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Arduino-Based Light Intensity Measurement

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Abstract: A concise and factual abstract is required (maximum length 200 words). The abstract Light is a form of energy that is very important and needed by all living things on earth. The intensity of light can be measured using an instrument, namely, Luxmeter. In this study, a light intensity measuring instrument was developed that utilizes electronic components, namely the LDR sensor and Arduino Uno so that it has the same function and working principle as a standard Luxmeter. Based on the test results of the tool, the error rate of the developed light intensity measuring instrument is 2.99% of the standard luxmeter. These results indicate that the developed tool is suitable for measuring light intensity.

Keywords: Light intensity; Luxmeter; Arduino Uno; LDR sensor.

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Introduction

Light is a very important form of energy needed by all living things on earth. White light, which is commonly known as visible light or visible light, consists of all the color components of the light spectrum (Manik, et al., 2020). Furthermore, light is also defined as electromagnetic waves that can be seen with the eye. A light source emits energy, some of this energy is converted into visible light. The emission of light is none other than the emission of electromagnetic waves which are generally called radiation (Pamungkas et al., 2015; Gunadhi, 2002).

The amount of light emitted or luminous flux is expressed in lumens. The luminous flux emitted from a point source of light should be described as a line radiating from the point source in a radially uniform manner. Thus, the amount of light flux hitting a surface will be expressed by the number of flux lines arriving at the surface. A surface exposed to light is said to be illuminated and the intensity of illumination is expressed by the flux density, i.e., the number of lines of light flux hitting it. The density of the light flux lines emanating from the light source represents the intensity of the light, while the density of the light flux lines striking the surface indicates the intensity of the light. Light intensity or light intensity is defined as the amount of luminous flux that radiates per corner of the room, while the intensity of illumination or illumination is defined as the amount of light flux that hits one unit of surface area that is illuminated (Gunadhi, 2002). The tool used to measure the amount of light intensity from a light source at a location is a Luxmeter where the unit is Lux (Manik, et al., 2020).

Standard lux meters that we find in the market have a fairly expensive price, for that we can design a tool that has the same function but is relatively cheaper. We can design Lux meter by utilizing electronic components, namely sensors. state that a sensor is a component that can be used to convert a certain quantity into an analog/digital unit so that it can be read by an electronic circuit. One type of sensor is the LDR sensor (Manik, et al., 2020).

LDR (Light Dependent Resistor) is a light sensor made of high resistance semiconductor material that is not protected from light (Desyantoro et al., 2015). LDR as a type of resistor whose resistance value is influenced by the light received by it. The value of the resistance on the LDR depends on the size of the light

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received by the LDR itself. The LDR resistance will change along with changes in the intensity of light hitting it or those around it. In the dark the LDR resistance is about 10MΩ and in the light it is 1KΩ or less (Kumar et al, 2016).

This light intensity meter can work if all components are connected to a microcontroller, namely Arduino. Arduino is a microcontroller board based on the ATmega328. This device has 14 input/output pins consisting of 6 pins that can be used as PWM outputs, 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP head, and a reset button. Arduino is able to support microcontrollers so that it can be connected to a computer or laptop using a special USB cable. To operate the Arduino, you can use a USB cable that is connected to a computer or other power source such as a battery (Supatmi, 2011).

Method

This research was conducted from May to June 2021 at the Physics Laboratory of the FKIP University of Mataram.

Tool Design Stage

The first step in developing this light intensity measuring instrument is to create a block diagram which can be seen in Figure 1. Next, the hardware design of the developed tool can be seen in Figure 2.

Tool Trial Stage

In the trial phase, the measuring instrument calibration process was developed using a standard luxmeter. From this trial it will be known the error rate of the developed tool so that it can be known whether the intensity measuring instrument is suitable for use or not.

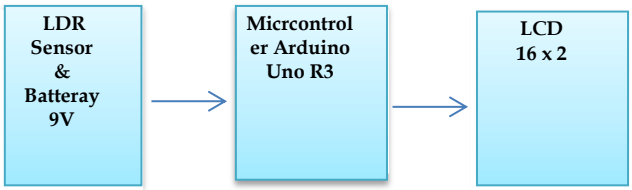

Figure 1. Block Diagram

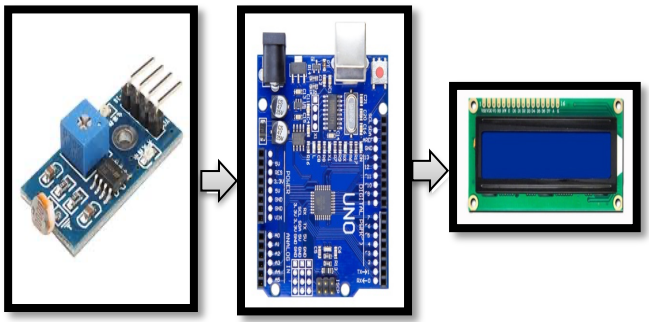

Figure 2. Hardware Design

Result and Discussion

In the activities that have been carried out based on the design and testing of Arduino-based light intensity measuring instruments, the following data are obtained:

Table 1. Data Analysis of Light Intensity Measuring Instruments

ADC Value	Lux Meter (Lux)	Standart Lux Meter (Lux)	Light intensity error (lux)	Error (%)
27	1980	2000	20	1.00
32	1970	2000	30	1.50
35	1964	2000	36	1.80
37	1960	2000	40	2.00
38	1958	2000	42	2.10
39	1956	2000	44	2.20
41	1952	2000	48	2.40
44	1946	2000	54	2.70
48	1938	2000	62	3.10
50	1934	2000	66	3.30
49	1936	2000	64	3.20
56	1922	2000	78	3.90
62	1910	2000	90	4.50
54	1926	2000	74	3.70
72	1890	2000	110	5.50
68	1898	2000	102	5.10
47	1940	2000	60	3.00
46	1942	2000	58	2.90
47	1940	2000	60	3.00
46	1942	2000	58	2.90
Average				2.99

The data above is obtained from several stages:

1. Calculate the value of the output voltage (Vout) of the LDR using the following equation:
$$V_{out} = \frac{R_{LDR}}{R_1 + R_{LDR}} \times Vcc$$
2. Calculate the ADC value of the LDR using the equation:
$$ADC = \frac{V_{out}}{V_{ref}} \times 1023$$
3. Calculate the calibration value of the light intensity measuring instrument by comparing the light intensity value from the standard Luxmeter using the equation:
$$1ADC = \frac{the\ value\ of\ light\ intensity\ on\ a\ standard\ Luxmeter}{number\ of\ ADC\ on\ luxmeter}$$
4. Convert the ADC value to the light intensity value with Lux units using the equation:
$$Light\ intensity = sensor\ ADC\ value \times value\ 1ADC$$

This research activity aims to develop an Arduino-based light intensity measuring instrument. The first step is to find sources of information from various literatures and scientific journals that support knowledge related to light intensity measuring instruments and the components used in designing these tools. Furthermore, the design of the tool scheme is carried out to make it easier to design tools in

hardware. The tools and materials needed in the manufacture of this tool include: Arduino Uno R3, LDR sensor, breadboard, jumper cable, 9volt battery, transparent box, double-sided tape, and cutter.

After the literature study has been carried out and the material tools are ready, the next step is to design the tools according to the previously made tool scheme. All components are connected using jumper cables according to their respective pins. After everything is installed, the series of tools are connected to the laptop to upload the program to the arduino microcontroller. The uploaded program is adjusted to the expected output. The component that will display the output of the designed tool is a 16x2 LCD. The LCD screen will display the ADC value and the voltage from a light source being measured.

After the series of tools and programs are uploaded, the light intensity meter is ready to be tested. Overall, the working principle of this tool to measure the light intensity that was developed begins by connecting the power supply/battery to the device design, in this case the author uses a 9V battery, then puts a light sensor on the light source whose intensity will be measured. The light that illuminates the photo cell as energy is transmitted by the photo cell into an electric current. The lighter the cell absorbs, the more current it produces. The intensity of light captured by the sensor will then be processed by the microcontroller to be displayed on the LCD.

Testing the tool is done by calibrating the tool that has been designed. The calibration process is carried out by taking data using a light intensity measuring instrument that has been made and using a standard Luxmeter. These two measuring instruments are brought closer to the same light source and at the same distance, while the light source used is an HP flash. Furthermore, the observation data is displayed on the serial monitor in the Arduino Uno application that has been previously installed on the laptop and can also be observed on the LCD screen on the laptop. The data obtained in the measurement using a light intensity measuring instrument (artificial lux meter) and a standard lux meter in the form of an analog value of light intensity. To determine the value of the difference in error and the percentage of error (%) obtained from the measurement results using a standard lux meter and an artificial lux meter stored in the MS program. Excel.

Based on the testing of the tools that have been carried out, the results obtained (Table 1) that the light intensity measuring instrument designed has an error rate of 2.99% from the standard lixmeter. The error rate that appears can be caused by several factors, including the components used in the circuit, errors in placing the tool during testing so that it has an impact on the results and other factors such as bright room conditions that affect the light source being measured. However, the developed tool is feasible to use and has the same function, namely being able to measure the intensity of light from a certain light source because it has a fairly low error rate, which is below 10%.

Conclusion

Based on the description, the light intensity measuring instrument developed was declared eligible to be a light intensity measurement tool, because it only had an error rate of 2.99% from the standard Lux meter.

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