Design and development of measurement of measuring light resistance using Light Dependent Resistance (LDR) sensors

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Abstract. Light Dependent Resistance (LDR) is one type of resistor whose resistance value is affected by the intensity of light received by it. This study aims to measure the amount of resistance in each color of light measured in the LDR. The research method is done by making a measurement device in which a light source parallel to the LDR is placed, where the color layer is inserted which will change the white light from the lamp to the color light according to the color layer used. The variation in distance (x) between the lamp and LDR causes greater resistance. The results of this study indicate that 1) the distance of the light source is inversely proportional to the intensity of light, 2) The distance of the light source is directly proportional to the magnitude of resistance, 3) The intensity of light is inversely proportional to resistance, and 4) the dominant large resistance value is in the dominant blue light the value of large light intensity is in the color of yellow light.

1. Introduction
The interaction between energy and matter that forms the basis of natural science is part of physics. Light is material that cannot be separated from what happens in the universe and is always related to everyday life [1]. Physics learning is not only oriented to the mastery of knowledge and attitudes, but also aimed at developing aspects of student skills in the concept of 21st century learning [2]. This learning requires an understanding of concepts in the process of forming knowledge through discovery [3].

This is in accordance with the purpose of learning physics as a process to improve students' thinking skills, so students are required not only to be able and skilled in the psychomotor field, but also able to think systematically, objectively, and creatively [4-5]. The concept of light is a concept that is very close to life, discussion and practice of the symptoms and phenomena that occur in it is an interesting discussion. Light has properties that can be used as a source of stimulation for sensors, namely the Light Dependency sensor (LDR) [6].

The use of Light Dependent Resistor (LDR) sensors is very beneficial for life, including applications in street lighting. The sensor serves as a tool to detect and also to know the magnitude. LDR with Arduino UNO to measure light intensity by means of conversion resistance to Lux [7]. LDR can be used to measure light brightness, detect object color, detect day or night [8].

Light can be seen with the eye and is an electromagnetic wave. The light propagation relationship (v = 3 x 108 m / s), wavelength (λ), and frequency (f) are:
\[ \lambda = \frac{\nu}{f} \]  

(1)

Light appears to have a wavelength between 340 nm to 700 nm which is composed of several colors of light. Light intensity \( I \) in units of candela (cd) is a light current in the lumen emitted every corner of the room (in a certain direction) by a light source. The word candela comes from a light source is a unit of lighting techniques and is measured based on standard light intensity [9].

Luminous intensity is defined as the amount of light flux that radiates \( \Phi \) per space angle \( \omega \):

\[ I = \frac{\Phi}{\omega} \]  

(2)

The total space angle is \( \omega = 4\pi \) (Steradian). Light flux is the amount of light intensity that radiates at a certain angle of space [10].

Light illumination is a ray that falls (comes) on a surface or light flux that illuminates a field in one unit area, so that it can be written

\[ E = \frac{\Phi}{A} \]  

(3)

If the light flux emitting from the point of all space is \( \Phi = 4\pi I \) and the spherical surface area is \( A = 4\pi R^2 \) then the source of the intensity of light \( I \) produces a total illuminance of

\[ E = \frac{I}{d^2} \]  

(4)

This shows that the illumination at distance \( d \) is directly proportional to the source of light intensity and inversely proportional to the square of the distance [11].

Lighting power (E) is a quantitative statement for the intensity of light (I) that overrides or reaches the surface of the plane. Strong lighting is also called the level of illumination or intensity of illumination. The light source is considered to be the point which is spaced \( d \) from the field of illumination, resulting in a strong illumination (E) in the potometer at a point in the illumination field:

\[ E = \frac{\Phi}{d^2} \times \cos \theta \]  

(5)

\( \Phi \) is Light Flow (Lumen) and \( \theta \) there is an angle between the light source and the perpendicular projection point from the light source to the work surface [12].

2. Material and methods

This research is an experimental quantitative research conducted from January to March 2019 at the Physics Education Laboratory, UIN Sunan Gunung Djati, Bandung, West Java. Light measurement is done by varying the color lattice and distance of the light source with LDR (d). Measurements were made using five different color grids, namely red, yellow, green, blue, and purple as in Figure 1 with variations in the distance of light sources, namely 20 cm, 28 cm, 36 cm, 44 cm, 44 cm and 52 cm. The material used is Arduino Uno R3 Atmega328, 16x2 LCD Screen White / Blue LED Backlight 3.3V, Mini Breadboard, 20 Watt lamp, LDR sensor, multimeter, color grid, and jumper cable.

![Figure 1](grid.png)

Figure 1. Grid of yellow, blue, green, purple, and red.

The experimental step, the lamp is placed at a distance (d) from the light sensor. The light source will pass through the colored lattice before illuminating the LDR sensor. The LDR sensor illuminated with a light source will get a resistance value that can be measured using a multimeter (ohm meter) and the
value of the intensity of light produced will be measured in Arduino-based lux meters. The experiment was repeated ten times for each distance in the measured color box. The sketch of the LDR and Arduino series is shown in Figure 2.

![Figure 2. Sketch of the lux meter circuit.](image)

The tool set casing is placed in a closed container made of rectangular duplex with a size of 80 cm x 15 cm x 20 cm. In Figure 3 (a) there are two rooms, namely the room for lights and the space for the sensor circuit. The light as a light source is placed on the rail so that it can be moved closer to and away from the LDR (distance variation). Between the two rooms are separated by a color grid so that the light received by the LDR is the desired color of light. In the sensor room there are two circuits, namely a circuit to measure resistance and a lux meter circuit to measure intensity. The circuit for measuring resistance is shown in Figure 3 (b). The lamp is placed at a distance (d) from the light sensor. Light source that will pass through the colored lattice before illuminating the LDR sensor. The LDR sensor illuminated with a light source will obtain a resistance value that can be measured using a multimeter (ohm meter) and the value of the intensity of light produced will be measured in an Arduino-based lux meter. The experiment was repeated ten times for each distance in the measured color grid.

3. Result and discussion
LDR sensor resistance will change according to changes in light intensity. Based on the measurement and processing of data that has been done, the results of the measurement of resistance and light intensity for each color grid are shown as shown in Table 1.
### Table 1. Variation in distance between resistance and intensity.

| d       | 20 × 10^{-2} m | 28 × 10^{-2} m | 36 × 10^{-2} m | 44 × 10^{-2} m | 52 × 10^{-2} m |
|---------|----------------|----------------|----------------|----------------|----------------|
| R_{\text{Red}} (Lx) | 20800 ± 0.5 | 30800 ± 0.5 | 41300 ± 0.5 | 53950 ± 1.72 | 67750 ± 1.75 |
| Error R_{\text{Red}} | 0.00% | 0.00% | 0.00% | 0.03% | 0.03% |
| I_{\text{Red}} (Lx) | 1.23 ± 0.04 | 0.52 ± 0.02 | 0.30 ± 0.01 | 0.178 ± 0.06 | 0.12 ± 0.04 |
| Error I_{\text{Red}} | 3.17% | 4.44% | 4.29% | 34.69% | 33.97% |
| R_{\text{Yellow}} (Lx) | 12800 ± 0.5 | 18750 ± 1.75 | 25000 ± 0.5 | 31560 ± 1.72 | 39850 ± 1.76 |
| Error R_{\text{Yellow}} | 0.00% | 0.09% | 0.00% | 0.05% | 0.04% |
| I_{\text{Yellow}} (Lx) | 10.62 ± 3.74 | 5.90 ± 2.09 | 1.22 ± 0.41 | 2.10 ± 0.73 | 1.26 ± 0.43 |
| Error I_{\text{Yellow}} | 35.23% | 35.39% | 33.75% | 34.87% | 34.08% |
| R_{\text{Green}} (Lx) | 26300 ± 0.5 | 40100 ± 0.5 | 54200 ± 3.5 | 70850 ± 1.76 | 90690 ± 5.31 |
| Error R_{\text{Green}} | 0.00% | 0.00% | 0.01% | 0.02% | 0.06% |
| I_{\text{Green}} (Lx) | 4.39 ± 1.54 | 2.20 ± 0.76 | 1.22 ± 0.41 | 0.74 ± 0.23 | 0.45 ± 0.20 |
| Error I_{\text{Green}} | 35.04% | 34.75% | 33.75% | 31.19% | 23.31% |
| R_{\text{Blue}} (Lx) | 43750 ± 6.6 | 67600 ± 0.5 | 94720 ± 1.5 | 128500 ± 0.25 | 168300 ± 0.21 |
| Error R_{\text{Blue}} | 0.15% | 0.00% | 0.02% | 0.02% | 0.01% |
| I_{\text{Blue}} (Lx) | 3.34 ± 34.99 | 1.37 ± 0.47 | 0.71 ± 0.22 | 0.43 ± 0.09 | 0.26 ± 0.007 |
| Error I_{\text{Blue}} | 34.99% | 34.28% | 31.10% | 21.71% | 2.59% |
| R_{\text{Purple}} (Lx) | 31700 ± 0.5 | 47500 ± 0.5 | 64840 ± 5.4 | 849500 ± 0.33 | 112200 ± 0.2 |
| Error R_{\text{Purple}} | 0.00% | 0.00% | 0.01% | 0.04% | 0.02% |
| I_{\text{Purple}} (Lx) | 0.583 ± 0.17 | 0.28 ± 0.01 | 0.14 ± 0.01 | 0.09 ± 0.003 | 0.06 ± 0.002 |
| Error I_{\text{Purple}} | 28.65% | 3.89% | 3.74% | 3.02% | 3.70% |

**Figure 4.** (a) Effect of variations in distance on resistance on the color of light and (b) effect of distance variations on light intensity on the color of light.

Based on the measurement results it can be obtained that the closer the LDR sensor is to the light source (red, yellow, green, blue, and purple) the greater the intensity of the light. This explains that the distance of the light source is inversely proportional to the intensity of light. The amount of resistance will be
greater according to the magnitude of the distance between the LDR sensor and the light source. This explains that the distance of the light source is directly proportional to its resistance.

Figure 4 (a) shows the resistance values from the largest to the smallest are light yellow, green, blue, red, and purple. The most dominant resistance value is indicated by a yellow light. Figure 4 (b) shows that the intensity values from the biggest to the smallest are light blue, purple, green, yellow and red. The highest value of dominant intensity is indicated by blue light. Based on Figure 4 it can be concluded that the greater the intensity of light received, the smaller the resistance for all colors of light. This statement corresponds to the formula in equation 5. This shows that polychromatic light consists of several monochromatic lights including red, yellow, green, blue, and purple which have different intensity and endurance in each color of light. This difference in intensity and resistance is strongly influenced by differences in the wavelength of monochromatic light. This difference in the intensity and resistance of visible light can illustrate to students that polychromatic light consists of several monochromatic light with different wavelengths.

4. Conclusion

Based on the results of experiments that have been conducted, it can be concluded that (a) the distance of the light source is inversely proportional to the intensity of light, (b) the distance of the light source is directly proportional to the amount of resistance, (c) the intensity of light is inversely proportional to resistance, and (d) dominant value of large resistance is in the color of blue light and the dominant value of large light intensity is in the color of yellow light.

References

[1] Andhika N 2013 Deskripsi Konsepsi Siswa Sma Tentang Jurnal Pendidikan Fisika Tadulako 1 p.1
[2] Putri DH, Risdianto D and S 2017 Identifikasi Keterlaksanaan Praktikum Fisika SMA dan Pembekalan Keterampilan Abad 21 Komersialisasi Karya Inovatif sains dan pembelajaranannya untuk mendukung sustainable Development Goals (SDGs)
[3] R. Shinta dan K 2015 Pengaruh Pembelajaran Berbasis Praktikum Terhadap Pengembangan Sikap Ilmiah Siswa Kelas XI IPA SMA Islam Sudirman Ambarawa Unnes Physics Education Journal, 04 01, pp. 49-53
[4] I E 2017 Penggunaan multimedia laboratory virtual fisika untuk meningkatkan hasil belajar siswa kelas x sama n 4 lahat Jurnal iNovasi dan pembelajaran fisika 1, p. 1
[5] Malik A 2007 HOT Lab Based Practicum Guide For Pre Service Physics Teachers
[6] Fahmi 2007 Perancangan Algoritma Pengolahan Citra Mata Menjadi Citra Polar Iris Sebagai Bentuk Antara Sistem Biometrik Universitas Sumatra Utara
[7] Tsauqi AK, Hadijaya M, Manuel I, Hasan MV, Tsalsabila A, Chandra F, Yuliana T, Tarigan P and I 2016 Saklar Otomatis Berbasis Light Dependent Resistor (LDR) pada mikrokontroler Arduino in Prosiding Seminar Nasional Fisika (e-journal)SNF2016
[8] Caroline 2014 Pengaruh Cahaya yang Diterima Sensor Ldr (Light Dependant Resistor) pada Robot Pengikut Cahaya Mikrotiga, 01, 2355 - 0457, p. 25
[9] Tipler PA 1998 Fisika untuk Sains dan Teknik, Jakarta: Erlangga
[10] Frederick B and David LW 1994 Technical Physics 4th Ed, Inggris: John Wiley & Sons, Inc.
[11] Sears dan Francis W 1948 Principles of Physics III Optics Wesley: Addison-Wesley Press, Inc.
[12] Arina 2012 Analisis Intensitas Pencahayaan Pada Bidang Kerja Terhadap Berbagai Warna Ruangan, Universitas Hasanudin