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Running Speed Device Development Using a Microcontroller with a Computer System Interface

Agus Rusdiana*

Abstract : With ever growing needs and society demands today, technology has become a must use component in each aspect of life. The field of sports science has adopted technology applications as an integral part of improving performance and athlete achievement. In developed countries, different kinds of sports science centres and laboratories have been set up with advanced test and measurement devices which are supported by reliable human resources. This study aimed to develop software and hardware for measuring running speed using a microcontroller with personal computer interface. The assembling of the device comprised of circuit-based electronics microcontroller, phototransistor sensors and laser beams to collect signals from athletes and send them to a microcontroller for processing on a personal computer interface for display via connector cabling. In the process, research and development was used to help assemble system components. The system consisted of eight sensors spread over 100 meters, meant to detect running speed in a 100 metres' sprint race. The device was designed to operate automatically in synch with the race start buzzer, monitoring the sprint from start to finish then display the results of the race time and speed to a computer interface.

Keywords : Software, Personal computer, Running speed measurement, Microcontroller, Hardware.

1. INTRODUCTION

In this modern era, technological advances in all areas and disciplines have become integral part of society and life in specific. These advances have also influenced fields like that of sports science, where technology is said to have contributed to its improvement tremendously. For instance, the use of technology as an effort to improve performance in sports has been carried out in developed countries in Asia such as Japan, China and Australia. This is proven by pursuits in various laboratories of science, among others, in Japan there is Japan Institute of Sport Science, in Australia there Australian Institute of Sport Science, in China there also Beijing Institute of Sport Science and many other countries. Experts in such sports centres and laboratories collaborate to diagnose, evaluate, and provide scientific input to the coaches and athletes about various sports components.

Speed as one component of the physical sports conditions is very important and its measurement has been done using various tools and advanced technologies. Examples of such technology are sensors attached on the shoes of athletes, Global Positioning System (GPS) and the Differential Global Positioning System (DGPS).

Besides there are also radar, photo finish, kinematic analysis, photocells and opt jump which is normally used to measure the speed when running, these tools are made to diagnose, evaluate and analyse the performance of athletes for performance enhancement. Running is a sport that takes speed as a benchmark of evaluation, especially sprinting. There is already use electronic technology to measure time,

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velocity, and acceleration both during practice or competitions. During training, measurement results are used for analysis and evaluation of athletes. One tool that has been frequently used to measure speed in athletes is a photo cell, a kind of sensor mounted on the edge of the track that can detect the running time when an athlete passes the sensor, but this is only used in developed countries that have developed or source the tool at an expensive price. Contributions from sports analysis, especially running speed in sprints is very desirable to conduct research and evaluation of athletes. In Indonesia the development of test equipment and measurement, especially for sprints is still undeveloped, this is so because there is no sufficient technology, besides experts in sports are still have less collaboration with other disciplines especially regarding the development and implementation of technology in sports. So, there is lack of scientific problem-solving solutions to analyse various situations and conditions in sports. In contrast to our country still has many products using technology from abroad used as testing and measurement instruments.

Indonesia itself has electronics experts that when we collaborate with experts that can give birth to a variety of tools that can support an increase in the athlete's performance. The potential is immense if we the men and women involved in sports can work with them to create technology based means of testing and measurement as well as high-tech learning in sports. Problems still occur in the measurement of running speed due to the use of manual tools in measurement like a stopwatch. Use of a stopwatch presents problems of accuracy in the capture of data because of the differences in the time interval in keystrokes. So, it can cause a lot of errors due to the sensitivity, reflexes and reactions of the operator. Thus, a need for an automatic timer and runner speed detecting system is very important. One solutions of such problems the development and manufacture of innovative measuring devices for the measurement of athletes' running speed based a microcontroller with Personal Computer Interfacing System. Innovations to be performed include, first to make this tool to be able to measure running speed in 100 meters with an option of adjusting the distance depending on the desires of the user, it can be intervals of every 5 metres, 8 metres, 10 metres and other distances. To make the system cost much less but with the same function requires use of phototransistor sensors and display results to a personal computer with installed with a monitoring software application instead an expensive LCD. A software application created using Visual Basic 12 enables display of the measurement results to the computer. The tool may not only be used for the measurement of running speed in races but also data collected using the tool can be used in other analyses in in studying outcomes of sports activities, such data may include running speed, endurance at a specific running speed, maximum running speed, running speed per metre, per what is to be analysed.

Running Speed Measurement

Figure 1: Using the Speed Measurement by photocells system

According to Dolenec at al. 2009 & Bergamini at al. 2012 that velocity measurements can he carried out using various tools that have been developed such as devices affixed to shoes of athletes namely Foot Pod, Polar and Suunt, and GPS, Differential Global Positioning system radar, photo finish, kinematic analysis, photocells and Opto Jump. Different ways of measuring the speed with different tools have varieties in terms of accuracy, complexity and price. In the measurement of running, the most frequently used tool is the photocells. This tool can be used to measure running speed according to the distance and time.

Running speed can also be measured through Dias Frame IV software which provides an object trajectory tracking systems either automatically or manually. Dias Frame can be used to analyse the variation of motion in 2 or 3 dimensions. It uses video of the runner as input data that will be analyzed. In the 100-meter sprint, sprint technique can be broken down into several phases as proposed by Dunn at al. 2015 who explains that, "There are five phases in a sprint among others: (*a*) start techniques, (*b*) acceleration techniques, (*c*) maximum speed techniques, (*d*) technical maintenance of speed, and (*e*) technical finish". There are four an athlete goes through in the 100 meter race: the starting position, the starting action, sprinting action, and finishing action. Starting position is an attitude or position of the runners at start time. Starting action has aspects that include: rapid reaction left start block, the time between the sound of the gun with explosive muscle reactions to encourage movement on board repulsion (Exell at al. 2012 & Miller at al. 2012).

Sprinting action has technical specifications including maximizing the horizontal speed of movement and movement prop overpass. According to Kugler at al. 2010 & Miller at al. 2012 that finishing action has aspects that include movement of the upper body and coordination of the upper and lower body. A 100 meter race can be divided into three parts, namely the acceleration at 0-30 meters, the maximum speed from 30-60 meters, and the speed maintenance from 60-100 meters. Acceleration speed increases after the start reaction in order to achieve maximum speed, the transition from acceleration to maximum speed is the directionality of technical coordination to the maximum speed until the beginning of the decline of speed and next to the maintenance speed, due to fatigue in the muscle nerves resulting in decreased speed.

Visual Programing C

Microcontroller in relation to the programming language C is now beginning to shift the language first used for programming Microcontrollers *i.e.* assembler language. The use of the C language is very efficient, especially for programs that are relatively large on a microcontroller. Compared with the assembler language, the use of C language in programming has several advantages: Accelerating the development time, modular and structured, while it weakness is compiling source code is relatively larger and consequently it will sometimes reduce the speed of execution. The software CodeVision AVR is basically a software programming language-based AVR family of C language for microcontroller. There are three essential components integrated in this software: C compiler, IDE and program generator. The Visual Basic is a software suitable for creating an application program that can work within the Windows system application environment. The language used in Visual Basic is very easy to learn, with visual programming techniques that allow users to create better application programs, the user can set the display form which is then executed a script which is very easy. Visual Basic 6.0 is the development of previous versions with several additional components that are the current trends, such as the ability of Internet programming with DHTML (*Dynamic Hyper Text Mark Language*), and some additional features as multimedia databases get better. Until the time of writing it can be said that Visual Basic 6.0 is still the leading programming language in creating application programs that exist on the software market internationally. This is due to the ease of the process of development of an application. A Phototransistor sensor device is a type of transistor that works in association with light. In general, infrared light is needed to activate a phototransistor, when seen from the way it works, phototransistor is similar to a light switch, if a phototransistor exposed to infrared rays then colector foot-emitter connects and serves as a switch that

connects. However, if the phototransistor is not exposed to infrared light or simply exposed to ordinary light-emitters the colector legs do not connected. Its application in a phototransistor is easy, by simply adding a resistor at the colector foot before being connected to Vcc, while the emitter is connected to the ground feet, and the output is taken from the leg colector.

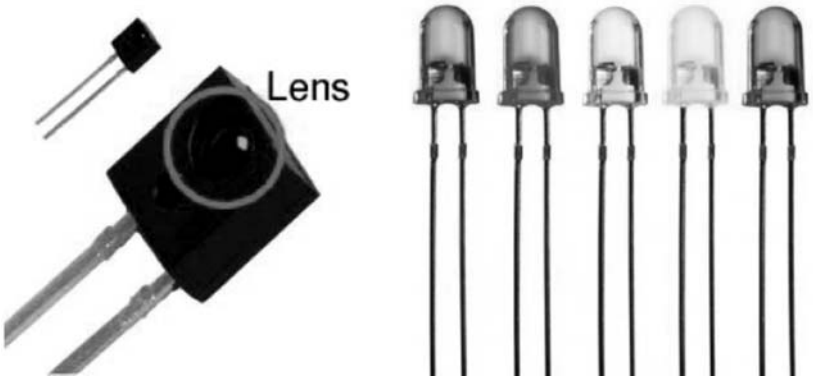

Figure 2: Phototransistor device system

A laser works by light amplification stimulating emission of radiation, which means that it is light that is amplified by stimulated emission of radiation, so laser light is generated from the source of radiation. In laser technology, the light produced has its own characteristics, namely: monochromatic (one specific wavelength), coherent (at the same frequency), and towards the same direction so that the light becomes very strong, concentrated and well-coordinated.

2. METHODOLOGY

The research methodology employed in this study is the Research and Development (R & D) method used to test the effectiveness of the product. Before products are produced for general use, there is need to test the effectiveness of these products. Results of this study are to be applied in producing a measuring tool for running speed which is based on microcontroller with personal computer system interfacing. Below is a step by step illustration of the research and development method according to Sugiyono (2011: 298).

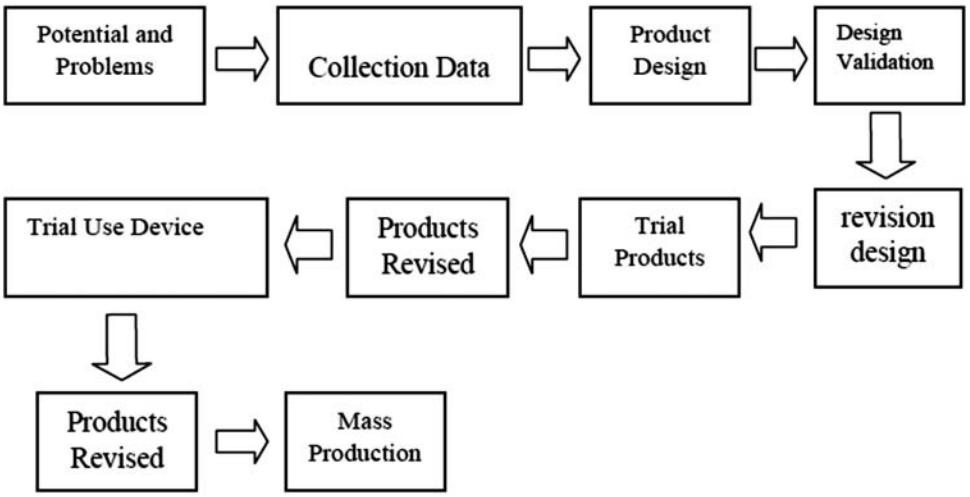

Figure 3: Diagram Illustrating the R & D procedure

Product design model for the assembly of the running speed measurement tool comprising of a system of phototransistors and sensors which send signals to the microcontroller which processes the signals into data of running time and speed which are displayed on the computer screen. The electronic circuit works as an automatic timing system and recording running speed and running time of the athlete as well. Below is an illustration of the whole system.

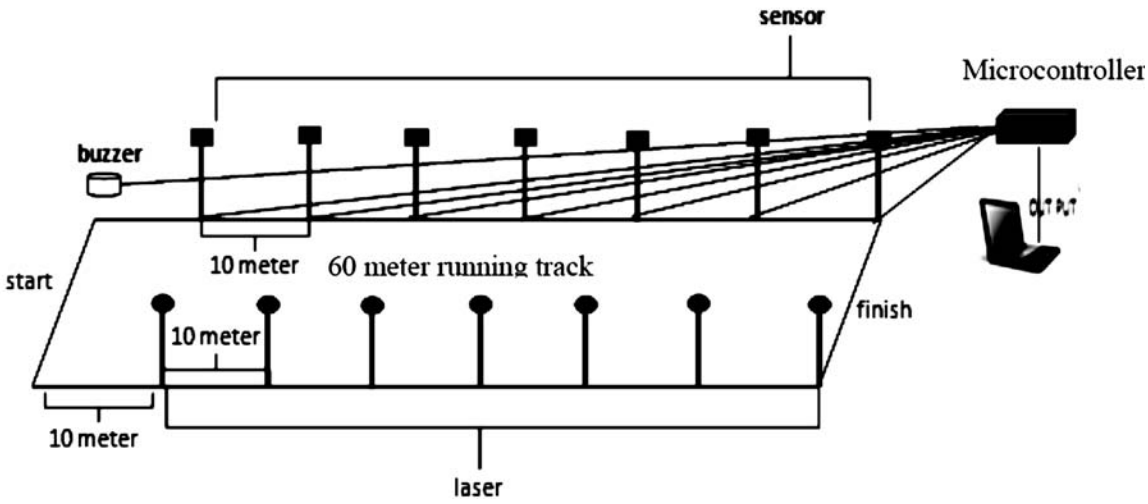

Figure 4: Product Design Schematic

3. RESULTS OF STUDY

Sensors and Lasers : These components work automatically as timing controllers, each sensor receive signals as runners obstruct/cut laser rays that shoot to the phototransistor sensor which are then be read as and sent to the microcontroller for processing, and the processed data is sent to a computer that uses the installed software to display readable results on the monitor. The main objective of this research is to produce hardware and software product for measuring running speed of athletes using a microcontroller for processing and a personal computer interfacing. The main function of this tool is to record the sprint speed of athletes. The system consists of several main components; the following literature explains the components and their functions:

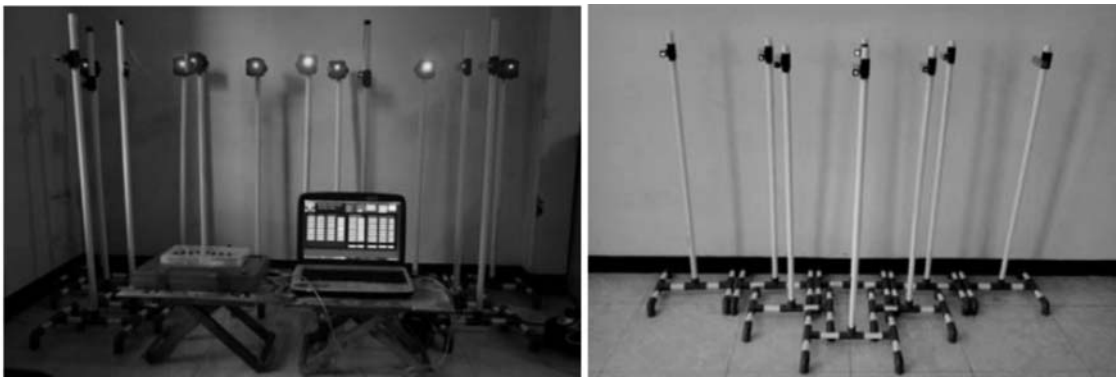

Figure 5: All Components running speed measuring device

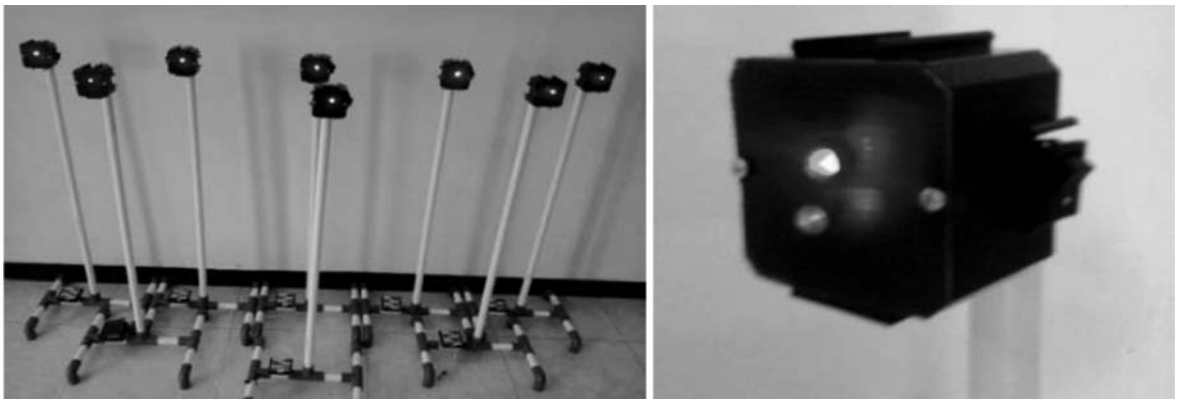

Figure 6: Eight Pieces of the Phototransistor Sensor Network

The main function of phototransistor sensors is to send signal to the microcontroller circuit when there are runners who cut the laser light emitted at this sensor. When the laser beam is interrupted by the passing of the runners the sensor sends a signal to the microcontroller that then sends the processed data to the computer. The main function of the laser is to emit light is to the phototransistor sensor, these light beams are the ones runners cut when running and signals generated after are sent to the microcontroller circuit which can be regarded as the brains of the system. This circuit consists of several electronic components that are assembled into a single hardware. The main function of this tool is to receive signals sent by the sensor which are marked by the cutting of LED lights on the circuit of the microcontroller.

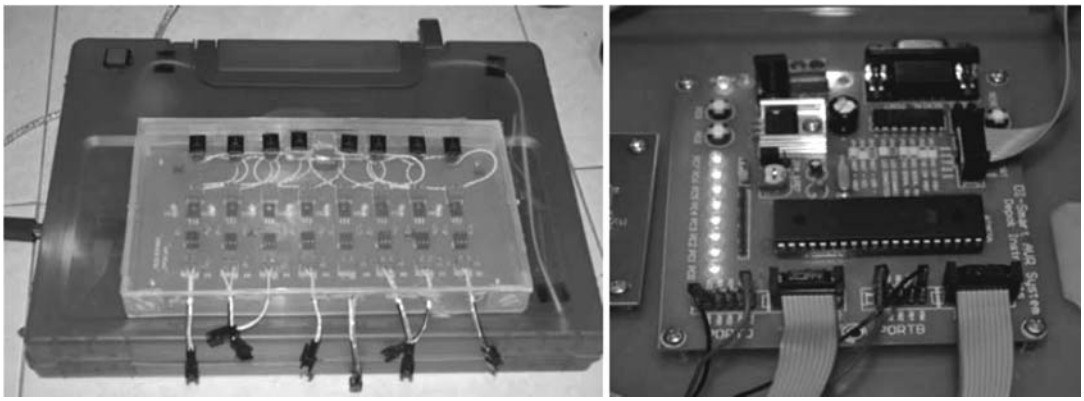

Figure 7: Network Microcontroller and LED indicator

After signals are received, they are forwarded through microcontroller to the software program already installed on the computer. The signal received by the computer from microcontroller is interpreted by the software on the computer. To create an application that displays data for speed results on a personal computer Visual Basic 12 program is used. The researcher named the computer application made as Monitoring Applications Running Sprint 100 meters. In the application made, data is recorded of the running time of each line, the speed of each line, total running time and average speed. Below is a view of the application interface

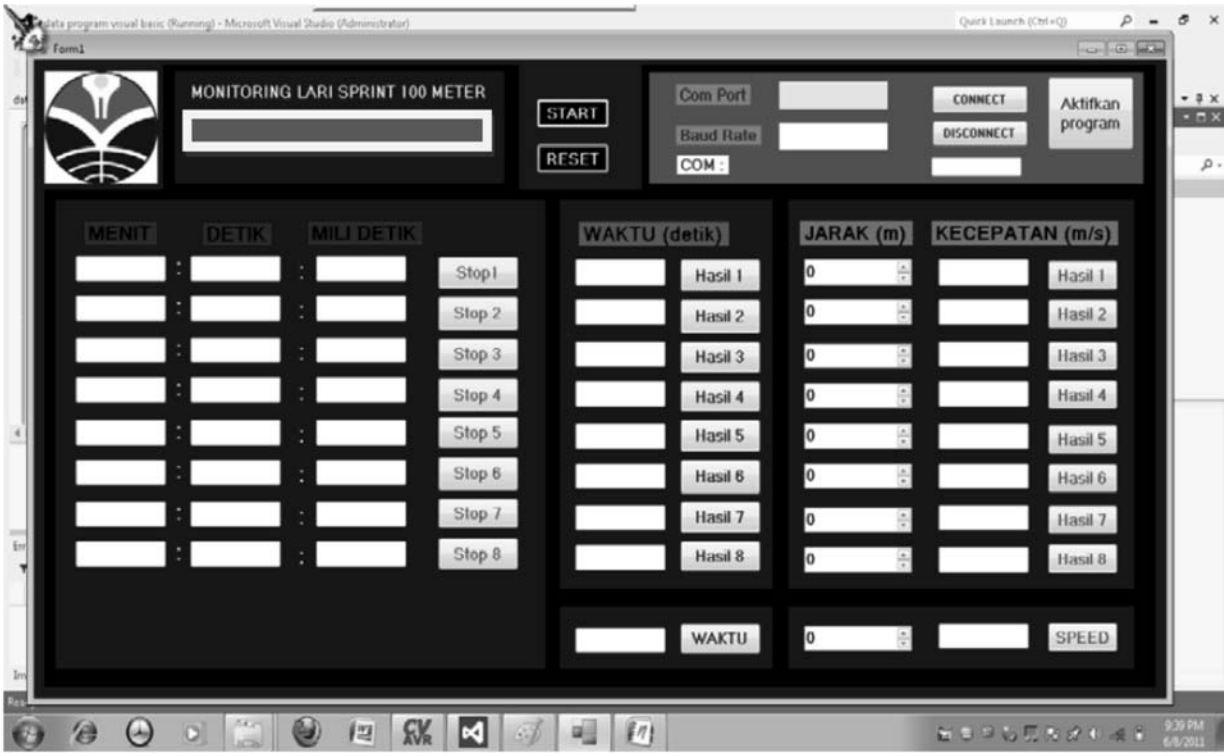

Figure 8: Software Personal Computer System

Testing Device

At this trial the researchers conducted measurements of the speed at a distance of 40 meters. A total of eight sensors mounted at every distance of 5 meters to determine the speed of the athletes run every 5 meters.

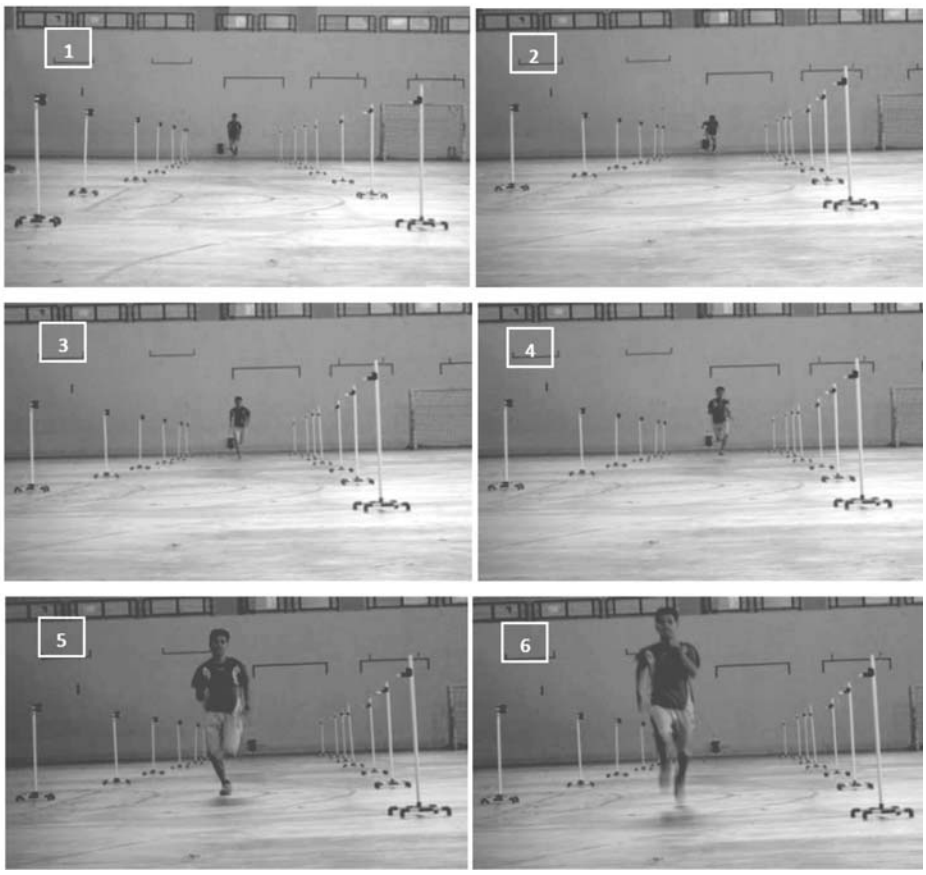

Figure 9: Running Sensor setting at running way

Table 1
Result of running time

Distance (m)	*time (sec)*	*Time / 5 m (sec)*	*Velocity / 5 m (m/s)*
5	1.6	1.6	3.1
10	2.3	0.7	6.8
15	3.1	0.8	6.1
20	3.9	0.7	6.6
25	4.6	0.7	6.9
30	5.3	0.7	6.5
35	6.1	0.7	6.7
40	6.9	0.8	5.7
Total time		6.9 sec	
Avarage velocity		5.7 m/s	
Maximum velocity		6.9 m/s	
Distance		25 m	

4. CONCLUSION

The running speed measuring system based on a microcontroller and interfacing on a personal computer can be constructed using available electronic components. Costs are reduced in the production of this system as the expensive component of the LED display board is absent. The system can go a long way in measuring and recording vital sporting data useful in training athletes and as reference in further sports science studies. This in turn improves the way sports is managed and studied in Indonesia, putting the country on the road to modernizing sports science management and study to match the developed countries soon.

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