COMPILER
Vol. 11, No. 1, May 2022, pp. 21~28
ISSN: 2252-2403 (Print), ISSN: 2549-2403 (Online)
Aaccredited Fourth Grade by Kemenristekdikti, Decree No:200/M/KPT/2020
DOI: 10.28989/compiler.v11i1.1253

Implementation of independent leg muscle training aids using Wemos D1 Mini

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Article Info

Article history:

Received May 25, 2022
Accepted June 24, 2022
Published June 30, 2022

Keywords:

Badminton
Wemos D1 Mini
Powerbank
Muscle
Client Server

ABSTRACT

One form of badminton exercise that is often applied in training the strength of the leg muscles is shadow training with the aim of simulating athletes doing leg exercises properly and correctly. Usually, athletes training leg muscles and leg agility manually use shadow exercises, namely by moving the shuttlecock or cone from one side to the other with instructions from the trainer, client, and server applications. The connection between the client application and the server application uses a wifi network. The server application can control the light on the client application. There were tests by players on the badminton court which were carried out as many as 20 trials with a time of 30 seconds for each trial; the results obtained with the sequential method obtained an average of 5.84 times muscle training, with the random method obtained an average of 5.9 times muscle training, approaching the number of 6 times the ideal muscle exercise during exercise. In the method determined by the system, the average time is 30.12 seconds, 0.12 seconds more than the targeted time. So that the adaptation of the ability of the leg muscles is obtained according to the specified training target.

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1. INTRODUCTION

Sport is a game that is played by many people, it is proven that sport is not only seen and understood as a game but also an activity to establish friendly relations for all people in the world. Sport currently is important for human survival. Sports not only become a necessity but also become a lifestyle. In essence, sport is a planned and purposeful physical activity involving large muscles, the body's skeletal system, joints, respiration, and others [9]. In addition, exercise is a series of regular and planned exercises that people do consciously to improve their functional abilities, in accordance with the purpose of doing sports.

Sports use leg muscles include Futsal, basketball, and badminton. Futsal is a sport that forms a player so that he is always ready to receive and pass the ball quickly under pressure from opposing players [1, 4]. Basketball is a sport in which the ball becomes the main medium in the running of a game by putting the ball into a basket and collecting as many points as possible to come out as a winner [6]. Badminton is a game that uses a shuttlecock as a tool which is played by hitting it with a racket [2]. Of the three sports, they are a sport that really requires leg muscle strength, so the warm-up and training focus on muscle strength, especially in the legs (Abdurahman, 2018).

One form of exercise that is most often applied in training leg muscle strength is shadow training. This exercise aims to stimulate athletes to do footwork properly and correctly. However, this form of exercise is quite classic in the world of sports, so there is a need for special formulas and media that can provide new motivation and enthusiasm when athletes train, namely with leg muscle trainers [8].

Shadow training is an exercise to train leg muscle strength and leg agility. This tool can be used by athletes in the sports mentioned above. Apart from that, athletes can also use this tool like students in sports lessons, but with a smaller portion of training than the athlete's portion of the training. Usually, athletes training leg muscles and leg agility manually use shadow exercises, namely by moving the shuttlecock or cone from one side to the other with instructions from the coach. Exercise in this way is still less effective, requiring a coach to provide instructions and the results of the exercise are not recorded properly, so another alternative is needed, namely using a tool that can replace the role of the trainer.

Preliminary research related to the leg muscle training system and leg agility uses a pressure sensor and the resulting data is sent to a computer [7], and there is efficient and optimal resource management on a microcontroller device [3, 10], and the provision of mobile activity data on mobile phones using web server services [5]. Based on the existing problems, research was carried out by making leg muscle training aids by recording activity data on mobile devices by a wireless network using Wemos D1 mini. Besides, there is backup data storage on each device using an SD card.

2. RESEARCH METHOD

The research method is carried out in stages of requirements, design, implementation, testing, and result from analysis, according to Figure 1.

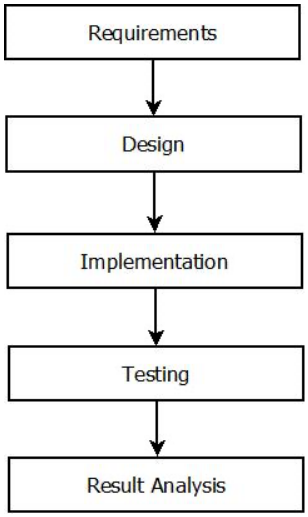

Figure 1. Research method

In general, the system description of research activities is as shown in Figure 2

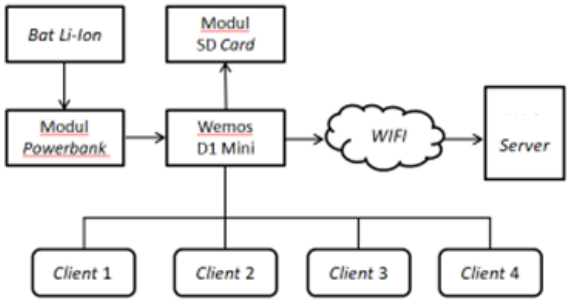

Figure 2. System Description

When players do exercise, the trainer connects the parts of the tool to the application using a Wi-fi signal, then the trainer manages the training portion on the server application. In this tool, there are two training modes, namely sequential mode, and random mode. If the trainer uses sequential mode, the lights that are pressed will move sequentially according to the number sequence, starting from 1 to 4 as shown in figure 3. Meanwhile, for the random mode, the lights that are pressed will move randomly or not sequentially, the steps are also the same, namely by pressing the light 4 times too but can be randomly started from any number.

When the tool has been connected to the application using a Wi-fi signal, then there is a start button or start as a marker for the activity of shadow training has begun. After the player performs the exercise according to the portion given, the time data, and the number of lights that are pressed will appear on the

Web server. After that on the web server, it will display the results of the exercise in the form of time and the number of lights pressed.

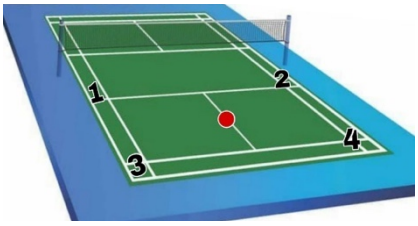

Figure 3. Device placement design.

Based on the conditions in the application design field, there are two devices, namely client devices and server devices as shown in Figure 4.

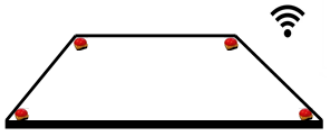

Figure 4. Client and server device design

Next, the schematic is made on the client device in Figure 5 and the server device in Figure 6.

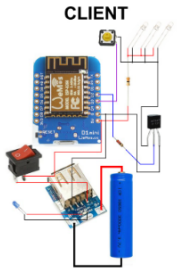

Figure 5. Client schematic

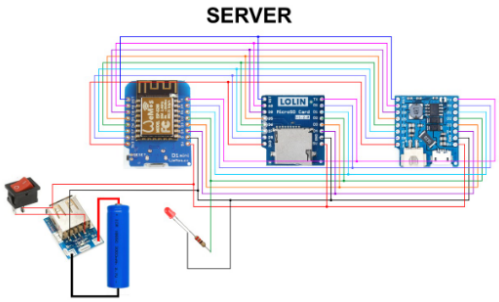

Figure 6. Server schematic

The client and server devices use battery power that can be recharged using a micro USB cable by connecting the micro USB cable to the power bank module. Wemos D1 Mini on the Client device functions as a data receiver and sender, the intent of the data receiver is Wemos D1 Mini on the Client functions to receive data from the server, which light signal will light up according to the server's choice, and the intent of the data sender is Wemos D1 Mini on the Client serves to send the pressed light data to the server which will later be recorded on the report page.

Wemos D1 Mini on the Server tool functions as a sender and receiver of data, the intent of the data sender is Wemos D1 Mini on the Server functions to send data to the Client, which light signal will light up according to the server's choice, and the intent of the data receiver is Wemos D1 Mini on the Server serves to receive pressed light data from the Client which will later be recorded and stored in the Memory Card Module. This data can be seen on the report page. The Memory Card module in this tool functions to store data such as the number of lights that are pressed, the number of clients used, the time, date, and name.

The summary of Wemos D1 Mini specifications is shown in Table 1.

Table 1. Wemos D1 Mini specifications

Item	Parameter
Microcontroller	ESP8266
Operating Voltage	2.5 V – 3.6 V
Operating temperature	-40℃ – 125℃
CPU	Tensilica L106 32-bit processor
Flash memory	4Mbyte
Clock speed	80MHz
Eeprom	512 Byte
Security	WPA/WPA2
Network protocol	IPv4, TCP/UDP/HTTP

While the summary of the specifications for the TP5410 Powerbank Module is shown in Table 2.

Table 2. specifications for the TP5410 Powerbank Module

Item	Parameter
Microcontroller	134N3P
Input voltage	3.7V-5.5V
Charging current	1A
Output voltage	5V
Output current	1A

The results of making client devices are shown in Figure 7. While the results of making server devices are shown in Figure 8 and Figure 9.

Figure 7. Client Devices

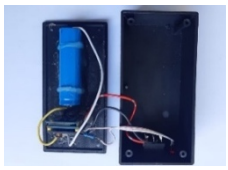

Figure 8. Inside server devices

Figure 9. Server devices in packaging

On the device, the server contains an application that records the date of use, username, random or sequential mode, duration, or time, as well as the number of lights pressed. The application on the server functions as follows:

a. Control, as a regulator to send to the client device.
b. Report, to report the results of using the client device in the form of a web page.

3. RESULTS AND ANALYSIS

In this research there is a test scenario as follows:

a. Testing the connection of client devices and server devices

In this test, a test is carried out regarding the connection between the client device and the server. A test is carried out regarding the light on the client device which is set from the server device. The test was carried out in as many as 50 trials of activating the lamp.

b. Testing on a badminton court
This test was carried out by badminton players on the field using 3 methods, namely sequentially, randomly and input from the system. Each method carried out as many as 20 trials.

Furthermore, trials are carried out according to the planned scenario with the following results:

a. Testing the connection of client devices and server devices
The test was carried out in as many as 50 trials of activating the light on the client device by the server device with the results in table 3.

Table 3. Test results of client device and server device settings.

Number	Lights Conf. (Server)	Lights (Client)	Status
1	3	3	On
2	1	1	On
3	3	3	On
4	4	4	On
5	2	2	On
6	3	3	On
7	1	1	On
8	2	2	On
9	3	3	On
10	2	2	On
11	2	2	On
12	1	1	On
13	1	1	On
14	4	4	On
15	1	1	On
16	2	2	On
17	3	3	On
18	3	3	On
19	4	4	On
20	3	3	On
21	3	3	On
22	4	4	On
23	3	3	On
24	4	4	On
25	3	3	On
26	1	1	On
27	3	3	On
28	1	1	On
29	1	1	On
30	4	4	On
31	2	2	On
32	1	1	On
33	2	2	On
34	2	2	On

35	4	4	On
36	2	2	On
37	3	3	On
38	3	3	On
39	1	1	On

Table 3. Test results of client device and server device settings (continues).

Number	Lights Conf. (Server)	Lights (Client)	Status
40	4	4	On
41	2	2	On
42	3	3	On
43	4	4	On
44	1	1	On
45	2	2	On
46	3	3	On
47	4	4	On
48	1	1	On
49	3	3	On
50	3	3	On

In table 3, the results of the configuration of the lights on the server device with the client device match 100% in 50 trials. So that the device is running according to design.

b. Testing on a badminton court

The test was carried out on a sequential, random, and system input method which was carried out for 20 trials with a time of 30 seconds for each trial. The position between the client device and the player is 7 meters away. The test results are in table 4, table 5, and table 6.

Table 4. Sequential method trial results

Number	Lights Conf. (Server)	Lights (Client)	Counter
1	1 2 3 4	1 2 3 4	6
2	1 2 3 4	1 2 3 4	6
3	1 2 3 4	1 2 3 4	7
4	1 2 3 4	1 2 3 4	7
5	1 2 3 4	1 2 3 4	5
6	1 2 3 4	1 2 3 4	6
7	1 2 3 4	1 2 3 4	7
8	1 2 3 4	1 2 3 4	5
9	1 2 3 4	1 2 3 4	6
10	1 2 3 4	1 2 3 4	7
11	1 2 3 4	1 2 3 4	4
12	1 2 3 4	1 2 3 4	5
13	1 2 3 4	1 2 3 4	6
14	1 2 3 4	1 2 3 4	7
15	1 2 3 4	1 2 3 4	6
16	1 2 3 4	1 2 3 4	6
17	1 2 3 4	1 2 3 4	7

18	1 2 3 4	1 2 3 4	5
19	1 2 3 4	1 2 3 4	4
20	1 2 3 4	1 2 3 4	5

In testing using the sequential method, an average of 5.84 muscle exercises were performed, approaching the number of 6 times the ideal muscle training at training time.

Table 5. Random method trial results

Number	Lights Conf. (Server)	Lights (Client)	Counter
1	1 3 2 2 3 3	1 3 2 2 3 3	6
2	1 4 4 4 4 3	1 4 4 4 4 3	6
3	4 3 1 2 1 4	4 3 1 2 1 4	6
4	2 1 4 1 3 2	2 1 4 1 3 2	6
5	2 4 4 4 2 3	2 4 4 4 2 3	6
6	2 1 3 1 3	2 1 3 1 3	5
7	4 4 2 3 4 1	4 4 2 3 4 1	6
8	2 2 2 1 4 2	2 2 2 1 4 2	6
9	2 4 1 2 2 1	2 4 1 2 2 1	6
10	2 3 3 2 3 3 4	2 3 3 2 3 3 4	7
11	4 3 1 3 2 4	4 3 1 3 2 4	6
12	2 4 1 3 2	2 4 1 3 2	5
13	2 3 2 1 1 3	2 3 2 1 1 3	6
14	4 1 1 1 2 3	4 1 1 1 2 3	6
15	3 2 2 1 2 2	3 2 2 1 2 2	6
16	3 2 4 2 3 2	3 2 4 2 3 2	6
17	4 1 3 2 1 3	4 1 3 2 1 3	6
18	2 1 3 4 1	2 1 3 4 1	5
19	4 2 1 3 1 4	4 2 1 3 1 4	6
20	3 2 4 4 3 2	3 2 4 4 3 2	6

In the randomized test, it was found that an average of 5.9 muscle exercises were performed, approaching the number of 6 times the ideal muscle training at training time.

Table 6. The results of the trial method are determined by the system

Number	Lights Conf. (Server)	Lights (Client)	Time (s)
1	4 1 3 1 2 3	4 1 3 1 2 3	30
2	4 1 1 4 3 3	4 1 1 4 3 3	30
3	3 3 3 1 2 3	3 3 3 1 2 3	29
4	4 3 4 3 3 2	4 3 4 3 3 2	30
5	1 1 4 3 4 4	1 1 4 3 4 4	31
6	4 4 3 4 2 1	4 4 3 4 2 1	30
7	1 4 3 1 1 3	1 4 3 1 1 3	30
8	2 4 4 2 4 1	2 4 4 2 4 1	29
9	3 3 4 3 2 1	3 3 4 3 2 1	30
10	4 3 1 2 2 4	4 3 1 2 2 4	30
11	1 3 3 3 1 3	1 3 3 3 1 3	32
12	1 4 4 2 1 3	1 4 4 2 1 3	30
13	1 2 4 2 4 2	1 2 4 2 4 2	30

14	1 2 1 1 4 4	1 2 1 1 4 4	30
15	4 2 3 2 3 1	4 2 3 2 3 1	31
16	4 2 1 4 1 4	4 2 1 4 1 4	30
17	3 2 4 2 1 1	3 2 4 2 1 1	30
18	4 4 2 2 1 2	4 4 2 2 1 2	30
19	4 3 4 4 3 1	4 3 4 4 3 1	31
20	1 1 1 3 4 2	1 1 1 3 4 2	30

In testing with the method determined by the system, the average time is 30.12 seconds, 0.12 seconds more than the target time.

Based on the test results, it was found that the server device had succeeded in controlling the client device with the 100% trial results as shown in table 3. While the tests by players on the badminton court were carried out as many as 20 trials with a time of 30 seconds for each trial; the results obtained with the sequential method obtained an average of 5.84 times muscle training, with a random method obtained an average of 5.9 times muscle training, approaching the number of 6 times the ideal muscle exercise during exercise. In the method determined by the system, the average time is 30.12 seconds, 0.12 seconds more than the targeted time. So that the adaptation of the ability of the leg muscles is obtained according to the specified training target.

4. CONCLUSION

In this study, a leg muscle training tool has been implemented using Wemos D1 mini which consists of a client application and a server application. The connection between the client application and the server application uses a wifi network. The server application can control the light on the client application. There were tests by players on the badminton court which were carried out as many as 20 trials with a time of 30 seconds for each trial; the results obtained with the sequential method obtained an average of 5.84 times muscle training, with the random method obtained an average of 5.9 times muscle training, approaching the number of 6 times the ideal muscle exercise during exercise. In the method determined by the system, the average time is 30.12 seconds, 0.12 seconds more than the targeted time. So that the adaptation of the ability of the leg muscles is obtained according to the specified training target.

Further research was developed by adding a security system to the client application and server application, monitoring the client application battery capacity by the client application, and adding justification for the conclusion of muscle training results based on activity history records.

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