DEVELOPMENT OF CYLINDRICAL LAUNCH CONTROL SYSTEM ON INCLINED PLANE USING ARDUINO-ASSISTED MAGNETIC FIELD.

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DEVELOPMENT OF CYLINDRICAL LAUNCH CONTROL SYSTEM ON INCLINED PLANE USING ARDUINO-ASSISTED MAGNETIC FIELD.

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Abstract

The topic of cylinders, inclined planes and magnets is quite popular in physics in college. In addition to being learned through direct learning, this material can be studied more interestingly with experimental methods. This study aims to develop a cylinder launch control system on an inclined plane using an Arduino -assisted magnetic field, determine the influence of the number of turns on the magnetic field generated and to determine the effect of the number of turns on the sliding speed of the cylinder. This research uses research and development methods. Research activities are carried out to obtain information about the need for experiments from literature studies while development activities are carried out to develop or produce products the form of experimental tools and experimental monographs. This research refers to the ADDIE development model, namely Analysis, Design, Development, Implementation, and Evaluation. The experimental device made includes a solenoid made using 0.5 mm enamel wire windings of 350 windings and 550 windings. As well as Arduino and relays used for automatic control of solenoid connectors/circuit breakers so that they can become magnets . . The object observed is a cylinder sliding on an inclined plane with angular variations of 10 degrees, 20 degrees and 30 degrees for each turn. The movement of this cylinder is then tracked to get a speed profile. The function of the solenoid is to control the launch of the cylinder on a slope that has been programmed using Arduino. The results of the experiment found that the more the number of twists, the greater the magent field will be. the number of turns of 350 causes a magnetic field of 7.8231 mT and for the number of turns of 550 causes a magnetic field of 8.1582 mT. The object observed is a cylinder sliding on an inclined plane with angular variations of 10 degrees, 20 degrees and 30 degrees for each turn. The movement of this cylinder is then tracked to get a speed profile. The function of the solenoid is to control the launch of the cylinder on a slope that has been programmed using Arduino. The results of the experiment found that the more the number of twists, the greater the magent field will be. the number of turns of 350 causes a magnetic field of 7.8231 mT and for the number of turns of 550 causes a magnetic field of 8.1582 mT. In addition, the more the number of turns, the faster the cylinder in the inclined plane will move, this can be seen from the results of the study for an angle of 10 degrees, a speed of 0.53184 m/s was obtained for the number of turns of 350 and a speed of 0.54308 m/s for the number of turns of 550. A 20-degree angle yields a speed of 0.61412 m/s for 350 turns and a speed of 0.67778 m/s for 550 turns. A 30-degree angle obtained a speed of 0.76517 m/s for the number of turns of 350 and a speed of 0.77186 m/s for the number of turns of 550. From the results of this study, it was also found that the development of the device has very good quality, this is proven by getting quite good results in the research.

Keywords: Automation, Cylinder, Inclined Field, Magnetic Field, Arduino

INTRODUCTION

The forms of landslides that occur in general can be categorized into 5 types, namely *Slides* , *Falls*, *Topples*, *Flows* and *Lateral. spreads* . Where the type of *Slide* (Slide) can be categorized into 2 parts, namely *rotational* (rotation/rotation) and *translational* (translation). The types of translational and rotational landslides are the types of landslides that occur most in Indonesia (Ilyas, 2011:5) . The motion of solid balls, solid cylinders and hollow cylinders is one example of rigid body dynamics. When a cylinder rolls on an inclined plane, the object will experience two movements at once, namely rotational motion about the cylinder axis and translation on the inclined plane that is passed. In other words, rotational and translational motions are related to the motion of the cylinder rolling on an inclined plane. This is interesting because we can study the *Slide type landslide* by examining more deeply the motion of the cylinder on an inclined plane that has similar symptoms produced by the *Slide type* landslide.

It would be better if in the process later in studying the motion of the cylinder on an inclined plane a system is created that has a control to regulate when the cylinder will roll on an inclined plane. Solenoids have the potential to be used in various modern instruments including in providing magnetic fields that can be used for control systems (Hidayat & Pramudya, 2018) . Therefore, solenoids can be used as a control to control cylinders on inclined planes which of course must meet various provisions. The number of coils used affects the magnetic field generated, the more coils used in the solenoid, the greater the magnetic field will be. In addition, the solenoid core affects the intensity of the magnetic field generated by the solenoid, the magnitude of the magnetic field generated will be different if using different materials, for example using air, iron, copper and aluminum (Wahyuni &, Erwin, 2015) . and of course by regulating the current flowing in the solenoid, it will be possible to obtain variations in the magnetic field as desired, the greater the current flowing, the greater the magnetic field generated by the solenoid.

From the preliminary research that has been done using solenoids that are already sold on the market (12VDC *Solenoid Door Lock*) by setting the voltage input from 9-12 V with a current of 500mA - 2 A and the number of turns as many as 25, a small magnetic field value of 0.500 mT was obtained. of course, with the magnetic field produced it is not able to hold the iron cylinder on the inclined plane track to roll. Therefore, further characterization is needed related to the number of turns, solenoid core material and current flowing to ensure the success of the cylinder launch control system on the inclined plane properly.

The control system has recently become an interesting topic in recent years, where the use of technology in the industrial revolution 4.0 has become something that is absolutely necessary to follow, from the beginning which was all manual, it began to shift to all automation, therefore it is necessary to follow this topic to create a control system that has automation with the help of an Arduino microcontroller, this Arduino is a link between the solenoid and the automated system so that it produces the desired system. There are several studies related to the rotation of rigid bodies and the manufacture of solenoids that have been carried out previously, such as determining the moment of inertia of a solid cylinder with an inclined plane experiment studied by (Setyadi & Oktova, 2011) where in this study they looked for the *K value* that corresponds to the theoretical value for all different path lengths. Development of Instrumentation for Determining the Speed of Solid Cylinder Motion on an Inclined Plane Using Arduino (Saputra & Pramudya, 2019) where in this study measuring the speed of an object rolling on an inclined plane has been a problem so far. *The Study of Hollow Cylinder on Inclined Plane to Determine the Cylinder Moment of Inertia* . *UNNES Physics International Symposium (UPIS)* (*in press*), this study was conducted by (Reza & Yudhiakto, 2018) which examined the moment of inertia of a hollow cylinder. From several of these studies, all of them used a manual method to release the cylinder moving on an inclined plane.

Research on Arduino-based solenoid magnetic field control system (Hidayat & Pramudya, 2018) . (Wahyuni &, Erwin, 2015) studied the Analysis of the Effect of Coil Core on Magnetic Fields and Charges on Capacitors in LC Series Circuits, (Fardhani et al., 2019) studied the topic of

Coil Parameter Optimization to Increase Magnetic Field Strength in Solenoid-Based Magnetic Field Sources (Sadewa et al., 2015) This study examines the Implementation of Microcontrollers in Electrical Equipment Control Systems and Website-Based Home Monitoring.

The objectives of this research are:

1. Knowing the influence the number of turns of the magnetic field generated.
2. To determine the effect of the number of turns on the sliding speed of a cylinder on an inclined plane.
3. Resulting in the development of a cylinder launch control system on an inclined plane using a magnetic field assisted by Arduino with good quality.

METHODS

Research Object

The objects in this study are as follows: an inclined plane track board 1,20m, a control system device, a solid cylinder (aluminum) with a mass of m =85.92 gr or $(0{,}8592 \pm 0{,}0002) \times 10^{-1}$kg and a density of $\rho_s = 2{,}71$g/cm^3 or 271.000kg/m^3.

Research Tools and Materials

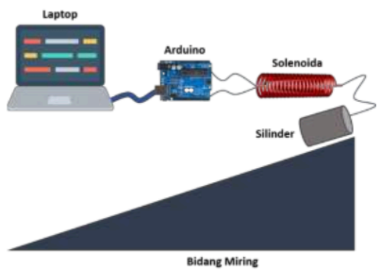

Figure 1 . Launch control system development design

The tools and materials used in this study are as follows:

In this study, the hardware used is an Asus Vivobook X441U laptop (*4 GB RAM, Ms. Windows 10 OS, Core i3-gen6*) which functions as a means to run the control system software using Arduino. Solenoids that have 100, 125, 150, 175 and 200 turns, solid cylinders made of iron and aluminum. As well as connecting cables to unite the circuit. The software used in this study is *Arduino Software* is a means to control the device to launch a cylinder that is under the influence of a magnetic field, *Tracker Software* is a means to process video to obtain time, speed and position data experimentally. and Microsoft Excel which is a means to obtain a graph of the relationship between distance and time and speed and time.

The following is the design of the experimental equipment and experimental monograph that will be developed:

Figure 2. Experimental equipment

Figure 3. is an experimental tool that was successfully developed by the researcher. In this figure all components used in the study are shown consisting of solenoids, power adapters, cylinders and automatic cylinder launch controls.

Research Procedures

This research begins with preparing all the tools and materials used, then measuring the angle of the inclined plane track board before inserting it into the aquarium. After the track board is inserted into the aquarium, the next step is to put water into the aquarium. The next activity is connecting the system control device to the electric current when everything is connected and ready to use. The first is to connect the Arduino to the magnetic field originating from the solenoid that is flowed by current, then the second is to run the camera to record the cylinder speed and process it using the *tracker application* to determine the speed and profile of the graph created. Then the third is to vary the number of coils and types of cylinders to collect other data.

RESULTS AND DISCUSSION

Solenoid Magnetic Field Data

Based on the experiments that have been carried out, the results of the magnetic field at the end of the solenoid are 7.82310 milliTesla obtained from the measurement results using a magnetic field sensor from vernier. Measurements were carried out 5 times.

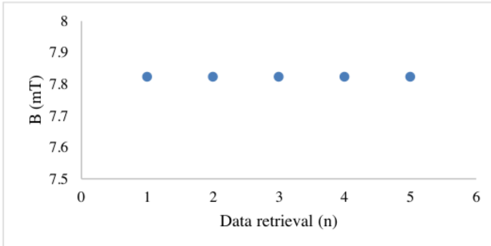

Figure 4. Measurement of the magnetic field of 350 turns vernier magnetic field sensor

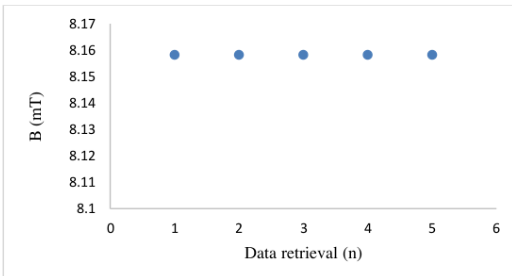

Figure 5. Magnetic field measurement of 550 turns of vernier magnetic field sensor

Relative uncertainty is closely related to measurement accuracy, namely we can state that the smaller the relative uncertainty, the higher the measurement accuracy. If the measurement uncertainty above is the smallest ½ scale error of the measuring instrument used, then we can see the results from the measurement error table below.

Table 1. Error in measuring the magnetic field of 350 turns

The smallest scale of measuring instruments	½ smallest scale measuring instrument	Percentage of errors (%)
0.004 mT	0.002 mT	0.0511

Table 2. Error in measuring the magnetic field of 550 turns

The smallest scale of measuring instruments	½ smallest scale measuring instrument	Percentage of errors (%)
0.004 mT	0.002 mT	0.6184

Speed Data from Video Tracker Analysis at Multiple Angles

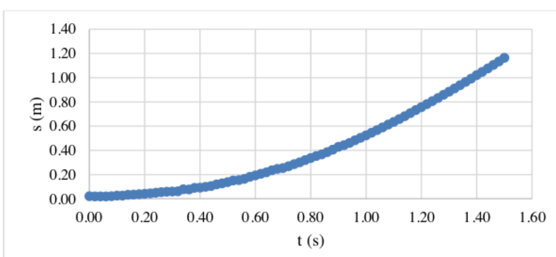

Figure 6. Speed graph profile of winding 350 with 10 degree angle variation

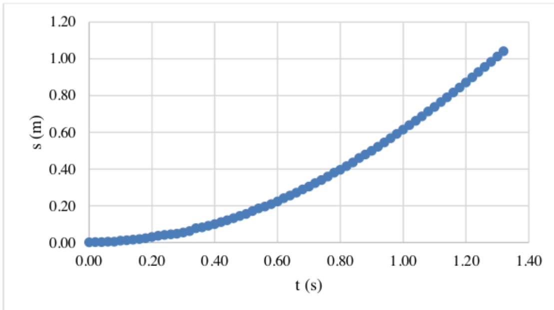

Figure 7. Speed graph profile of winding 550 with 10 degree angle variation.

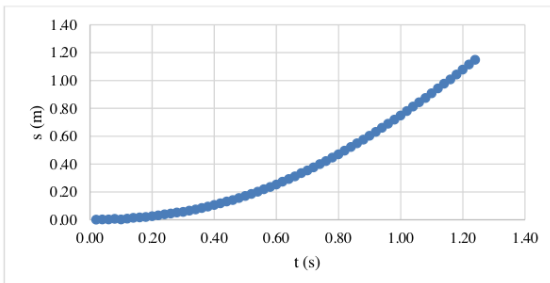

Figure 8. Speed graph profile of winding 350 variations of 20 degree angle

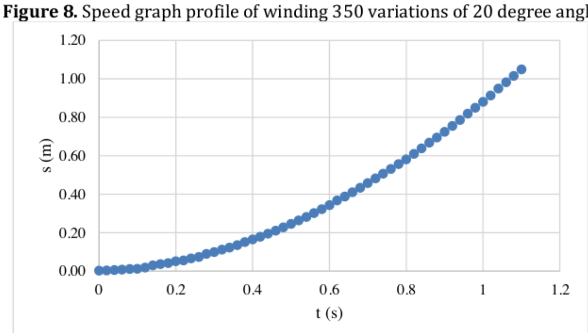

Figure 10. Speed graph profile of winding 550 with 20 degree angle variation.

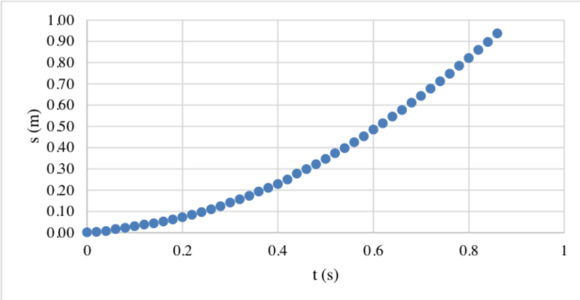

Figure 11. Speed graph profile of winding 350 with 30 degree angle variation.

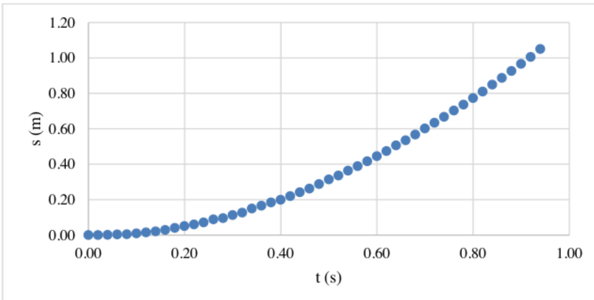

Figure 12. Speed graph profile of winding 550 with 30 degree angle variation.

Discussion

The magnetic field generated has a fairly good value due to the influence of the number of coils used, as well as the current strength. The more coils used, the greater the demand for current, resulting in a fairly strong current. The electric current flowing in the enamel wire is what creates the magnet in the solenoid. So it can be used as a control for a cylinder that will slide on an inclined plane. When electricity flows, the solenoid will conduct a magnetic field that holds the cylinder on the inclined plane. When the electric current is disconnected with a relay that has been programmed with the Arduino Uno microcontroller, when the button is pushed, the electric current will be disconnected so that the cylinder on the inclined plane that was initially held by the solenoid magnet will slide on the inclined plane. From this process, the results of the graph of the influence of position on the cylinder slide time can be seen based on the number of coils and the angular variation on the inclined plane.

From this study, quite good results were also obtained but must still be corrected because there is always uncertainty or error in the experiment. Relative uncertainty is closely related to measurement accuracy, namely we can state that the smaller the relative uncertainty, the higher the measurement accuracy. If the measurement uncertainty above is the smallest ½ scale error of the measuring instrument used, then we can see the results from the measurement error table. With this data obtained, it can be seen in table 4 that the measurement error is 0.0511% (350 turns) and 0.6184% (550 turns) so it can be said that the measurement has very good accuracy.

In accordance with previous research (Wahyuni & Erwin, 2015) that has been done which states that each material will have its own characteristics so that it produces its own different magnetic magnitudes that are also generated. From this study, variations in the diameter of copper enamel wire with sizes of 0.5 mm, 0.75 mm and 1 mm have been carried out which are varied with the same number of turns, but the most ideal to use is the size of 0.5 mm.
(Hidayat & Pramudya, 2018) stated that the number of turns on the solenoid will affect the magnetic field generated. The more turns, the greater the magnetic field generated. This is in line

With this study where different results were obtained between the number of turns of 350 and the number of turns of 550. The number of turns of 350 obtained a measurement result of 7.8231 mT while the number of turns of 550 obtained a measurement result of 8.1582 mT.

The cylinder sliding on the inclined plane is controlled by an automatic launching system using a magnetic field originating from an electric solenoid. From the cylinder moving on the inclined plane track, a position profile is obtained against time or commonly called velocity. The resulting speed differs based on the angle of the inclined plane of the cylinder track and the number of turns that affect the magnitude of the magnetic field generated in the solenoid. From the speed profile of the number of turns of 350 variations of 10 degree angles using the average speed equation, a speed of 0.5318 m/s was obtained. While with the number of turns of 550 variations of 10 degree angles using the average speed equation, a speed of 0.5430 m/s was obtained. This means that with a greater number of turns, a faster speed is also obtained.

From the speed profile of the number of turns of 350 variations of 20 degree angles using the average speed equation, a speed of 0.6141 m/s was obtained. While with the number of turns of 550 variations of 20 degree angles using the average speed equation, a speed of 0.6778 m/s was obtained. This means that with a greater number of turns, a faster speed is also obtained. From the speed profile of the number of turns of 350 with a variation of 30 degree angle using the average speed equation, a speed of 0 is obtained. 0.7652 m/s. While with the number of turns of 550 variations of the angle of 30 degrees using the average speed equation, the speed obtained is 0.7718 m/s. This means that with a greater number of turns, the speed is also faster.

CONCLUSION

Based on the results of the data analysis carried out, the following conclusions can be drawn: Amount coil influence the magnitude the magnetic field generated in the solenoid , where the more Lots amount coil so will the more big field too magnets generated . From the research This obtained results For amount coil as many as 350 causes magnetic field of 7.8231 mT and for amount coil as many as 550 caused magnetic field of 8.1582 mT. Amount coil influence speed launch cylinder on an inclined plane where the more Lots amount coil so will the more also fast the cylinder on the inclined plane moves . This is can seen from results obtained Where For 10 degree angle obtained speed of 0.53184 m/s for amount 350 turns and speed of 0.54308 m/s for amount 550 turns . 20 degree angle obtained speed of 0.61412 m/s for amount 350 turns and speed of 0.67778 m/s for amount 550 turns . 30 degree angle obtained speed of 0.76517 m/s for amount 350 turns and speed of 0.77186 m/s for amount 550 coils . Development system control launch cylinder on an inclined plane using assisted magnetic field Arduino get good quality , thing This obtained through the revision process as well as repair tool so that get composition the best that can be used with Good.

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