Development of Microcontroller-Based Straight Motion Experiment Devices

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Abstract. Learn to pronounce
This study aims to design a straight-motion experimental device using an Arduino Uno microcontroller to produce accurate data. The method used in this research is the Research and Development (R&D) research method. The model used is the development of a 4-D model. The 4-D (Four D) development model is a development model of learning tools. Based on data analysis, it can be concluded that this study has successfully designed a timer using a microcontroller to be developed as an alternative learning media in accurately calculating the time of a straight moving object.

1. Introduction
Physics as a subject in school is one branch of Natural Sciences (IPA) that can explain various natural phenomena in everyday life. This natural phenomenon can be explained through a concept, theory and physical laws so that it can be accepted by the human mind. Learning physics means studying nature and the concepts in it. These concepts can be concrete or abstract [1].

Physics learning in class X is dominated by the lecture method, the dominant role of the teacher in learning makes students very passive and lazy when learning. Such learning methods are thought to be the cause of the low physics learning outcomes of students. Practicum plays an important role in science education, because it can provide scientific method training to students by following the instructions detailed in the instructions sheet. In practicum activities, it is very possible to apply various science process skills as well as the development of scientific attitudes that support the process of acquiring knowledge (scientific products) in students.

The limitations of practical tools make it difficult for teachers to explain the concept of straight motion. Measurement of linear motion parameters in experiments so far is still done manually. Some sets of straight motion experiments that have been developed are still limited to automatic recording of time. Time recording still uses a stopwatch while the height of the object is still set manually. In addition, data processing to obtain the value of the earth's gravitational acceleration is still done manually. This causes the measurement data to have a fairly low accuracy and accuracy. Therefore, it is necessary to develop a set of straight-motion experiments to produce data with good accuracy and accuracy [5]. In the implementation of Atwood aircraft practicum where time measurement is done...
manually using a stopwatch can result in inaccuracies in the measurement results. This inaccuracy is caused by the interval of time to turn on and off the stopwatch and also depends on the accuracy of the practitioner [3].

Through a simple circuit by modifying the timer using a microcontroller and light sensor, accurate data will be obtained. Light sensor functions to activate the timer by detecting the motion of objects. A timer that has been modified using this light sensor can be used to measure the time of objects moving in various forms of straight paths.

Microcontroller-based time gauges have been developed in previous studies. But the use of tools in a straight motion experiment is limited to one form of trajectory. Time measuring devices on the vertical path were developed based on the research of [5] and on the horizontal path by Muhammad Ridho [2]. So the researchers developed props that could be used on horizontal and vertical trajectories. Through a series of microcontroller-based time gauges is expected to be able to facilitate students to understand the concept of irregular straight motion through practicum-based learning and produce accurate data.

2. Methodology
Research and development methods (Research and Development) is a research method used to produce certain products and test the effectiveness of these products. The research design used in this study is a 4-D (Four D Models) model development research design according to Thiagarajani [4]. This includes 4 stages, namely the stages of definition (define), design (design), development (develop) and dissemination (disseminate). The design of the device includes a series of electronics and mechanical design.

Electronic circuit design consists of a microcontroller with the input signal coming from the sensor. The sensors used in the circuit are lasers and photodiodes. The output generated from the circuit is the time displayed on the LCD after the object passes the sensor. The design is made in the form of a sketch shown in Figure 1.

The mechanical design consists of lines made of acrylic as shown in Figure 2. The tracks are designed so that they can be used in horizontal and vertical object motion experiments.
3. Results and Discussion

The results of the manufacture of the device consisted of straight-motion experiments changing irregularly on the horizontal path shown in Figure 3.

The props of straight motion on a horizontal path use beams which are connected to the load through ropes and pulleys. The load serves as a puller so that the beam moves accelerated at a certain distance. This experiment was carried out to construct the concept of irregularly changing straight motion by identifying the length of the object moving at a certain distance. Sensor 1 functions to activate the timer when the beam passes through the sensor. The timer will turn off automatically after the object passes through sensor 2. The microcontroller will process the input signal, and the length of time it takes for objects to pass through sensors 1 and 2 will be displayed on the LCD. The straight motion experimental device changes irregularly on the vertical path shown in Figure 4.
The straight-motion experiment changes irregularly on the vertical path using a ball and a base that serves as a buffer. The ball is dropped at a certain height. When the ball passes sensor 1, the timer will be active. Ball travel time will appear on the LCD when the object passes through sensor 2. This experiment is carried out to construct the concept of irregularly changing straight motion by identifying the length of the object moving at a certain height.

Time measurement data on straight motion changes irregularly on the horizontal and vertical paths shown in Table 1 and Table 2.

**Table 1. Measurement data of free falling motion objects from a height of 48 cm using arduino**

| Height (cm) | Time (Sekon) |
|------------|--------------|
| 48         | 0.12         |
|            | 0.12         |
|            | 0.13         |
|            | 0.14         |
| **Average** | **0.1275**   |

**Table 2. Time measurement data of horizontal moving objects with a distance of 55 cm**

| Height (cm) | Time (Sekon) |
|------------|--------------|
| 55         | 0.25         |
|            | 0.25         |
|            | 0.25         |
|            | 0.27         |
| **Average** | **0.255**    |

**4. Conclusion**

In this research, a timer has been designed using a microcontroller to be developed as an alternative learning media in calculating the time of free falling moving objects, moving percepatisan on the horizontal path. Through the collaboration of the Arduino program with the photodiode sensor. This testing tool is able to work with the sensitivity of the measurement of the time calculation of the movement of objects in vertical and horizontal paths. Thus it can be said that the design of a free fall motion prototype tool using a free fall microcontroller to calculate time can work well.

**References**

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