Design of Straight Motion Experiment using Electric Motor Ticker Timer Based on Microcontroller

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Abstract. Most school experiment tools are limited and successful abstract concepts and unsuccessful ones become difficult to learn. Therefore we need an experiment to see the facts of the concept of straight motion become real. The purpose of this study is to discuss an experimental device using arduino uno motion to calculate the speed, distance, time and acceleration that has been obtained by an object. The method used is R & D research and development, but only tests on product design. The results showed that this program was able to simulate the concept of straight motion through cooperation between the Arduino program with sensors that work to calculate the expected physical quantities well. 97% with a very high degree of accuracy. As for the empirical test in obtaining an accuracy score of 93% with a high degree of accuracy. Thus this tool has been able to produce the concept of straight motion and has reached accuracy.

1. Introduction

One form of learning media used in learning physics is an experimental device[1]. Learning media can help as a bridge to deliver students. So, before continuing the learning process, appropriate learning media need to be prepared [2]. Sensor learning based on physics learning media can also help in achieving learning objectives [3]. The low quality of education in Indonesia, especially physics learning is one of the causes is that science learning is not in accordance with the characteristics of physics itself[4]. One way or guidance in supporting the development of knowledge, skills, basic needs of the delivery of material, concepts and physical information by educators is through the use of media devices[5].

Experimental activities in learning physics obtain the findings from various investigative activities collected and arranged systematically into a collection of knowledge which is called a product. Experimental activities can help in understanding the concepts contained therein[6]. states one of the factors that is less successful in learning is the teacher in choosing learning methods that are not appropriate with mathematics, the teacher is not activating students so students can only listen to students so students cannot participate [7].

Chebii et al. [8] Concerning ATMEGA 328 Microcontroller-Based Kinematics and Dynamics Experiments found that physics practicum tools using sensors are believed to be more effective and efficient, so that learning objectives can be carried out as expected. While Yuliana [9] states that based on the calculation analysis also shows that the average value of student learning outcomes in the experimental class using the development of tools is only 73.714 and students who score above the completion value are only 17 out of 35 students or only 49%.

Students need to receive direct experience of the material phenomenon in learning, so that understanding of the concept does not only depend on the initial concept, which has the potential to
cause misconceptions. Especially in the subject of straight motion which has a great chance of misconception due to understanding the initial concept [10].

The experimental instrument developed was a ticker timer experiment using a dynamo called the electric motor ticker timer. The electric motor ticker timer is an innovation from the conventional ticker timer in the KIT mechanics. The timer ticker contained in the mechanical KIT is attached to an AC voltage with a frequency of 50 Hz, causing the object to move very fast. Innovations made are the ticker timer using an electric motor, so that it can be connected to the DC or AC voltage and the speed of the object's movements can be regulated, so that the object's movement is more clearly visible and can be read its measurement results. Furthermore, the objects mounted in the form of sensors that cause more accuracy in taking time and distance that can be seen on the LCD screen. Therefore, this study is interesting to do with the title Development of a Straight Motion Experiment Tool Using an Electric Motor Ticker Timer Based on Arduino Microcontroller

2. Methodology
The product design produced in this research development is hardware and software design, so that the creation of a straight-motion experimental tool using an arduino microcontroller-based electric motor ticker timer. Description of hardware design in the form of mechanical design and electronics design. The mechanical design of the experimental device is designed in the form of a long straight path and in a certain part a photodiode sensor is sent to the arduino uno microcontroller, to detect the time and distance of the car traveling in the path and will be displayed in the form of an LCD. A moving car is equipped with a dynamo and ticker timer to see the type of track that the car is traveling. In the car is also equipped with a potentiometer to change the speed of objects to be slower or faster and make the speed of the car so that the speed is fixed or constant. The product design can be seen in Figure 1

![Figure 1. Design of a Straight Motion Experiment Tool](image)

The electronic design based on Figure 1 of this experimental device is in the form of hardware design or electronic design that will be made in advance by inputting the design of a tool that is able to describe the phenomenon of straight motion in outline, that is what kind of process is used to produce an output based on arduino uno microcontroller. The electronic design that is made is expected to be able to see the type of path traveled by objects, the speed of objects that are constant or change regularly, as well as the time and distance required for objects to traverse the path using an arduino uno sensor and microcontroller.

3. Results and Discussion
Straight-motion experiment tools that have been made in accordance with the design and have gone through several improvements, both in terms of shape, function, and color. The tool is designed to identify the movements traveled by objects using an electric motor ticker timer. The straight-motion experimental experiment tool that has been designed can be seen in Figure 2. Straight motion experimental equipment consists of several components namely: the track, a car that has been
designed using an electric motor, typewriter, and LCD in order to display the distance of time and speed traveled by objects.

![Figure 2. Straight motion experiment tool](image)

This motion tracking tool uses this LCD to see the distance and time traveled by the car. LCD can be seen in Figure 3

![Figure 3. LCD screen display](image)

The LCD display of the device in Figure 3 can be read in time using a photodiode sensor, as well as a distance using an ultrasonic sensor. On the top display is the time that is read from minutes, seconds, and milliseconds and at the bottom of the LCD is read the distance traveled by the car in the form of centimeters (cm) and beside it reads the speed that has been traveled by objects in units of cm/s.

The empirical test is carried out by measuring the precision and error percentage. Experimental and calculation data are shown in Table 1.

| No | Distance (m) | Time (s) | Velocity (m/s) | Δv  | % error |
|----|--------------|----------|----------------|-----|---------|
| 1  | 0.52         | 1.014    | 0.512          | 0.004 |         |
|    | 0.53         | 1.009    | 0.525          | 0.009 |         |
|    | 0.52         | 1.014    | 0.512          | 0.004 |         |
|    | 0.53         | 1.005    | 0.527          | 0.011 | 3.2 %   |
|    | 0.52         | 1.015    | 0.512          | 0.001 |         |
|    | 0.52         | 1.016    | 0.511          | 0.005 |         |
|    | 0.516        |          |                |      |         |
| 2  | 0.67         | 2.008    | 0.322          | 0.002 |         |
|    | 0.67         | 2.008    | 0.322          | 0.002 |         |
|    | 0.65         | 2.014    | 0.322          | 0.002 |         |
|    | 0.61         | 2.009    | 0.303          | 0.017 |         |
Table 1 shows that the precision of the tool that was tested was 5 times the average precision for the first experiment, the speed obtained a score of 0.99 where the precision was in the very high category. As for the percentage of errors using percent (%) in the first experiment of 3.2%. The speed precision in the second experiment on the LCD which has been set has values ranging from 0.94 to 0.99 which can be categorized as very high.

The biggest error percentage was in the second experiment, which was 6.7% with a precision value ranging from 0.94 to 0.99 and categorized as very high. A fairly large percentage among the other five experiments could be due to the car's insufficient fit in hitting the sensor or the car not pressing the sensor. So that the readings on the LCD fluctuate which causes far differences from the theory.

Overall, it can be stated that the level of precision of the experimental equipment is in the very high category. The percentage of error also ranges from 0.2% - 6.7%. So that the comparison with the theory can be said to have no significant difference and the resulting numbers are stable. For this reason, straight motion experimental tools can be carried out the next stage, namely validity and practicality tests.

4. Conclusion
A Straight Motion experimental device has been successfully developed by following the scientific steps or stages of research procedures, namely: preliminary studies, designing experimental devices, and making experimental devices, as well as conducting empirical tests on these tools. The empirical test process pays attention to aspects of the accuracy and relative errors of the tools that have been designed. Based on the acquisition of an overall accuracy score, the straight-motion experimental tool is declared accurate.

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