Instrumental Development of 50 Meters Free Style Swimming Speed Measurement Based on Microcontroller Arduino Uno

Badruzaman, A Rusdiana*, M R Gilang and T Martini
Department of Recreation and Health Education, Faculty of Sport Education and Health, Universitas Pendidikan Indonesia, Indonesia

*agus.rusdiana@upi.edu

Abstract. This study is purposed to make a software and hardware instrument in controlling the velocity of 50 meters free style swimming speed measurement based on microcontroller Arduino Uno. The writer uses 6 participants of advanced 2015 college students of sport education. The materials he uses are electronical series of microcontroller Arduino Uno base, laser sensors shone on light dependent resistor, laser receiver functions as a detector of laser cutting block, cables as connector transferring the data. This device consist of 4 installable censors in every 10 meters with the result of swimming speed showed on the monitors using visual basic 6.0 software. This instrument automatically works when the buzzer is pushed and also runs the timer on the application. For the procedure, the writer asks the participants to swim in free style along 50 meters. When the athlete swims, they will cut the laser of every censors so that it gives a signal to stop the running timer on the monitoring application. The output result the writer gets from this used instrument is to know how fast a swimmer swim in maximum speed, to know the time and distance of acceleration and decleration that happens. The result of validity instrument shows 0.605 (high), while the reliability is 0.833 (very high).

1. Introduction
Nowadays, there are so many efforts in developing sport knowledge by utilizing the technology to increase sport achievement optimally. Therefore in swimming, technological application are used by world swimming experts. The using of technology in swimming is to increase not only physical and technical ability, but also mechanical movement in the water. The application technology in swimming has an important role to get a detail and accurate result of analysis. A modern swimming competition depends on the performance measurement that finally is used to monitor the progress of the athletes[1]. As technology improved, the analysis process become more automatic and at the same time more accurate, to the point that results could be provided within minutes of the end of the race rather than the months it took to analyze races in a major competition using earlier methods. Tehcnology makes regulare advances that improve the ability to analyze swimming technique[2]. A sophisticated measurement of swimming speed has been applied called “swimming touch pad”, which become a measurement of swimming speed from start to finish. This device is very helpful in decreasing human error (of using stopwatch) and also is more accurate. The using of the device[3], such as; Video based-kinematic analysis to quantify variations in swimming velocity, Inercial sensor, such as accelerometers, physical testing used force plates, drag laine[2]. The time analyical process in swimming should be done in detail from starting travel time, time reversal and finish.
In Indonesia, the swimming speed measurement is still manually done using stopwatch. The using of stopwatch often inflicts human error while pushing Start button for everyone’s reflects are different so the result will not always be accurate. The system is user-centric meaning that several athletes can wear their own sensor at time without interfering with the other athlets’ measurements. Development of such a tool can help coaches pinpoint the strengths and weaknesses of the athlets during workout sessions and desin an optimal personal training plan for athlets improve their performance[5].

The integrated accelerometer and GPS device offers a valid and accurate tool for stroke count quantification in breastsroke and butterflay as well as measuring mid-pool swimming velocity in freestyle and breastsroke[5]. The relationship between stroke rate, stroke legth, and swimming velocity is complex. One aspect of this complexity is that the relationship is negative forms the classic inverted U. The graph demonstrates that although stroke length will be very high at slow stroke rates, swimming velocity will be slow[3].

2. Method
The method used is Research and Development[6]. The participants are 6 students of sport faculty of UPI who have passed swimming lecture with A score. Their age are 20 years old in average. They are also registered as members of UPI's Swimming Club, and has had experiences of swimming practice in the club for 6 years, all participants are chosen purposively. The instrument’s validity and reliability is examined by using criteria validity correlating between the stopwatch test and the instrument of 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO test. For testing the reliability, the instrument uses retest approach. [7].

The device of speed detector moved by laser censor based on Microcontroller AT Mega 382 p. This functions as a place to process the tension received by laser censor, which is converted into information data showed on the monitor of the computer. Censors used on the system of moving thing’s detector consists of two parts, the laser as the light resource and LDR (Light Dependent Resistor) as laser receiver. This censor series is activated in supply +5 Vdc voltage. The device can detect the moving things when a thing passes the first censor to the second until the fifth cencors.

The validity is done by empirical validity by correlating the measurement result between stopwatch using and the instrument of 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO using, and also asks some experts’ deliberation in this study to assess the product, then sign it to prove and show the validity.

The experiment of the product can be done for several times depend on the analysis needs. The product examination is done to find characters, scheme, unit and magnitude value, an also the working principle of the 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO.
The working system of this device is that the buzzer, which is installed under the swimmer start block, will be beeping right after pushing the start button. When it beeps, it signs a start from the system, so the timer begin to count and the swimmer begin to jump to the swimming line. When the swimmer pass or block the transmitter sign from the laser censor to the LDR receiver, the receiver will transfer a conditional signal to the microcontroller exactly to pin 3. When PIN 3 receive a High condition, it continue to transfer the date through the serial communication line on the application.
After the application receive the data from PIN 3 Microcontroller, it orders the command button 1 to show the travel time after passing the first 20 meters. When a swimmer passes 30 meters, the LDR receiver censer gets no more light signal, which causing a High input from PIN 4 that makes microcontroller sends the data to the application formed in lick command button 2 that shows the travel time in every 30 meters far. And so with the third and fourth censers that order click command button to show the travel time based on a set particular distance. When the application shows the swimmer’s travel time, the data is automatically saved on Microsoft database access on PC.

There are two answering hypothesis and some research findings on this study. The first is to test the correlation of swimming speed measurement between stopwatch using and 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO using. The second is to test the correlation between the first 50 meters free style swimming speed test and the second one on the 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO.

3. Result

The instrumental developing product of 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO is shown in Figure 2-6.
Figure 3. Laser, LDR (Light Dependent Resistor), Microcontroller, Buzzer line

Figure 4. Software display on Personal Computer
The experiment toward active college students of sport department of UPI is purposed to test the validity and reliability of instrument over 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO (Figure 7).

**Figure 7.** Sample of the sixth 10 meters speed result
4. Discussion
From the entire experiments, we find some discussions, namely; (1) the instrument of 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO functions not only to count the time and the swimming speed in 0-50 meters distance, but also to analyse the 50 meters free style swimming speed in knowing travel time and swimming speed, travel time and swimming speed in each scale, maximum speed, deceleration, and speed durability.

Relate to those functions, we can conclude that the result of measuring the swimming speed using this 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO device really helps the coach especially in evaluating the athletes he trains to reach their best performances. By watching and analysing, the coach can see his athletes’ weakness and strength in swimming.

From the graphics of acceleration in every 10 meters and 50 meters travel time above, we can get some findings, such as; the acceleration every 10 meters tends to getting decrease from start to finish, and the fastest swimmer in 50 meters travel time named Faza. If we analyse the graphic above, the fastest swimmer has a constant speed in every 10 meters.

(2) There is a high correlation between the using of stopwatch and the 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO. After a statistical test using SPSS coefficient bivariate correlation, the hypothesis we get is 'There is a correlation between 50 meters free style swimming speed measurement using stopwatch and using the one based on Microcontroller Arduino UNO.' The value of Pearson correlation is 0.605 and p is 0.002. This means that it has a high correlation. In this case, the test using 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO is similar to the previous test using stopwatch in general. In other words, this instrument is valid.

In examining the reliability of a test, it needs to do double testing. In this study, the writer examine the same sample twice. The statistical measurement of coefficient bivariate correlation results a correlation which is 0.833 and p is 0.00. It concludes that there is a correlation between the first 50 meters free style swimming speed (test) and the second one (re-test) on the device. From the Pearson correlation value, it shows that the device has been able to do its function constantly, so it becomes reliable.

The instrumental development of 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO has some more advantages than today’s popular swimming speed measurement device, like ‘Swimming Touch Pad’, which becomes an international standard to use as a swimming measure in every swimming competition. Some advantages from this 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO are; the censors installing can be applied depend on the analysis needs of the research in every 5 meters, 10 meters, 15 meters, 20 meters, 25 meters, and so on, the result of the swimming speed is showed on personal computer with an installed software of swimming speed measurement device. Just like every thing in this world has weakness and strength, this instrument also has some weaknesses too which becomes a consideration to develop to be better. From the research experiment, we find some weaknesses of the device, such as; a week wave of laser that makes it can’t go through the water and is still way far under the midday sunlight, which causes an obstacle in reaching the LDR as a laser receiver. Next, the supporting laser and the LDR are still not strong enough because they keep moving by the water on the surface. This device also still uses many long cables that makes it not efficient to place here and there eventhough it’s portable.

The process of this instrument construction experiences some obstacles, like: censors changing of a malfunction ultrasonic in the water, the experiment using an ultrasonic waterproof censor can’t also be used since it only detects the water as a thing which makes this hard to detect the swimmer in the water, the electonical components line happens several inappropriate things because of some improper used port, the using of laser is not suitable because of the weak laser which can’t go into the water, the using of the lazy pod as the laser and receiver support is not strong enough because of the waving water when the swimmer passes the censors, the last is the synchronization between software and hardware has a problem of the incompatible hardware on the coding software.
5. Conclusion
From this study, it can be concluded that; first, there is a high correlation between swimming speed measurement using stopwatch and the 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO (valid). Seconds, there’s a very high correlation between the experiment of the first 50 meters free style swimming speed and the second one on 50 meters free style swimming speed measurement based on Microcontroller Arduino UNO (reliable). Third, the instrument development on this device has some problems as what explained above. Fourth, the product of the instrument developing of the device is developed by cheaper price, accurate, portable and easy to use.

References
[1] Beanland, E., Main, L. C., Aisbett, B., Gastin, P., & Netto, K. (2014). Validation of GPS and accelerometer technology in swimming. Journal of Science and Medicine in Sport, 17(2), 234-238.
[2] Reiwald S and Rodeo S 2015 Science of Swimming Faster. Humans Kinetic, USA.
[3] Maglischo E W 2003 Swimming Fastest. Human Kinetics. USA.
[4] Costill D L, Maglischo E W and Richardson A B 1992 Swimming. Blackwell Science. USA
[5] Dadashi F, Crettenand F, Millet G P, and Aminian K 2012 Front-crawl instantaneous velocity estimation using a wearable inertial measurement unit. Sensors 12(10) 12927-12939.
[6] Sugiyono 2014 Metodepenelitiankuantitatifkualitatifdan R&D. Bandung: Alfabeta.
[7] Suherman and Rahayu 2014 Modul Statistika untuk Ilmu Keolahragaan. Bandung:Universitas Pendidikan Indonesia.