EXPERIMENT
"LIGHT DEPENDENT RESISTORS AND DISTANCE MEASUREMENTS"

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January 23, 2022

Objectives

- The Light Dependent Resistor (LDR) component to be characterized.
- Distance measurement sensor mechanisms to be introduced.

Preliminary Work

1

Watch the videos (provided in Appendix).

2

Study "Notes on Multimeters".

3

Light Dependent Resistors (abrevieted as LDRs) are semiconductor based electronic component. An example of an LDR is shown in Figure 1.

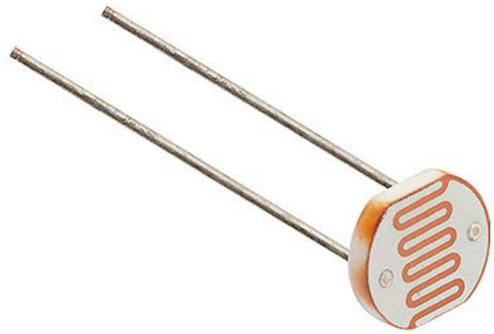

Figure 1: LDR picture

As easily can be inferred from its name, LDR has a variable resistance that depends on the illumination on its surface. So, its resistance is high in dark and low in light. Those resistance values are vastly dependent on the size and the model of the particular LDR. In this step, you are required to find an LDR from a manufacturer, and from the datasheet, provide the following pieces of information with necessary plots. You do not need to explain those data; it is enough to provide in the preliminary report with the appropriate format.

- Sensitive surface area.
- Resistance as a function of illumination (with plot).
- Spectral response (with plot).

4

The schematic symbol of LDR component is given in Figure 2.

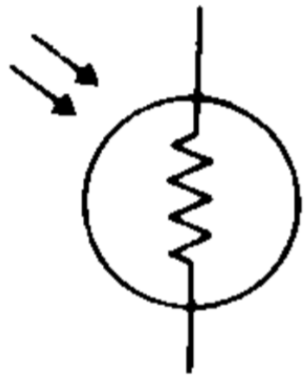

Figure 2: LDR schematic symbol

Using this information, briefly describe the functional behavior of the circuit given in Figure 3. (**Hint:** It would be nice to look back to comparator op-amp setup.)

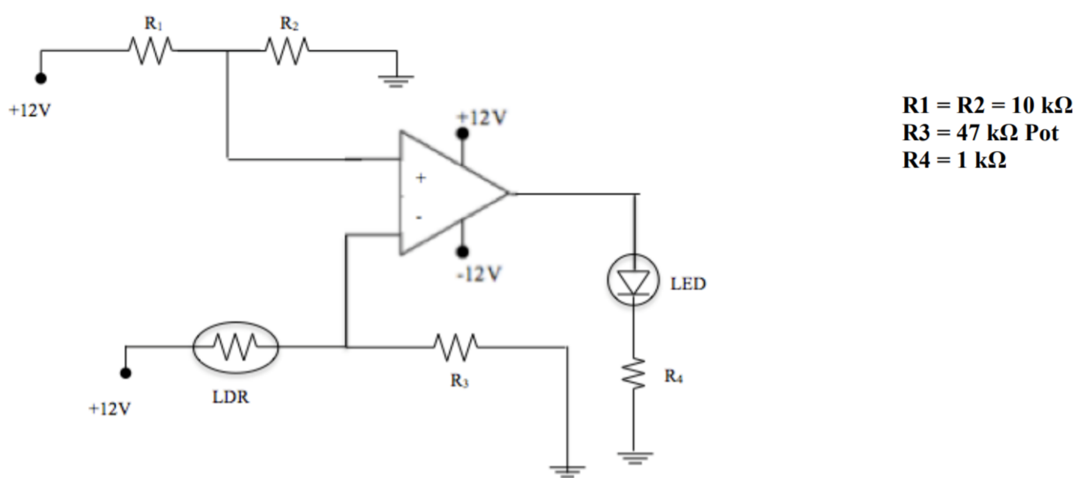

Figure 3: A circuit with LDR

5

For this step, you are required to do a little research about optical distance sensors. Independent from the experiment, this step is for you to gain an insight into optical distance sensors.

- Describe how triangulation measurement method works in $\sim$ 50-100 words with a credible source.
- Describe how time of flight (ToF) measurement method works in $\sim$ 50-100 words with a credible source.
- Describe how phase measurement method works in $\sim$ 50-100 words with a credible source.

Equipment List

- LDR (Light Dependent Resistor)
- Digital Multimeter.
- Ruler.
- A bright light source like a phone flashlight. (This is expected to be supplied from the student.)

Experimental Work

Important note - 1: You only need to show your work to the lab assistant for step 2. Important note - 2: In video demonstration mistakenly the term ”deviation percentage” used instead of ”deviation calculation using RMSE”.

Step 1

Describe the relation between illumination on a surface and the distance of the light source.

Step 2

In this step, you are required to measure the distance of a light source using the LDR component. Set up the configuration given in Figure 4 by connecting the probes to the digital multimeter. Adjust the multimeter so that it measures the resistance.

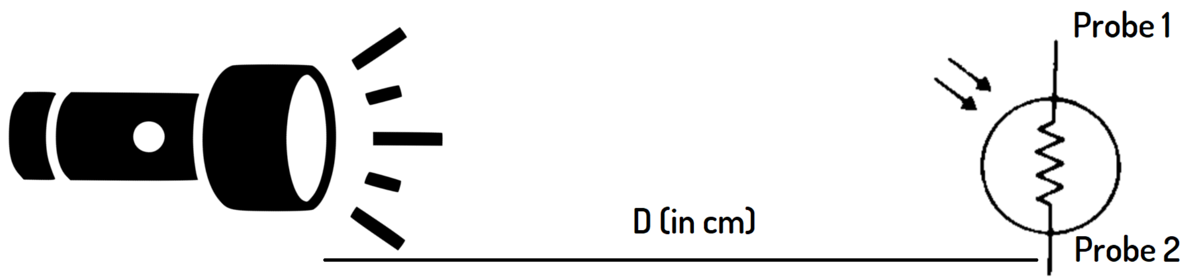

Figure 4: Simple distance measurement with LDR configuration

It is necessary to align the source with the surface of the LDR for better measurements. Also, pay attention not to cause the ambient light to fluctuate with shadows.

a)

Using a ruler, make the distance D as "15 centimeter". Then record the resistance value. The following equation relates distance with the resistance of an LDR prepared by us. X stands for distance in centimeters, and you need to find the α constant to shift the curve to the calibrated point by solving the equation with the resistance value you recorded. You may get help from a calculator.

$$resistance k\Omega = 10^{-5}x^3 - 0.0008971x^2 + 0.04738x + \alpha$$

Plot the resultant equation (in MATLAB). Convey a series of arbitrary distances' resistance measurements (at least 5) and record the values. Do not forget to obtain the real distance in centimeters with a ruler in order to compare with the results you found. Using the plot you have obtained, map the values you recorded to obtain the measured distance. Present values you found in tabular form in your report. Lastly, compare them with the actual ruler measurement and express the deviation by calculation the root mean squared error (see Appendix).

b)

As you practiced in preliminary work, LDR components have various manufacturers and different variations. So, only a base created using another LDR might not be as accurate as a map prepared for the particular LDR you use and the ambient light you have. Thus, you are required to measure the resistance with 15 different known (via ruler) distance values and record them. In the video demonstration this was 6 known values in order not to make video unnecessarily long. **Hint:** You can mark where the ruler ends and align the same ruler so the further distances can be measured. Provide data you have obtained in tabular form and plot (in MATLAB) resistance(in kOhm) vs distance (in cm). Fit an equation to this curve (see Appendix) and plot (in MATLAB). Compare the equation you obtained with the given equation in part a.

c)

Map the values you recorded in part a to the plot in part b and calculate the deviations with root mean squared error. Then compare the deviation values.

Step 3

Explain the limitations of the method used in Step 2 to measure distance of a light source ,and compare it with the methods you described in the Preliminary Work.

Appendix I

MATLAB has the feature of fitting curves to the data. You can fit a curve to a data like given in Figure 5.

Command Window

```
>> a=[1-e10 -0.0008971 0.04738 #alpha]; % coefficients of the cubic equation/alpha = your own alpha
fplot(@(x) a(4) +a(3)*x+ a(2)*(x .^2)+a(1)*(x.^3))%to plot the curve
fitted2 = fit(distances,resistances,'poly2') % to fit quadratic
plot(fitted2,distances,resistances)%to plot your data with the fit
fitted3 = fit(distances,resistances,'poly3') % to fit cubic
plot(fitted3,distances,resistances)%to plot your data with the fit
```

Figure 5: MATLAB fit a curve

Appendix II

Root mean squared error (RMSE) for this case can be computed as taking square root of the square of the difference between actual distance and the calculated distance.

$$RMSE = \sqrt{(actualdistance - measureddistance)^2}$$

For more information follow the link: https://www.sciencedirect.com/topics/engineering/root-mean-squared-error

Appendix III

The video link is: https://youtu.be/bJ5CMH2qEaE