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Assemble a Digital Magnetic Induction Gauge with Hall Effect Sensor UGN3503U and NodeMCU ESP8266 in Classroom Laboratory

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ABSTRACT
To support the understanding of magnetic induction and its application to technology, this research will develop IoT-based teaching aids. This study aims to provide an alternative experiment that can provide direct experience to students about the strength of the magnetic field. This study uses the ADDIE method (analysis, design, development, implementation, and evaluation). However, it was only carried out until the development stage. The product consists of a Hall Effect UGN350 sensor connected to a NodeMCU microcontroller. Experiments by measuring the strength of the magnetic field using a hall effect sensor can be used as a demonstration of magnetic field material. This research still needs to be researched by adding a variable change in the number of turns of the solenoid.

Keywords: *magnetic induction, hall effect sensor, IoT*

1. INTRODUCTION

Today, the development of information technology has entered the era of the internet of things (IoT) [1]. Internet network that connects various objects to exchange information quickly, easily, and efficiently. The internet has become the primary consumption of the public, including students. The use of smartphones to search for subject matter is a form of indirect use of IoT in the learning process. Learning using mobile learning has a positive impact on increasing student understanding [2]. The benefits of IoT in the learning process need to get more attention from teachers. This delivery process can be carried out by the teacher in various methods or ways with the aim of students becoming aware of the material being taught. Meaningful learning can be done by using the demonstration method through teaching aids. Teaching aids that are in accordance with the needs of students will be able to effectively increase students' interest in learning [3], [4]. Opportunities for the existence of IoT need to be used more broadly in learning in schools.

Physics is an empirical science, which is based on the phenomena that occur and can be observed with the senses. If the habit of observing physical symptoms through direct observations in the classroom, laboratory activities or even through observing symptoms in life is rarely carried out, then there will be potential problems for students in understanding the subject being studied [5], [6]. Especially if the material being studied is abstract. One of the symptoms and abstract things that are rarely observed and done in classroom learning is how to measure magnetic field strength [7], [8]. Magnetic fields are a physical phenomenon associated with electrical quantities. Current produces a magnetic field, and conversely, current can be generated from a magnet moving near a coil. To determine the amplitude and direction, the magnetic field must be measured.

Magnetic field strength is one of the most important physical quantities. a magnetic sensor is needed to measuring the strength of the magnetic field [9]. Magnetic sensors are often used and applied in various fields, such as industry, household, health, and others. This is because the use of magnetic sensors has many advantages including linearity, high stability, non-destructive, high sensitivity, relatively simple, low operating costs and relatively easy to use. Currently, the easy process of reading magnetic sensor data is a must.

This is related to the development of science and technology in meeting human needs, especially those related to electronic devices. Almost all electrical devices, from household appliances to communication devices, are sensitive to electromagnetic fields. [10].

To facilitate the reading of magnetic sensor data, there are several other alternatives that have been offered in measuring magnetic field strength. Among them is the measurement of the magnetic field strength of a magnetic bar using a smartphone sensor. Measurement of magnetic field strength on circular wires and straight wires using a magnetic field strength sensor on a smartphone. Experiments using smartphones require certain smartphone specifications, because not all smartphones are equipped with magnetic field sensors [11].

To support the understanding of magnetic field strength and its application to technology, this research will develop an IoT-based teaching aids. Given the limitations above, this study offers an alternative to measuring magnetic field strength by observing current using the Hall Effect UGN350 sensor which is connected to the NodeMCU micro controller.

2. METHOD

This study uses a research and development (R&D) method such as ADDIE. Addy consists of analysis, design, development, implementation and evaluation. However, these studies were carried out only before the development phase. Observational data will be displayed in the form of a graph between the strength of the magnetic field and the electric current.

3. RESULTS AND DISCUSSION

3.1. Analysis

At the analysis stage, a needs analysis was carried out using an online questionnaire using Google Form. Students who are reached are high school students Class XII Purworejo district a total of 10 respondents. The purpose of distributing this questionnaire is to find out whether the students receive the Magnetic Physics practicum in the classroom using a magnetic field practicum kit. From the survey that has been done, students admit that they have never made direct observations and measurements of magnetic field strength. From these data it can be interpreted that the experience received by students in measuring magnetic field strength is still limited. So far, observations in high school laboratories have only been limited to observing the symptoms of magnetic field lines around current-carrying wires and around magnets, and even then, not all schools do so due to time constraints, limited tools and so on.

3.2. Design

The initial stage of development begins with designing the hardware/body of the props. After making the body of the measuring instrument, then assembling all the necessary components such as NodeMCU ESP8266, ADS1115 module, 9 Volt battery, switch, mini volt ampere meter, current regulating resistor, solenoid coil, DC socket male, 9V 1A adapter, Hall Effect sensor UGN3503U, elco 100uF, and micro USB cable. The next stage is to design a program using Arduino software that is already installed on the laptop. The last stage is to design a system between the program and hardware so that the props can work properly and then connect to the blynk application on Android.

Figure 1. Overall system circuit

Figure 1 is a series of the overall system of the research to be carried out. Smartphone and NodeMCU ESP8266 are connected within Wifi range in order to communicate with each other. In the circuit, the NodeMCU ESP8266 has a magnetic induction output and as an input, the hall effect sensor. The input will detect the presence or absence of magnetic induction on the sensor, the output will detect how much magnetic induction is experienced.

The design of this magnetic field induction measuring instrument includes the design and incorporation of functions from several arrangements of each component arranged into a single unit. The sensor is used as an input which is connected to the NodeMCU ESP8266 and magnetic induction as an output. Supply voltage from NodeMCU ESP8266 using an adapter.

3.3. Development

At the development stage, a trial was conducted to generate data from the test results of the tool. Hall Effect Sensor testing is carried out to determine the accuracy of sensor readings and the percentage of error values that occur. In the Hall Effect Sensor testing system, it is done by calibrating the sensor readings with manual calculations contained in the reference book. This testing process is carried out by varying the current strength to obtain magnetic induction with each current strength being collected five times to get the sensor precision value.

Tabel 1. Magnetic Induction Test Results On Solenoid

I (A)		**Measurement (Gauss)**					**Average**	**error**
		1	2	3	4	5		
0.01	IoT	1	1	1	1	1	1	0%
	Manual	1	1	1	1	1	1	
0.03	IoT	2	2	2	2	2	2	0%
	Manual	2	2	2	2	2	2	
0.04	IoT	3	3	3	3	3	3	0%
	Manual	3	3	3	3	3	3	
0.05	IoT	4	4	4	4	4	4	0%
	Manual	4	4	4	4	4	4	
0.07	IoT	5	5	5	5	5	5	0%
	Manual	5	5	5	5	5	5	

The results of testing the props were carried out 5 times. The first test at 0.01 A produced a magnetic induction (1±0) Gauss. The second test at a current of 0.03 A produced a magnetic induction (2±0) Gauss. The third test at a current of 0.04 A produced a magnetic induction (3±0) Gauss. The fourth test at a current of 0.05 A resulted in magnetic induction (4±0) Gauss. The fifth test at 0.07 A produced a magnetic induction (5±0) Gauss. The results obtained indicate that the air flow velocity measuring instrument has good accuracy. The graph of the relationship between the strength of the current and the magnetic induction of the solenoid is presented in Figure 2.

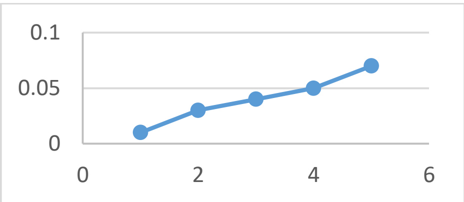

Figure 2. Graph of magnetic field versus current

Magnetic induction is a field formed by moving an electric charge (electric current) which causes a force to appear in another moving electric charge. If there is a solenoid carrying a constant direct current, the potential difference between the two ends of the solenoid is almost zero because the potential difference is equal to the product of the current and the resistance of the solenoid. But if the solenoid is subjected to a current that varies with time, the properties of the solenoid will change [12]. As seen in figure 2, this will affect the magnetic field as well as the magnetic flux contained by the solenoid and cause an induced emf.

The process of developing this IoT-based physics teaching aid based on the characteristics of a teaching aid is said to be good and feasible [13]. The characteristics of a teaching aid are durability (made of appropriately strong material), attractive shape and color, simple and easy to use (not difficult), the size is appropriate (balanced) with the student's physical size, can present concepts (does not complicate understanding), appropriate with learning concepts, can clarify concepts, and demonstrations aim to be the basis for the growth of students' thinking concepts[3], [5], [13].

4. CONCLUSIONS

The advantage of this IoT-based physics teaching aid is that the results of automatic time measurements and demonstration data can be observed by students directly and in real time. Experiments with measuring magnetic field strength using a hall effect sensor can be used as teaching aids for magnetic field material. This research still needs to be investigated by adding a variable change in the number of turns of the solenoid.

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