Development of Centripetal Acceleration Practicum Based on Arduino Nano and Infrared Sensors with Dimmer Switch

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Abstract---In the era of industrial revolution education 4.0 which characterized the use of digital technology in the learning process, this practical tool was born to make it easier for students to understand the concept of centripetal acceleration. This research phase consists of defining, designing, developing and disseminating or promoting. This study used three types of mass, 2 gr, 3.5 gr and 4.5 gr. Each treatment is carried out with a variation of five types of speed. At a mass of 2 gr, 3.5 gr and 4.5 gr, the faster the speed of the rotating object, the centripetal acceleration and centripetal force will also be large. Based on the wrong test results the tool has an accuracy of 78% and the tool's reliability is 85%. Therefore this tool can be categorized as a centripetal acceleration practicum with nano arduino and an infared sensor with a dimmer switch.

Keywords: tool development, sentripetal acceleration, arduino nano, infared sensor, dimmer switch

I. INTRODUCTION

The industrial revolution is a history of the most important developments in human life over the last three centuries that are sustainable in building the life of the modern world [7]. The era of industrial revolution 4.0 provides a challenge especially for education to prepare competent individuals to face future challenges by applying technological advances in learning activities. Facing these challenges, human resources must be met first, including being able to utilize technology, being a creative person, and being able to socialize [9] and the need for innovation, especially in learning, to make it easier to learn lessons delivered by teachers using digital technology. Educational innovations in learning methods include the formulation of the organization of teaching materials, delivery strategies and processing activities with due regard to the goals, obstacles, and characteristics of students so that the results are effective, efficient, and attract learning attractiveness [10]. So the importance of innovation in learning by using technology achieved learning objectives and made it easier to understand the concepts of physics. The learning process was fun and created new experiences for students.

Physics is a science that explains physical phenomena which are abstract in nature so that the delivery of various concepts of physics is needed in the learning process which does not merely prioritize the transfer of knowledge from educators to students. Physics is also part of science that understands natural phenomena that occur from the level of the college to the basic level because physics has benefits in everyday life [3]. Deep understanding of concepts is needed in the learning process that can be done by training skills and experiences that can change the mindset of physics is a ghost for students. By bringing learning in real life directly gives a very big effect for students to always be motivated in the learning process. Experimental activities in the learning process can be more meaningful and fun [8]. The diversity of global challenges caused by industrial flows 4.0 has led to an increase in the need for human resources capable of integrating scientific knowledge and its applications [4].

The low ability of students to understand abstract concepts and lack of activities to explore the abilities of students, a solution is needed, namely by learning media. One effective learning media to explain abstract concepts and attract students' interest in learning is practicum [5]. Technology-based era of industrial revolution 4.0, it is necessary to innovate in making practical tools that use control devices, such as detector devices or sensors, LCD, and microcontrollers. This is needed to reduce inaccuracies in measurement and more efficiency. Besides that education 4.0 builds on the concept of learning by doing, students are encouraged to learn different things in singular ways based on experimentation [1].

Therefore the researcher wants to develop a centripetal nano-based centripetal practicum accelerator and IR sensor with a dimmer switch. Based on previous research, it was revealed that with a variety of electronic devices available, the design of the teaching aids produced was more effective, efficient and had good results of measurement and visualization accuracy. Props that are produced with various electronic components make students have a

great interest in learning and also increase the ability of innovation and creativity of students [6]. The development of physics teaching aids for circular motion material for high school provides an opportunity for children to be able to analyze the relationships between components in circular motion and children become active in the learning process [2].

This study aimed at developing centripetal acceleration practicum based on arduino nano and IR with dimmer switch, and test the performance of hardware and software from practicum tools that have been made, can calculate centripetal acceleration and centripetal force easily, and analyzed peractic device performance accordingly with existing concepts. This is expected to provide benefits to educators in the learning process to achieve learning goals, and provide an opportunity to understand physics easily and provide motivation to students with the help of digital-based practicum tools

II. METHOD

This research used the RnD (Research and Developments) method and consisted of four steps. The first step, the definition phase is done by analyzing the needs of students; the second step, the design stage by making tool designs; the third step, the development step by testing and validating the appropriateness of the tool to the experts; and the last stage is the stage of dissemination or promoting to school.

The tools and materials that used in this study are a series of centripetal plugs which have nano arduino components, IR sensors, dimmer Switches, AC motors and battery boxes, load mass (less than 1 kg), thread ropes, and screwdrivers. After the all is ready to be used, the first step to note is to attach the acrylic disc above the center of the stem using a long screwdriver, as shown on the side; Install a mass of load with a rope, then tie it to the part of the dish; Connect fittings to the socket; Turn on the sensor switch; Change the dimmer switch part from the smallest to the largest rotation speed; Observe the rpm speed that appears on the LCD screen and if it is constant note it in the trial table; and repeat with different masses to find out the difference.

III. RESULTS AND DISCUSSION

In this study used variations of three types of mass, namely 2 gr, 3.5 gr, and 4.5 gr. Each mass is given a variation of five speed plates to spin. The results are in the table as follows:

Table 1. Results of practical data with mass 2 gr and radius 0.125 m

No	$\omega(rp$	$\omega\,(rad/s)$	$v(m/s)$	$a_s(m/s^2)$	$F_S\,(N)$
1	230	$7{,}7\,\pi$	$0{,}96\pi$	$7{,}37\pi^2$	$14{,}74\,x10$
2	270	$9\,\pi$	$1{,}125\pi$	$10{,}125\,\pi$	$20{,}25\,x10$
3	301	$10{,}03\pi$	$1{,}25\,\pi$	$12{,}5\,\pi^2$	$25\,x\,10^{-3}$
4	375	$12{,}5\,\pi$	$1{,}56\,\pi$	$19{,}47\,\pi^2$	$38{,}94\,x\,1($
5	379	$12{,}63\,\pi$	$1{,}58\,\pi$	$19{,}97\,\pi^2$	$39{,}94\,x\,1($

Table 1 showed that when given a small mass, and a dimmer switch is rotated with a slight angular velocity, then the speed for the disk rotates slightly too. Due to the smaller voltage given to the practicum to move the disc to rotate circularly by rotating the dimmer switch, but when given a large voltage by rotating the dimmer switch, the angular velocity detected on the LCD screen is also greater. This affected the value of centripetal acceleration and centripetal forces. The results of the data from the mass of 3.5 grams are in Table 2 below.

Table 2. Results of practical data with a mass of 3.5 and radius of 0.125 m

No	$\omega(rpi$	$\omega\,(rad/s)$	$v(m/s)$	$a_s(m/s^2)$	$F_S\,(N)$
1	201	$6{,}7\pi$	$0{,}82\pi$	$5{,}78\pi^2$	$20{,}23\,x10$
2	262	$8{,}73\,\pi$	$1{,}09\pi$	$9{,}5\,\pi^2$	$33{,}25\,x10$
3	300	$10\,\pi$	$1{,}25\,\pi$	$12{,}5\,\pi^2$	$43{,}75\,x\,1($
4	355	$11{,}83\,\pi$	$1{,}48\,\pi$	$17{,}52\,\pi^2$	$61{,}32\,x\,1($
5	379	$12{,}63\,\pi$	$1{,}58\,\pi$	$19{,}97\,\pi^2$	$69{,}895\,x\,1$

Table 2 showed that when the mass of the object associated in the disk gets bigger, then to find the value of constant angular velocity on the LCD screen is very long, unlike a small mass. Because the weight of the mass will affect the value of speed to rotate the disk and the voltage applied to the practicum. In addition, the effect is the length of the rope used, but in this lab using the same radius.

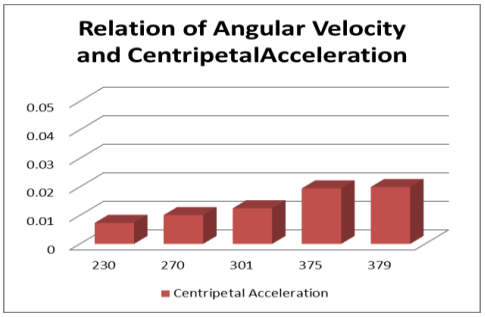

Figure 1. Relation of angular velocity and centripetal acceleration on mass 2 gr

Figure 1 showed the relationship between centripetal acceleration and readable angular velocity on the LCD screen. The magnitude of centripetal acceleration depended on the speed of the disk moving around every second. Because centripetal acceleration is acceleration in a moving object with the radius leading to the center of the fire and the speed to which the direction is centered. That the

function of centripetal acceleration is not to increase the speed of an object but to change the direction of motion of an object so that it stays on its circular path.Centripetal force which has the ability for the object to move in a circle. The magnitude of the centripetal force depended on the amount of centripetal acceleration on the moving object and on its mass. When the mass value is large, the value of the centripetal pun acceleration will affect the magnitude of the centripetal force so that the object remains circular. This is in accordance with table 1 and table 2 about the results of practical data with different masses.

Based on the results of the above data analysis, this practicum tool has a speed limit that is used which is around 200 - 390 rpm and the mass that is commonly used for the dish is still rotating circularly between 1–8 gr. This affects the accuracy value of only 78%. And the results of the validation of physicists are 85%. So that this tool can be used for practicum learners, and provide motivation to learn and eliminate the word that now physics is easy, not difficult and scary like a ghost. In addition, it helps educators achieve the success of the learning process which is assisted by digital practicum tools. And this tool was designed simple and easy to carry anywhere, which given teachers the opportunity to demonstrate to students in the laboratory or in the classroom.

IV. CONCLUSION

In the era of the industrial revolution 4.0 presents new challenges to humans, especially in the world of education. The challenge is how humans use technology in the future and as a tool to make it easier to solve problems. In the world of education, technology is very useful to facilitate the learning process, especially learning physics. To understand the concept of physics there need to be a tool to make it easier for students to understand physics material, so as to be able to eliminate difficult physics thinking that has a decreasing effect on student motivation. In this research, the school provided a solution to bring a practical and easy to understand practicum tool that is an arduino nano based centripetal acceleration practicum and an IR sensor with a dimmer switch with accuracy test results and the feasibility results showed that the tool is suitable for practicum use.

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