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Development of Speed Measurement System for Pencak Silat Kick Based on Sensor Technology

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Abstract. This work develops the speed measurement system for pencak silat kick based on sensor technology. The system operates digitally, was made cheaply and is easy to carry for outdoor measurement. Measurement system can record sequentially speed data of reaction and action of a kick in milliseconds. Two sensors are applied in the system for detecting the movement of the kick consisting of Force sensor and Ultrasonic PING Sensor. The force sensor is used to detect the response kicker after receiving an instruction. Meanwhile, an Ultrasonic PING sensor is used to detect the kicker's foot after arriving at the target. The speed measurement system based on the experiment gives good result. The accuracy of the speed of action and the speed of reaction showed was 99.29 % and 99.33 %.

1. Introduction

Generally, the factors influencing the athlete condition are internal factor and external factor. Four elements to attain achievement; physical condition, technique, tactics and mentality [1]. In other words, the influential thing to attain achievement is not only the physical condition but also other significant elements. The influential factor to attain achievement is the use of advanced technology [2]. Nurhasan says that the obstacles found in the system of maintaining and training are caused by the inappropriate maintaining ways and the unused of advance technology [3]. One of the problem is the use of measurement instrument. Within a research, the quality of the instrument influences the quality of the data and the quality of the data influences the quality of the research [4].

In order to obtain valid data, it is needed to use a high quality and empirically tested instrument. The appropriateness of choosing an instrument is one of significant thing that should be considered by a trainer while collecting the data about his athletes. There are certain characteristics before choosing an instrument. The characteristics are valid, reliable and usable [5]. One important thing before constructing an instrument is the consideration about the variables used in order to able to measure what should be measured. Based on the definition of variable, there would be some indicators taken as the items to measure [6]. It means that the developed test should represent the definition of variable. This fact is along with the instrument used in sport.

In relation with the instrument used to measure the speed of kick technique, the usual instrument used is the one developed by Dirjen Olahraga Depdiknas. The purpose of this instrument is to measure



the speed of kick technique performed by the fighters [7]. Based on the instruction, the athlete / fighter should kick by one foot one by one during 10 seconds. The score is taken based on how the kicks can be performed during the available time. Based on discussion with some sport experts and practitioners, it can be concluded that the existed instrument has not entirely able to measure the speed movement. One of educational sport evaluator says that the existed instrument only shows the output data of repetitive action. It is because the characteristics of speed are the time used and the distance taken for one movement. Besides, the existed test is still manual in which the data error will probably occur (human error). That is why it is needed to design a speed measurement tool for pencak silat kick using digital technology.

Speed is the ability to do an action or to reach certain distance in short time [8]. Speed is someone ability to respond the stimulation through a movement or series of movement in a brief time [9]. Classic speed is defined as a shortest time needed by an object to move along a constant distance with no certain direction [10]. Simply speaking, it refers to the ability to move the body as fast as possible through certain distance. Nevertheless, speed is more complicated than those definitions since it will not always constant gradually; it consists of several stages; acceleration, maximum speed maintaining and deceleration [11]. Speed is a scalar defined as the distance divided by time to move [12]. Speed consists of three elements; speed in reaction, frequency of movement in certain time, and exercise to increase the ability to move faster for certain distance [13].

Based on the speed definition stated above, it can be said that speed can be defined in several point of view. It is appropriate with the meaning used by the user of speed. The first definition can be viewed as the ability of part of the body to move for one action within a short time. It is said as One Single Action. The example of this speed in pencak silat is the ability to kick from the foothold to the target spot in one action. The speed measured in this situation is the time needed to do the kick. The next definition is viewed from the ability of part of the body to do a repeated action quickly within certain distance and time. The speed in this term is called as repetitive action. In this situation, the speed is viewed from the ability of the object to do the action frequently and quickly within certain time and distance. The example of this action in martial is the frequent kick movement in certain time. Speed is an independent strength which makes it requires its own specification [14]. It means that the speed is an independent and basic physical condition which is required in sport. In sport and game, the movement of athlete based on the signal of receptor requires the speed of reaction time [15]. In training the speed, there are several factors to consider. During the implementation, the strength is often included with speed which is called explosive power [16]. Kick is one of attack technique using the foot to attack. There are several forms of kick in pencak silat. In line with the form of movement, based on the view of mechanical moves, there are three forms of movement; straight move, turning move, and the compilation move [17]. In order to perform an optimal speed movement, there are three simulations needed; (a) the speed movement of body part, (b) the speed of acceleration and (c) maximum speed [18].

The development of instrument to measure the kick speed in pencak silat based on digital technology requires such measurement tools and electronic components like power supply, censor, interfacing and display connecting structure (LCD). Ultrasonic SRF-04 censor module is a product produced by Advantech as absolute equipment in robotic or aeronautic application. SRF-04 is basically used to measure the distance between censor and object in front extend to 2 to 3 cm. SRF-04 consists of two parts, N1076 as the transmitter and N1081 as the receiver. The first censor transmits ultrasonic signal in 40 KHz frequency produced by PIC12C508 and ST232. Then, the receiver receives 80 KHZ frequency. The result of PNTLAN and distance is measured by calculating the pulse of postponed width (delay) between transmitter pulse and Gemma (echo) from PWM signal. The extension of postponed width received by SRF-04 is between 100 μ s and 18 ms. Microcontroller AT Mega328 is included as CMOS 8 bit microcontroller supplier based on Risk Architecture, within execution time of instruction is in one machine cycle. The received system by microcontroller ATmega328 is almost 1MIPS/MHz, this microcontroller is designed to optimize the supply consumption toward the speed process. Microcontroller ATMega528 serves: data and memory program 8Kbyte in-System Programmable Flash, 512 Byte EEPROM (Electrically Erasable programmable Read-Only Memory), 1Kbyte SRAM, 23

general purpose lines, 32 general purpose working registers, 3 flexible times/counters, internal and external interruption, series of USART program, 6-channel ADSC. The architecture and microcontroller Atmega328 is effectively included with 32 general registers. Arduino uno is a board based on microcontroller in ATmega328. This board has 14 digital input/output pin (when the six pin can be used as the output PWM), 6 input analog, 16 MHz crystal oscillator, USB circuit, jack electric reset button. These pins included all needed to support microcontroller, only connect to computer through USB cable or other power supply can be taken from adaptor AC-DC or battery. Arduino Uno can be activated through USB circuit or external supply flow. The electrical resources are chosen automatically. External (non-USB) supply can be taken form AC-Dc adaptor or battery.

2. Research Method

Appropriate with kind of research used; that is developmental research, so that the phases conducted were along with developmental research procedure. This research developed kick speed instrument in pencak silat. Based on the kind of the research and the result to obtain, the researcher made pre-design product development based on the review of related theories and need analysis. The process consisted of product development, the limited trial-error implementation technique, revision, wider trial-error, and final revision of product, dissemination and implementation. In this research, the experts chosen as the evaluator are; sport evaluation expert, evaluation and measurement in sport, martial art experts and IT experts.

3. Result and Discussion

The result of this research is the developed instrument to measure the speed of kick. The main purpose of this research is to design such an instrument to measure the speed of kick using digital technology. It is hoped that the developed instrument could accommodate the need of measuring the speed of kick by using digital technology. This research is begun with the preliminary study. It was done to research every related elements about the measurement of kick speed in pencak silat. This preliminary study was conducted by the researcher through focus discussion group from several experts. The experts involved were sport training experts, pencak silat experts, evaluation expert, instrumentation development expert and IT expert.

3.1. *The Design of Kick Speed Instrument in Pencak Silat based on Digital Technology*

The purpose of the first step is to design a speed of kick instrument for pencak silat based on digital technology. Along with this purpose, the team created and designed an instrument which based on physical work system. Based on the discussion with the experts, the team successfully designed a digital instrument of kick speed. The processes are:

3.1.1. Tools and Materials. The tools used in this research consist of digital multimeter or analogue and stopwatch. The mutimeter was used to measure and to test the input and output voltage from electronic circuit. The stopwatch was used as the calibration tools. The process of constructing this instrument used a distance censor named PING censor and electric switch, other electronic components which support the system that is the microcontroller ATmega328 and Arduino Uno, transformator (trafo step-down), diode, resistor, capacitor, IC, regulator, LCD, and others tools or materials needed to design the instruments such as saw, drill, aluminium as the place to put the ultrasonic censor etc.

3.1.2. Hardware Design. The system of this instrument consists of the power supply, censorial circuit, microcontroller, arduino uno, and LCD circuit. Built in Arduino, there is a microcontroller

ATmega328 to program the input sensor. Ultrasonic SRF-04 sensor was connected to input port built in Arduino Uno, as well as Switch 1 and Switch 2, then the output from both sensor will be displayed in LCD. The result showed in LCD is the responding time and the time of kicking.

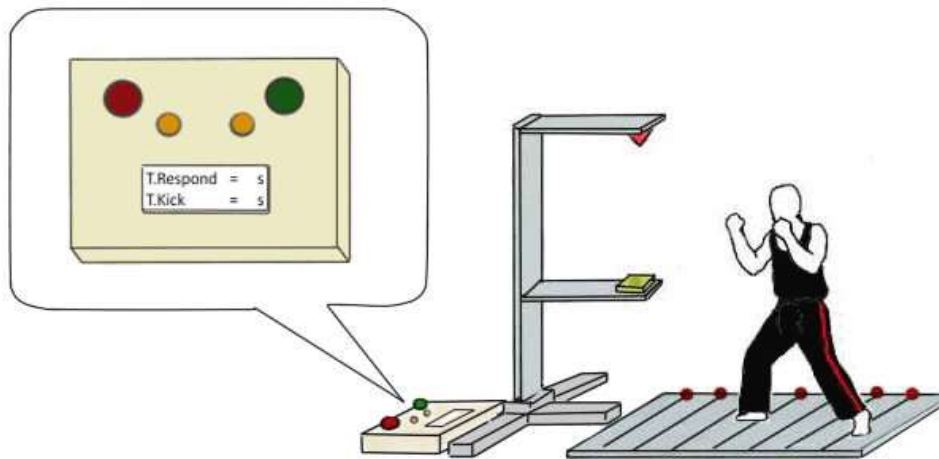


Figure 1. The Design of Instrument Mechanic Usage

Figure 1 shows the design of digital kick speed instrument in which the system of the instrument consists of ultrasonic sensor as the distance sensor. The ultrasonic sensor is put in the hand, and the height is about 1.5 meter. In other words, the sensor is put above of the pole. If the athlete kick and the foot is under the sensor, it will count the distance between the head to the ultrasonic sensor. The height can be counted by lessening the position of the sensor (150cm) to the position of foot counted by the sensor.

3.1.3. *Software Design.* The software is used to give instruction and to run the hardware. The language program used was C language. Compiler used was Arduino RV3. Figure 2 shows the diagram flow chart.

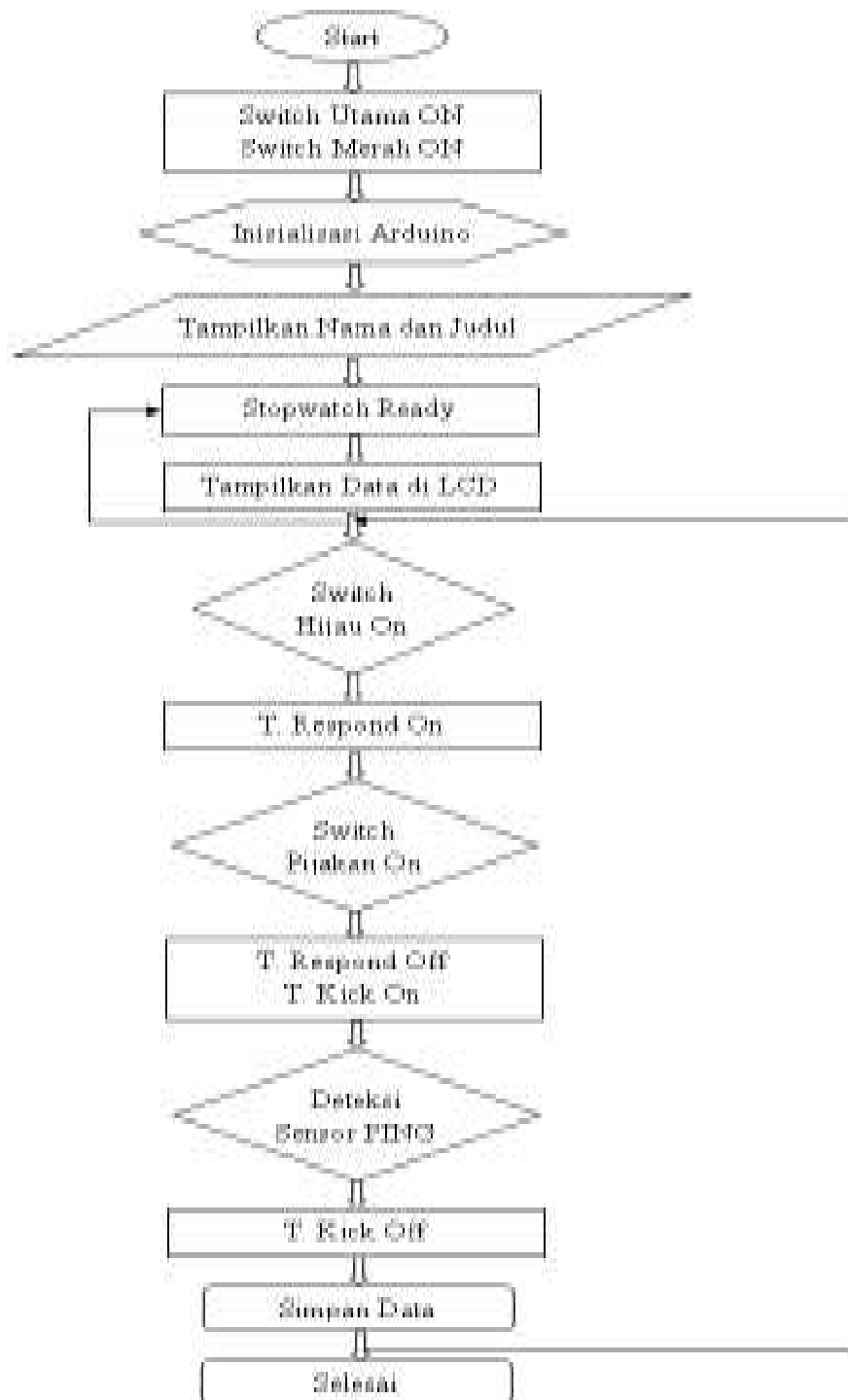


Figure 2. Diagram of Instrument Program Flow

Figure 2 is the flow chart of instrument program to measure the speed of kick using Arduino microcontroller. The first process in programming is to do the initialization process. Arduino microcontroller was then displayed. The reading of sensor and the data processing was done by Arduino microcontroller and the result will be displayed in the LCD to show the responding time and kicking time.

3.1.4. Instrument Testing. The testing consists of two kinds, validity and reliability. The validity testing used was construct validity. Meanwhile, to test the reliability, there were two tests used; the test to know the reliability of the developed instrument and the test to know the usage of the instrument. To test the instrument, the researcher used tool calibration test and to test the usage, the researcher used test and retest technique.

1) *Construct Validity test*

This test aim at knowing and analyzing whether the developed instrument is effective and efficient based on the needs in order to be able to measure what should have to be measured. The technique used to test the construct validity is by doing interview. This was done to dig the experts' opinion deeply. The interview is followed by demonstrating the instrument usage. There were 4 experts involved, they were sport training experts, martial arts experts, evaluation experts, and digital instrumentation experts. The interview items were; (1) the effectiveness of the instrument to measure the speed of kick, (2) other neglected considerations to be revised during data gathering, and (3) the revisions to do. Based on the gathered data through interviewing the experts, there were some aspects to be considered and to be revised in order to develop the instrument better. Nevertheless, it can be said that the developed instrument was effective to measure the speed of kick in pencak silat, especially for one kick. So that, it can be concluded that the kick speed instrument developed was effective to measure the speed of one kick in pencak silat.

2) *Reliability Testing*

Calibration test is one of the reliability test mentioned above. The aim of this test is to know whether the developed instrument is basically appropriate with the standardized instrument. The calibration test used was time calibration test. This is because the instrument is developed to measure the time needed to perform a kick. Appropriate to the developed instrument, the times measured are the speed of action and the speed of reaction. The calibration test was done to know whether the instrument have good reliability aspect or not. In testing the calibration, the researcher did two ways; first, testing the instrument in instruments testing laboratory and second, testing the instrument in Dinas Perindustrian and Perdagangan Sumatera Barat. The purpose of this calibration test is to dig deeply about the usage of the instrument.

The test was done in the laboratory of Math and Natural Science Faculty of Universitas Negeri Padang. The test was done by using the standardized instrument existed in this laboratory. The aspects tested were the time of reaction and the time of action. The following is the result of the testing. The result of speed reaction time is 99.334% while the result of speed action time is 99.288%. It shows that the developed instrument has high standard of effectiveness. Conclusively, it can be said that the instrument is proper to measure the speed of kick in pencak silat.

The test was done to test both speeds, speed reaction time and speed action time. The test was done in Metrology Division of Dinas Perindustrian and Perdagangan Sumatera Barat. The comparison tool used was the existed tools available in this place. The result is then legalized through result testing letter no. 510.3/555/METRO-APV.2/V/2016, which states that the developed instrument is categorized "good enough" and can be used to measure the

speed reaction time and speed action time. Based on the result of these two tests, it can be concluded that the developed instrument in this research was standardized. To conclude, this tool is proper to measure the speed of kick.

Having testing the instrument, it can be said that the design of electronic system of pencak silat kick consisting of sensor and other electronic components is able to measure the time of reaction and time of action. Specifically, the procedure of this electronic system is showed in diagram below.

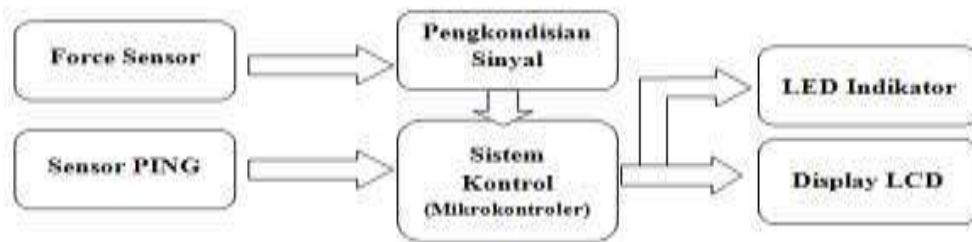


Figure 3. Diagram of Speed of Kick Instrument of Pencak silat

The testing of the developed instrument was done in 5 steps. The first step is done in every component used. The second testing is done by having calibration to test the time. The third testing is to try the responding time and action time from the fighter/athlete. The process to test the force sensor is the kicker foot the step above the sensor, when the kicker is instructed to kick, then the responding time counting will be activated. Force sensor will detect the respond of the kicker. When there is a little movement of the kicker, the sensor will be active and at the same time the responding time will be deactivated. To test the action sensor (PING sensor), the time action begin when the responding time is deactivated or when the kicker start kicking. The kicking time will be off when the kicker foot touches the target (PING Sensor). The action time will be deactivated and the action time will be counted.

The data gathering began when the kicker is instructed to stand above the force sensor, the operator press the start button, then the start indicator button will be activated and start counting the time. When the kicker had done the kick, the responding time stopped after the kicker respond to the instruction. For action time, the kick is begun when the respond of the kicker touches the target and at the same time, the action time is counted. This was done by the samples for several times in order to get the effectiveness and carefulness.

4. Conclusion

Based on the conducted research, it can be concluded that the developed instrument had fulfiller the requirements of a good and standardized instrument, they were the validity and reliability aspects. So that it can be used to measure the speed of kick in pencak silat.

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