Comparative study of magnetic fields measurements with logger lite and Arduino on electronic devices

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Abstract. A study of magnetic field measurements of electronics devices has been conducted. Magnetic field measurement is done by two methods, that is Arduino based measurement by using magnetic field sensor with C + language. Other measurements use magnetic sensors and Logger Lite software with Labquest Mini interface. In Arduino measurements, the measurement results are made in units of Tesla. ADC Arduino has 10 bits. The resolution of this magnetic sensor is 1.6 gauss /volt. Display data in the form of sensor read voltage is changed in milli Tesla (mT) by dividing the data reading voltage sensor value with a value of slope 0.160 mT and intercept -0.32 mT. Measurement results are compared with measurements using magnetic field sensors and free Logger Lite software. The results found that there was no significant difference on measurement data between Arduino and logger lite. The larger difference is 0.032, a result of Servo measurement and the lower is 0.002 mT, result of Coil with 1 Ampere measurement. The conclusion of these two methods is the measurement of the magnetic field using Arduino is recommended to be used.

1. Introduction
The magnetic field is a physical phenomenon related to electrical quantities. An electric current creates a magnetic field, and vice versa electric current can be generated from a magnet driven near a wire coil, Faraday's induction law. To know the magnitude and direction, the magnetic field needs to be measured. The magnetic field is expressed in units of Tesla, for example, a normal earth magnetic field near the equator of about 45,000 nano Tesla, with north-south direction.

Such measurements have already been published [1-3]. The magnitude of the magnetic field is one of the most important physics is the magnetic field and to measure it required magnetic sensors. At this moment magnetic sensors are growing rapidly along with the advance of science and technology. One of them is the hall's magnetic sensor effect. This sensor is designed to sense the presence of magnetic objects with changes in position. Continuous magnetic field changes cause the occurrence of pulses which can then be determined frequency, this type of sensor commonly used as a speed gauge.

The development of science and technology is very rapid and closely related to human needs. In this case, human needs are much related to electronic devices. Every electrical equipment from household appliances up to communication tools reacts to the electromagnetic field. For this purpose, the process of easy reading of magnetic sensor data becomes a necessity.
2. Literature Review

2.1 Sensor of magnetic field
Hall effect occurs when a current carrying conductor is held in a magnetic field, the field gives a lateral force to the charge flowing on the conductor. All Hall Effect appliances are activated by the presence of a magnetic field [4]. The magnetic field has two important characteristics, flux density, and polarity. Most of the Hall Effect digital switches are designed to die if there is no magnetic field (open circuit at the output). The switch will be active if only subjected to a magnetic field that has sufficient density and proper direction. Magnetic field sensors are used instead of Gaussmeter for data to be automatically displayed on the computer and easy to analyze, and better results can also be obtained. The magnetic field sensor in this study used the Vernier manufacturer's output.

2.2 Sketch for Arduino
Fortunately, the vast majority of Vernier analog (BTA) sensors have linear calibrations. For these sensors, we only have to add a few lines of code to Vernier Analog Voltage sketch to get meaningful readings. Specifically, we need to convert from a raw voltage to sensor reading using equation (1).

\[ \text{Sensor reading} = \text{intercept} + \text{voltage} \times \text{slope} \]  

For any Vernier sensor with a linear calibration, we can get the slope and intercept from the user manual from any sensor's web page or in the Vernier support section. The Arduino comes with a built-in, 10-bit analog-to digital (A/D) converter to read voltages. The voltage is read as a count in the range of 0 volts and 1023 representing 5.0 volts [5].

2.3. Logger lite
Logger lite is software with support tool which consists of Labquest and two sensors. Labquest as the link between the Current Probe Sensor, Voltage Probe Sensor and Magnetic Field Sensor to the computer, the lab quest used is Vernier’s mini lab quest. Two sensors are Current Probe Sensor and Voltage Probe Sensors that exist in energy sensor devices. Function as a substitute Amperemeter and volt meter, so that data directly read by the computer and also possible to get more accurate results [6].

2.3 Vernier Arduino Interface Shield
The SparkFun Vernier Interface Shield, a simple add-on to give Arduino the capability to interface with Vernier sensors. Attached to this interface shield are four British Telecom sockets (2 Analog, 2 Digital) which all Vernier sensors use as connectors. Simply attach it to an Arduino development platform. This shield was developed to be used with the Arduino Uno platform [7].

3. Method
In this study used magnetic field sensor based on Vernier production hall effect with 3.2 mT measuring interval and 1.6 Gauss/volt sensor output. The sensor is useful for detecting the magnetic induction of electronic devices.

This observation was using 7 sample. There were handphone, motor stepper, magnet U with four times various distance, coil 500 with 1 A DC. The magnetic field detected by the sensor will be displayed and processed data in 2 ways. First by using Vernier production interface before reading on the laptop that has been installed Logger Lite +Labquest Mini. Secondly by using Arduino + Vernier Arduino Interface Shield with the same sensor. The results of the data processing displayed then compared to get whether there is a difference between the two applications.
4. Results and Discussion
The comparison of two measurement data was the aim of this research. The result of magnetic field measurement can be seen in table 1.

| Sample | Measurement data with Logger Lite (mT) | Measurement data with Arduino (mT) | Difference between measurement with Logger lite and Arduino (mT) |
|--------|----------------------------------------|----------------------------------------|---------------------------------------------------------------|
| 1      | 0.023 ± 0.001                          | 0.03 ± 0.00                            | 0.007                                                         |
| 2      | -0.318 ± 0.000                         | -0.32 ± 0.00                           | 0.002                                                         |
| 3      | 0.011 ± 0.001                          | 0.02 ± 0.00                            | 0.009                                                         |
| 4      | 0.032 ± 0.001                          | 0.04 ± 0.00                            | 0.008                                                         |
| 5      | 0.104 ± 0.010                          | 0.11 ± 0.00                            | 0.006                                                         |
| 6      | -0.061 ± 0.001                         | -0.053 ± 0.001                         | 0.008                                                         |
| 7      | 0.396 ± 0.001                          | 0.364 ± 0.0001                         | 0.032                                                         |

Data obtained from mini Labquest and lite logger at every second and data retrieval can be obtained as many as 5 data, 10 data even 100 data. The measurement result using lite logic is very precise, as evidenced by the standard deviation value of each sample is very small. The average standard deviation value of 7 sample size is 0.002, with the largest standard deviation value in the 5th sample (0.104 ± 0.010) mT. For magnetic field measurements using Arduino, a sketch of voltage data reading by Analog to Digital Converter (ADC) from Arduino is built-in with float command as shown in equation (2).

\[
\text{Voltage} = \frac{\text{Count}}{1023.0} \times 5.0
\]

The value 1023 refers to the maximum value of digital data that indicated by the Arduino, while the value 5, and indicates the magnitude of the reference voltage used by the Arduino of 5 volts. Next, the value of the Arduino is converted to the magnitude of mille Tesla with the float equation Sensor Reading. For a 3.2 mT range, the slop value of the magnetic field change to the voltage by the Vernier magnetic sensor is 0.160 mT / V, and the intercept value is -0.32 mT. The Arduino measurement results have a good accuracy level with an average deviation standard score of 7 samples measured 0.001 with the highest deviation standard in sample 6 (-0.053 ± 0.001) mT.

From this result, we saw that there was no significant difference between two measurement data. It means that the using of Arduino with magnetic field sensor from Vernier was recommended. The validation level can be increased by multiplying the numbers behind the comma from the measurement results. This is done by adding a sketch after the conversion process into mille Tesla in the form of `Serial.println(SensorReading, X);` where X denotes the number of numbers to be displayed behind the comma. The more of numbers behind the comma the greater the level of accuracy.

Several studies on magnetic field measurements have also been performed. Design instrumentation measurement instruments for strong magnetic fields using Atmega8535 microcontroller [8]. The use of magnetic sensors in magneto static experiments has also been done with smartphones [9]. Our result in measurement by Arduino and Logger lite device was able to provide an alternative in experimental measurement of a more economical and easy magnetic field.

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