The Development of Microcontroller-based Reaction Time Measuring Instrument for Sprinter

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Abstract: The purpose of this research is to create a microcontroller-based start reaction time measuring instrument using Research and Development (R&D) approach. This measuring instrument works when the START button is pushed, LCD becomes active, buzzer rings, and the LED indicator turns on. When athletes hear the sound from the buzzer, they release their feet from start block which causes push button on the right and left side of the start block sends voltage to ATMega micro controller and causes timer to stop and LED showing timer stops turn on. From this process, athlete reaction time can be seen on LCD. To restart the initial process, RESET push button can be pressed. The sample in this research was divided into two groups. The first group consisted of 30 students from sport science major, batch 2012 and the second group consisted of five sprinters from PPLP Atletik Jabar, using simple random sampling technique. The analysis showed that this measuring instrument had high validity score, which is 0.771 and a high reliability score, which is 0.834. The analysis also showed that the relationship between sprinter's start reaction time and 30-meter distance was not significant.

1 INTRODUCTION

Technology utilization in order to improve achievement has been implemented by developed countries with good achievement. One of sport technology product benefit is to make it easy to conduct test and measure athlete's ability. But, in order to get sophisticated sport technology product, a large amount of money is needed. This cause's technology involvement in sport is not fully accepted in all countries, especially Indonesia.

In Indonesia, the test to measure sprinter' start reaction time is still rare. If it exists, it only measures reaction time which is measured using whole body reaction. But, the test using whole body reaction only measure reaction time in general, not specific for each sport. High technology sport reaction time measuring instrument is expensive, but it does not mean we ignore this technology and how sophisticated it is. Based on the importance of specific time measurement for each sport, in sprint the sprinter speed is determined by the fast sequential leg movement. Speed depends on several influencing factors, which are strength, reaction time, flexibility. (Wilmore in Harsono, 1988, p.216). According to Oxendine (in Harsono, 1988), "Reaction time is time between stimulus and the first movement". Reaction speed includes time from stimulus to the first muscle contraction. In sprint, initial reaction time is time interval (ms) between starter gun signal and initial moment when athletes can give pressure to starting blocks (Pilianidis, T. et al.2011). Study by other authors (Schot and Knutzen 1992; Harland and Steele, 1997; Wang, 2006; Pain and Hibbs, 2007; Babic, 2008; Babic and Coh, 2010) showed that they agree that sprint result depends on the position of initial block from center of gravity from reaction time and initial acceleration time. Initial reaction time from previously mentioned event contributed around 1% to 2% to sprinter's overall performance (Baumann, 1980; Helmick, 2003). Another research shows that if the reaction time is better, sprinter performance will be better (Pilianidis, T. et al. (2011). From various researches above, start reaction time affects sprinter performance very much. This is the reason why researcher tries to make sprinter's start reaction time by developing existing instrument with cheaper, more accurate, easy to use, with microcontroller-based system which will show the

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result on LCD. The data from using this instrument can be used for practice and to analyze athlete's reaction time which can be used to improve athlete's performance. In this research, researcher will develop start reaction time measuring instrument for sprinter, based on microcontroller.

2 METHOD

The method used in this research was Research and Development (R & D) cycle. This research used R&D method because final result from this research produced microcontroller-based sprinter reaction time measuring instrument.

2.1 Participants

Research was conducted at Athletics and Football Stadium, Sport Science FPOK UPI Laboratorium, and Padjajaran Stadium Bandung by involving 30 students from sport science major batch 2012 and five sprinters from PPLP Atletik Jabar as sample. The participants are 12-25 years old and are used to doing squat start.

2.2 Tool's

This instrument aims to measure sprinter reaction time, which is the time between the sounds of modified starter gun with buzzer until the first jump start on start block. The sprinter reaction time measuring instrument was designed to be portable. It took two months to build the measuring instrument. Researchers cooperated with electrician and welder.

This is the microcontroller-based sprinter reaction time measuring instrument.

2.2.1 Push Button

Figure 1: Push button.

This start reaction measuring instrument uses two box-shaped push buttons which are attached to foot step device on start block.

Figure 2: Box-shaped push button on foot step device on start block.

The box-shaped push button acts as button located on right and left side of start block which sends voltage to microcontroller ATMega and causes timer to stop if it is released or if athletes perform jump start shown on LCD.

The push button has a function to start the time if it is pressed (start button) and to restart measurement if it is pressed (reset button).

Figure 3: Push button.

Push button can be seen on figure 3.

Figure 4: Push button in box.

Push button on box can be seen on figure 4.

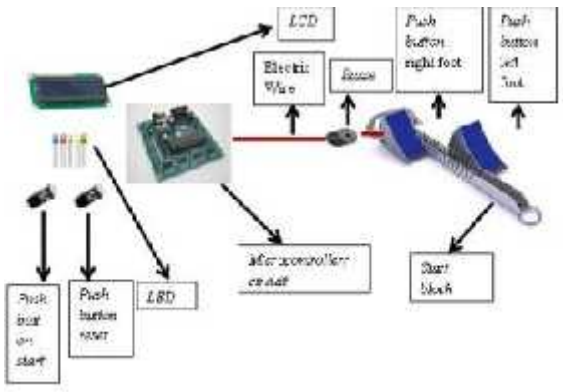

Figure 5: The Product Design of Starting Blocks test reaction time.

2.3 Operating System

The first step to see how the instrument works is by connecting connector between box (microcontroller) with box-shaped push button on start block and also to buzzer/ speaker. Next, accumulator connector is connected to box (microcontroller). Make sure that LED is turned on as a sign that box (microcontroller) and push button on box have been attached well. Make sure that everything has been installed well, and then the test is ready to be conducted.

Make sure that sample is already on crouching start position and both feet have stepped on box-shaped push button on start block. If it is correct, LED will not turn on. After that, press start push button on box, buzzer will automatically rings as a sign that time measurement has started. When sample has already heard the sound, sample immediately does start or jump start on start block. If the foot has been released from box-shaped push button on start block, time measurement will automatically stops. The time will be shown on LCD on the box. To reset timer to initial condition, press reset push button on box. Repeat the steps from the beginning if you want to continue to the next samples.

2.4 Validity and Reliability

In order to measure validity on this research, criterion validity was used. Criterion validity according to Suharsaputra, U (2014) is "the validation of an instrument by comparing it to other valid and reliable measuring instrument by correlating them. If the correlation is significant, the instrument has validity criterion."

In this research, the test result correlated whole body reaction test with test using specific reaction time measuring instrument for sprint (start block equipped with microcontroller).

In order to measure reliability, this research used Test-retest approach. Suherman dan Rahayu (2014) stated that "Reliability is obtained by calculating correlation between score from first measurement and score from second measurement". This research correlated test using specific reaction time measuring instrument for sprint (start block equipped with microcontroller) and the measurement was conducted twice.

3 COPYRIGHT FORM

Table 1: Reaction time test result with whole body and starting block.

No	Test Name	Average
1	Whole Body Reaction Time (s)	0,341
2	First Start Block (s)	0,348
3	Second Start Block (s)	0,354

Table 1 explains the result of reaction time test. The average of whole body reaction time test is 0,342 s, while the average of first starting block test is 0.348 s and the average of second starting block test is 0.354 s.

3.1 Statistical Validity Result

Validity test in the research correlated whole body reaction test to test using specific reaction time measuring instrument for sprint (start block equipped with microcontroller). Correlation test analysis is shown by Pearson correlation with the value of 0.771, $p = 0.00 < 0.05$ which means there is significant relationship between reaction time using whole body reaction and specific reaction time measuring instrument for sprint (start block equipped with microcontroller).

It can be concluded that the instrument developed can measure what it has to measure. (Serpell, Ford, and Young 2010; James et al. 2010; Y Hachana, H chaabe ` ne, M A. Nabli, A Attia, J Moualhi, N Farhat 2013; Pauole K, Madole K, Garhammer J, Lacourse M 2000).

3.2 Statistical Reliability Result

In order to measure reliability in this research, Test-retest method was used to calculate correlation between score on first measurement and score on second measurement for reaction time test using microcontroller-based starting block. Correlation test analysis showed pearson correlation of 0.834, $p = 0.00 < 0.05$ which means there is significant correlation between the first and second reaction time test on specific reaction time measuring instrument

for sprint (start block equipped with microcontroller). The sprint-specific reaction time measuring instrument (start block equipped with microcontroller) has performed constant function, so it was categorized as reliable. (Serpell, Ford, and Young 2010; James et al. 2010; Y Hachana, H chaabe ` ne, M A. Nabli, A Attia, J Moualhi, N Farhat 2013; Pauole K, Madole K, Garhammer J, Lacourse M 2000).

3.3 Discussion

After the statistical test was conducted, Pearson correlation of 0.771 and p = 0.00 were found. It means the relationship between whole body reaction instrument and sprint-specific reaction time measuring instrument (start block equipped with microcontroller) was high. It can be interpreted that the test using sprint-specific reaction time measuring instrument (start block equipped with microcontroller) resembled the previous test (general reaction time test using whole body reaction) which has been specifically developed for sprint. So, sprint-specific reaction time measuring instrument (start block equipped with microcontroller) is valid.

Researchers tested the same sample twice. From statistical calculation using bivariate correlation coefficient, it was obtained that the Pearson correlation is 0.834 and p =0.00.

It can be concluded that there was relationship between the first and second reaction time on sprint-specific reaction time measuring instrument (start block equipped with microcontroller). Based on Pearson correlation score, it can be seen that sprint-specific reaction time measuring instrument (start block equipped with microcontroller) has been able to run its function constantly, so the instrument is reliable.

4 CONCLUSIONS

This instrument works when START push button is pressed. Timer on LCD will become active, buzzer will ring, and LED indicator will turn on. When athletes hear the sound from speaker or buzzer, athletes released his foot from start block, causing push button on right and left side of start block sends voltage to microcontroller ATMega and causes timer to stop, LED indicator to stop timer will turn on. From this process, time reaction value/athlete reaction speed can be seen on LCD. In order to restart the initial process, you can press RESET push button. Sprint-specific reaction time measuring instrument (start block equipped with microcontroller) measures what it is supposed to measure, or in other words, it is valid. Sprint-specific reaction time measuring instrument (start block equipped with microcontroller) has been able to perform its function constantly so it is reliable. This explains that the development of microcontroller based sprinter reaction time measuring instrument can measure sprinter reaction time well.

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