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Original Article

Development of agility, coordination, and reaction time training device with infrared sensor and WiFi module Arduino in badminton

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Abstract

The nature of badminton games is fast, agile, having a high intensity, and requiring full concentration. In the aspect of physical conditions, including the agility, reaction, and quickness, a technological development of a training device to support and to improve the performance required by the nature of badminton game is needed. This study was aimed at developing a WiFi module based training device prototype for agility, reaction, and coordination for badminton. The WiFi module based device for agility training was developed with wireless technology. This training device consists of four slaves; the placement of each LED slave depends on the needs of the user. The suite of the slave involves sensors, a WiFi module, an LED RGB, and a buzzer. The function of a sensor is to detect objects around the sensor range. LED RGB has a function as a sign when a sensor receives stimulation. Furthermore, another device developed in this research was an application published in Play Store that can be downloaded for free. This application was created as an effort to facilitate the user to move the lamp signal randomly according to the needs. The name of the application is "Agility LED Control" from the Warriorrnux application system.

Keywords: agility, badminton, reaction, WiFi module, sensor

1. Introduction

Science and technology are now rapidly developing, started from the change of the human mindset to the development of devices that can be used for providing easiness in doing activities, thus it would probably replace the role of human resources (Rusdiana, Ruhayati, & Badruzaman, 2016). The advancement of technology, especially in sport, is an unseparated part to improve an athlete's achievement performance in this century (Jian-she, 2018). A badminton game requires a complex movement ability and skill, such as sprint, jump, leap, turn around, and split step without losing balance. The impact caused by the moving process is a fatigue that will directly affect the heart work, lungs, blood circulation system, respiratory system, and muscle and joint (Paul, Gabbett, & Nassis, 2016). Therefore, the player should have a good physical condition to maintain the performance during the game (Dube, Mungal, & Kulkarni, 2015).

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Badminton game is a net game with a fixed size of court (Singh & Sharma, 2018). In the game, the player will continuously focus the shuttlecock shoot into the opponent's weak spot to gain a maximum score and should return the opponent's shoot by running fast with a repetitive direction change that is supported by the stable balance of the body in anticipating the movement and direction of the unpredicted shuttlecock (Yang & Liu, 2013). By considering the short movement time of the shuttlecock during the rally, the players usually have only less than one second to give reaction and to run to anticipate the direction of the shuttlecock. Therefore, elements involving cognitive processing speed, motor quickness, and motor ability to anticipate the opponent's shoot are essentially needed by a professional player. On the other hands, results of other studies state that the maximum speed of a shuttlecock could reach 421 km/hour (Rusdiana & Mustari, 2017). During the rally, the shuttlecock bounces back in 0.93 second after the return, while the average time of the rally itself is about 6–11.5 seconds. The findings of other research argue that the duration of the longest rally is 34.6 for male group and 38.4 for female group (Singh & Sharma, 2018).

The characteristics required by a badminton player are fast, agile, having a high intensity and full of concentration (Dong, Lyu, Hart, & Zhu, 2018). In addition, the coordination between the sensory nerves and motor nerve stimulations are crucial in this sport game. One of the coordinative indicators is the reaction and agility to respond the stimuli quickly and accurately (Wong *et al.*, 2019). Since the movement time of a shuttlecock is very short, less than a second, a high concentration in taking a decision for responding the stimuli quickly and accurately during the game is required. One of the training models that has to be developed is an agility training device since agility becomes the main foundation for a player to master the game (Zhao & Gu, 2019). Agility is an ability of the body to change the direction quickly during a movement without losing the balance of the position of the body. Agility is useful to attack and to defend as the shuttlecock faced has different situations and conditions (Paterson, 2016). The change of the player's direction of movement is hard to be predicted due to its dependency on the shuttlecock direction of the opponent's shoot. The agility is created by the explosive power movement. The amount of the power is determined by the contraction of the muscle fibers (Wira Yudha Kusuma, 2015). The quickness of the muscle depends on the strength and contraction of muscle fibers. The quickness of the muscle contraction depends on the adhesive power of muscle fibers and the quickness of the transmission of nerve impulses (Kaplan, Akcan, Çakir, Kilic, & Yildirim, 2017).

The model of training should include a movement to change the position and direction of the body. The stimuli in the nerve center determine the success of the agility training, considering that coordination and quickness are the dominant elements of agility. Furthermore, various methods have been applied to train the agility. Shuttle run is one of the special skills that involves the change of speed and direction constantly to reach various angles of the court (Sonoda *et al.*, 2018). Shuttle run is an interval training model with a high intensity that is frequently used by the player since it resembles the characteristics of a real badminton player movement, the structure of the game duration and break time, and the heart rate and lactate concentration produced after playing. The training structure should be arranged effectively and efficiently based on the characteristics of the badminton player movement, thus it could support the performance to the high level. Various agility trainings in improving the footwork such as shuttle run, T-drill, shadow, zig-zag, and other skills have often been conducted by the trainer. In agility, reaction, and quickness training model, the technology development of a supporting device that can be used to increase the agility performance of the player that suits the characteristics of the real games is required (De França Bahia Loureiro, Costa Dias, Cremasco, Da Silva, & De Freitas, 2017). This technology development is an LED lamp-based with the Wi-Fi module system that gives an automatic on and off current signal when receiving a contact with the racket when moving. Moreover, another media developed is an application published in Play Store that can be downloaded freely. This application was created as an effort to facilitate the user to move the lamp signal randomly based on the need of the user. The name of the application is "Agility LED Control" from Warriorrnux. This device communicates by using Wi-Fi. It consists of two parts including the master part and the slave part. There is one master that has a function to give order to the slave part and to receive the feedback of the slave part. A slave part has a sensor, a buzzer, and ten small LED lamps that are arranged in a circular. Those three components are the output of a Wi-Fi module. The strength of this device is that this device is a wireless device that could give convenience to the user. The dimension of the device is 9 cm in diameter and 5.5 cm in height with 200 g of weight. In controlling the device, this device has been integrated with IoT (Internet of Things) that is connected to the server. To control this device, an android smartphone and "Agility LED Control" are needed.

2. Materials and Methods

The development of this training media related to agility, coordination, and reaction time training devices with the infrared sensor and WiFi module Arduino in badminton uses several material components including:

2.1. ESP8266 seri 12-F (Modul Wifi)

ESP8266 is an open source IoT platform and development kit that uses the LuA programming language to assist makers in making prototypes of IoT products with the Arduino IDE. The development of this Kit is based on the ESP8266 module which integrates GPIO, PWM (Pulse Width Modulation), IIC, 1-Wire and ADC (Analog to Digital Converter) all on one board. The type of ESP8266 used is the 12-F series which functions as access to communicate with the server, in which there is already a processor, memory and also access to GPIO that can perform input and output such as a microcontroller.

2.2. LED (Light emitting diode)

LED (Light Emitting Diode) is an electronic component that can emit monochromatic light when applied to a voltage made of semiconductor material. The color of the light emitted by LEDs depends on the type of semiconductor material used. LEDs can also emit infrared light such as on a TV remote control or other electronic device remote control.

2.3. Buzzer

Buzzer is an electronic device that functions to convert electrical voltage into sound vibrations. Buzzer is usually used as an indicator that the process has been completed or an error occurs in a device and has a voltage of 5 V.

2.4. Adjustable infrared switch sensor

Adjustable infrared switch sensor is a proximity sensor that can detect objects with the arrival of the racket at a distance that can be adjusted up to 80 cm by releasing infrared light.

2.5. Step up and step down booster

Step up Booster serves to increase the DC voltage of 3.7 volts to a 5 volt DC voltage which can be an input voltage to the sensor. Whereas step down booster functions to reduce the DC voltage of 3.7 V to the DC voltage of 3.3 V which will

be the input voltage to the Wifi module.

2.6. Research design

The research method used in this study is the research and development (R&D). This research method is used to produce certain products and test the effectiveness of these products. The following are the steps of research and development in accordance with Figure 1.

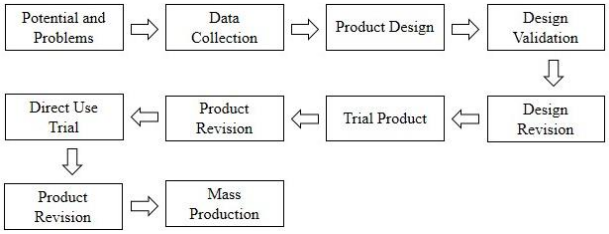

Figure 1. Steps of Research and Development

3. Results and Discussion

Figure 2 shows the design product of the agility, reaction, and coordination training device with WiFI module is the development of a footwork agility device training by using the reaction lamp device side view (A), top view (B), bottom view (C), isometric view (D) and full view (E). The Wi-Fi module based training medium has an interface media that utilizes android system. Besides that, by using 4 slaves where each slave consists of 16 LED RGBs with automatic on and off lamp control developed wirelessly, it becomes a more flexible device. The design of the prototype product explained this below Figure 2.

The working system of the further training device is the WiFi module that is placed in the master part that sends order to one of the slaves that has been programmed to activate the sensor, LED, and buzzer. The sensor uses infrared sensor with the working system that is equal to a proximity sensor. When an object is detected by the sensor, a WiFi module in the slave will give a signal to the master to execute and to send another address to a different slave. In the suite of a slave, there are sensors, WiFi module, LED RGB, and buzzer. The sensor has a function to detect the object that is in the range of the sensor.

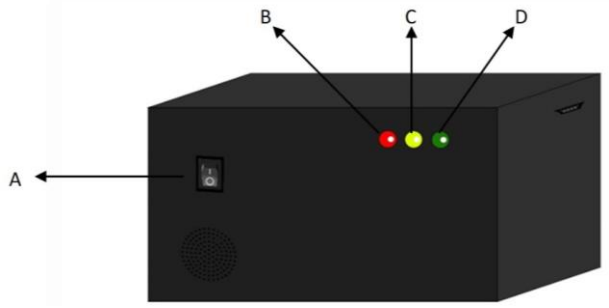

Figure 2. Master fitlight design. A: On/Off switch has a function to prepare the suite of the master fitlight B: Active LED Indicator is a sign that the master fitlight is in use. C: The charger LED indicator is a sign that the master fitlight is being charged. D: The charger hole has a function to charge the master fitlight.

LED RGB has a function as a sign when the sensor receives a stimulus. When the sensor is active the LED will also be active followed by the voice of the buzzer. The WiFi module based training has an interface device that utilizes android system. Besides that, by using 4 slaves where each slave consists of 10 LED RGBs with automatic on and off lamp control developed wirelessly, it becomes a more flexible device (Figure 3).

To connect the training media, an android smartphone is used by activating the same SSID hotspot setting and password with the master. After connected, another step taken is signing in to the web and writes the link provided by the browser. The program used in the Wi-Fi module is Arduino IDE software with the programming language C. The developed innovation in the hardware component is the combination of all of the outputs, including the sensors, LED, and buzzer as the indicator of the active and inactive signal.

Figure 4 shows a master fitlight that becomes the main drive that will receive feedbacks from slaves and give order to the slaves. In the master suite, there is a button functioned as the on/off button of the master suite. Moreover, inside the master, there are WiFI module, supply, module charger, and LED indicator. The WiFI module is programmed as the master control that eventually will give orders to the slaves. To connect the training device, an android smartphone is used by activating the same SSID hotspot setting and password with the master. After connected, another step taken is signing in to the web and writes the link provided by the browser. The program used in the WiFI module is Arduino IDE software with the programming language C. The developed innovation in the hardware component is the combination of all of the outputs, including the sensors, LED, and buzzer as the indicator of the active and inactive signal.

The picture above is the picture of a master fitlight that becomes the main drive that will receive feedbacks from slaves and give order to the slaves. In the master suite, there is a button functioned as the on/off button of the master suite. Moreover, inside the master, there are Wi-Fi module, supply, module charger, and LED indicator. The Wi-Fi module is programmed as the master control that eventually will give orders to the slaves. In the suite of a slave, there are sensors, Wi-Fi module, LED RGB, and buzzer. The sensor has a function to detect the object that is in the range of the sensor. LED RGB has a function as a sign when the sensor receives a stimulus. When the sensor is active the LED will also be active followed by the voice of the buzzer.

This device is controlled through android. To get the application, users could download it in Play Store under the name “Agility LED Control” from Warriornux. This application is created by using MIT App Inventor software (Figure 5).

Prototype product trials were done during agility, reaction and coordination exercises on the actual badminton court (Figure 6). Four slaves are positioned parallel to two meters on the left and right edges of the half badminton court. The player's position when training is in the middle of a badminton court. While opponents are on the field who are ready to give a hit shuttlecock that is not predicated of direction and speed. After the player a hit shuttlecock, then one of the slave will light up randomly, the player moves quickly towards the lamp by touching the surface of the racket

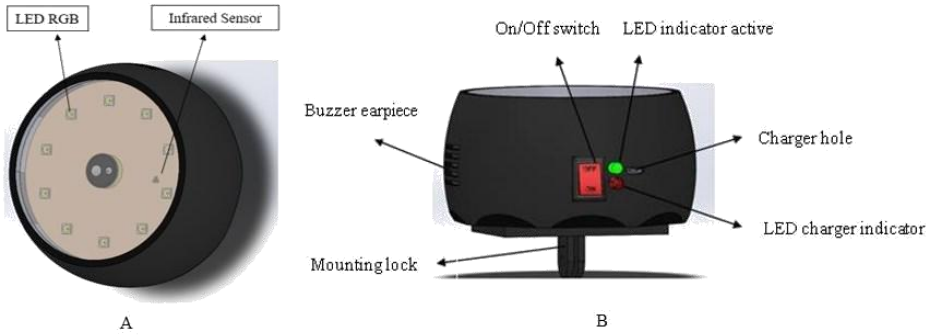

Figure 3. Suite of a slave top view (A) and side view (B)

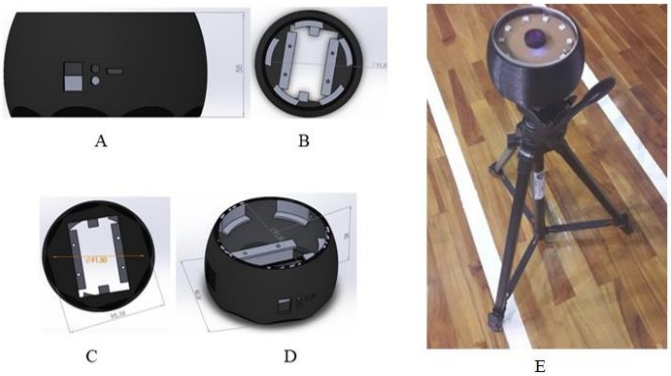

Figure 4. Mechanical design of the agility training media A (side view), B (top view), C (bottom view), D (isometric view), and E (full view)

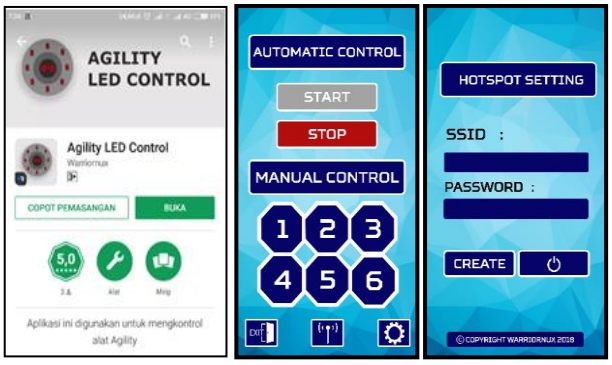

Figure 5. Agility, coordination, and reaction training media application

above the lamp. After that the player takes another hit (drop shot, netting, overhead forehand and backhand smash and clear) in the direction of the shuttlecock coming from the opponent. The exercise is carried out continuously until the player feels fatigue. After conducting a trial of two months of continuous training using this prototype product the physical condition of the player has increased especially in reaction, coordination and agility.

4. Conclusions

The agility, reaction, and coordination training device with WiFI module based is a training device that is developed with wireless technology. The prototype of the training device innovation is a wireless based technology, thus

Figure 6. Trial test of the agility, coordination, and reaction training

it becomes more flexible and provides a better convenience in operating the device. The agility training device operate automatically between one slave and another slave, which means that when one slave is shut down by the swing of the racket, another slave will automatically turn on until the set time. Besides that, during the operation, the user should download the application in Play Store freely by using the handphone that has WiFi and hotspot features. Moreover, the user of this agility training device will receive SSID and password. Furthermore, each LED slave works automatically. When the swing of the racket is detected by one slave, another slave will automatically turn on with two seconds of delay time for each slave. The looping slave LED works continuously until the set time. This prototype of training device is beneficial to improve the speed of reaction, coordination, and agility. This prototype product badminton training is useful for players to improve components of physical conditions, especially agility, reaction and coordination.

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