doing the simulation. This project proves that the monitoring and training light system on the athlete are developed using automatic system such as sensors, several electronics components to monitor the parameters. Last but not least, the other major findings that can be obtained from this project is the fitness monitoring prototype and training light system are also possible to be controlled wirelessly by human.

5.3 Future Recommendation

Although the project are completely developed, there is still have a lot of improvement that can be made to increase the efficiency of the system. In this section, all of possible recommendation are listed out in order to make improvement of the project by future researchers since this prototype was having some limitation to it.

5.3.1 Arduino IDE Latest Version

Arduino IDE is an important and efficient apps that can be used to do coding to the variety of Arduino model. However, some of the libraries are not being included and supported for older version of Arduino IDE. The library must be updated regularly to ensure the libraries are up to date to the model of the components that are being used. It is better to be use the latest version of Arduino IDE to avoid anyunwanted error during the compilation of code into the Arduino. Besides, by using the latest version of this software, it have a lot of improvement to make it easier to use with any type of Arduino model.

5.3.2 Use Higher Specification of Sensor for Accurate Readings

There a lot of pulse, temperature and ultrasonic sensors model that can be used for athlete monitoring. To achieve much precise and accurate readings, the pulse sensor module are not suitable since the module have slow respond rate to produce an accurate reading. It is the same with the LM-35 temperature sensor, the sensor require several start up time to calibrate and need to be placed on most area of contact on human body parts such as mouth or armpit to measure the readings accurately. As for ultrasonic sensor, it has a limited range of detection and sometimes it does not detect any tap on it. Therefore, it require specific distance to detect an object and this could be prevented by using a more expensive and high specification of sensor.

5.3.3 Use a Suitable IoT Monitoring Platform

ThingSpeak is one of useful internet monitoring platform to be used for monitoring any parameters. Since it is a free to use software, it lacks of many advantage compared to other software. The graph output on ThingSpeak is quite slow that it need 15 seconds of delay to record the data in order to create the graph. Also, the graph is not efficient and unable to store many sample data because it might causing data redundancy with each samples. Hence, it is better to use a high respond rate software to record the data efficiently with least time of delay.

Acknowledgement

First of all, I would like to express my humble gratitude towards Allah S.W.T because of His blessings that I managed to complete this FYP report. I also would like to express my sincere gratitude to my supervisor, Dr. Mohd Ismail Bin Yusof for his invaluable guidance, continuous encouragement and constant support in making this project possible. I really appreciate his guidance from the start of this final year project until the end that enabled me to develop an understanding of this project's research thoroughly. I also sincerely thankful for his time spent of reading my project report and taking an incentive to ask my project's progression. I would also like to express my very special thanks to Madam Fauziah for every briefing and co-operation on how to write a proper and effective project report every FYP class on Tuesday. Also, a special appreciation should be given to all lecturers and members of the staff of Instrumentation and Control Engineering section who have helped me in many ways and made my educational journey at Universiti Kuala Lumpur pleasant and unforgettable. Many thanks to all my friends that help me a lot during this project and research making. I acknowledged my sincere indebtedness and gratitude to my parents for their love, support and sacrifice throughout my life. I really thankful for their patience and understanding that were inevitable to make this work possible. Their sacrifice had inspired me from the day I learnt how to read and write up until now. I could not find the appropriate words that could properly describe my appreciation for their devotion and faith in my abilityto achieve my dreams. Last but not least, I would saythank you for any person which contribute to my final year project directly and indirectly. I would like to acknowledge their comments and suggestions, which was crucial for successful completion of study. Thank you.

References

[1] Caserta, R. J., & Singer, R. N. (2007). The effectiveness of situational awareness learning in response to video tennis match situations. Journal of Applied Sport Psychology, 19, 125–141.

[2] Ser, J. C. A., Janelle, C. M., & Vickers, J. (2012). Perceptual expertise: What can be trained?. In *Skill Acquisition in Sport* (pp. 332-350). Routledge.

[3] Durso, F. T., Rawson, K. A., & Girotto, S. (2008). Comprehension and situation awareness. In F. T. Durso, R. S. Nickerson, S. T. Dumais, S. Lewandowsky, & T. J. Perfect (Eds.), Handbook of applied cognition(2nd ed., pp. 163–193). Chichester, UK: Wiley.

[4] Ward, P., Farrow, D., Harris, K. R., Williams, A. M., Eccles, D. W., & Ericsson, K. A. (2008). Training perceptual-cognitive skills: Can sport psychology research inform military decision training? Military Psychology, 20 (Suppl. 1), S71–S102.

[5] Williams, A. M., Ford, P. R., Eccles, D. W., & Ward, P. (2011). Perceptual-cognitive expertise in sport and its acquisition: Implications for applied cognitive psychology. Applied Cognitive Psychology, 25,432–442.

[6] Buchheit, M., Racinais, S., Bilsborough, J. C., Bourdon, P. C., Voss, S. C., Hocking, J. & Coutts, A. J. (2013). Monitoring fitness, fatigue and running performance during a pre-season training camp in elite football players. *Journal of Science andMedicine in Sport*, *16*(6), 550-555.

[7] Capranica, L., Tessitore, A., Guidetti, L., & Figura, F. (2001). Heart rate and match analysis inpre-pubescent soccer players. *Journal of sports sciences*, *19*(6), 379-384.

[8] Halson, S. L., Peake, J. M., & Sullivan, J. P. (2016). Wearable technology for athletes: information overload and pseudoscience?. *International journal of sports physiology and performance*, *11*(6), 705-706.

[9] Cardinale, M., & Varley, M. C. (2017). Wearable training-monitoring technology: applications, challenges, and opportunities. *International journal of sports physiology and performance*, *12*(Suppl 2), S2-55.

[10] Chambers, R., Gabbett, T. J., Cole, M. H., & Beard, A. (2015). The use of wearable microsensors to quantify sport-specific movements. *Sports medicine*, *45*(7), 1065-1081.

[11] Bonfiglio, A., & De Rossi, D. (Eds.). (2010). *Wearable monitoring systems*. Springer Science & Business Media.

[12] Klein, W. M. (2011). *U.S. Patent No. 7,998,004*. Washington, DC: U.S. Patent and Trademark Office.

[13] Vacenovský, P., & Vencúrik, T. (2013). Improvement of reaction time through the one semester course of table tennis for non-athlete students. In *Proceedings of the 9th International Conference Sport and Quality of Life* (pp. 200-206).

[14] Vieten, M., Scholz, M., Kilani, H., & Kohloeffel, M. (2007, December). Reaction time in taekwondo.In *ISBS-Conference Proceedings Archive* (Vol. 1, No. 1).

[15] Bellows, S. D., Kling, T. D., & Schultz, W. J. (2005). *U.S. Patent No. 6,929,479*. Washington, DC: U.S. Patent and Trademark Office.

[16] Mori, S., Ohtani, Y., & Imanaka, K. (2002). Reaction times and anticipatory skills of karate athletes. *Human movement science*, *21*(2), 213-230.