STEMKIT 4SCHOOLS

PHOTORESISTOR AS A DUSK SENSOR

LESSON PLAN 2

Co-funded by the Erasmus+ Programme of the European Union

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1.1 General information

1.1.1 Short description

This lesson introduces the use of a simple circuit that with the use of a photoresistor can be set up in a way to power on and off bigger appliances through the relay. The use of the relay enables to use more power-hungry devices such as the outside lightning. For the purpose of this lesson, we will simulate the external circuit to be switched on and off with the use of a battery-powered LED.

1.1.2 Learning objectives

The main learning objectives of the lesson plan or educational activity are:

- Concept of photoresistors used as dusk sensors.
- Familiarising with hands on console building activities to enhance experimentation in STEM related subjects.
- Familiarizing with readings from GPIO pins.
- Understanding the use of a relay / circuit to switch on / off external power lines.
- Understanding positive voltage and power received from Raspberry Pi.
- Demonstrating sample coding in Scratch to track a simple circuit.
- Designing coding in Scratch.
- Using relay and other elements to experiment with the STEMKIT console.
- Performing basic assembly of the circuit on a breadboard.
- Experimenting with coding in Scratch.
- Autonomy in the reading, analysing and understating coding in Scratch environment.
- Autonomy in the creation of a simple circuit that can serve as a demonstration of a simple dusk sensor / relay to power on or off external appliances.
- Autonomy in introducing the concepts of coding in the classroom environment.

1.1.3 Links to curriculum

The domains, subdomains, subjects/topics that this lesson plan can be linked to are:

Science (Physics/Chemistry/Biology/Geology): voltage, power, circuits, photo resistance, light intensity, scientific method, investigation, experimentation, analysis and interpretation of results

Computer Science/Informatics: processing unit and peripherals, interfaces, programming language and main structures, coding

Technology: electronics, open-source hardware and software, sensors, digital signal, single board computers, console

1.1.4 Materials required

In order to carry out this lesson plan, the STEMKIT console with Raspberry Pi is needed along with the following elements:

- 1 x photoresistor
- 1 x 5V relay
- 1 x Female-to-Female jumper wires
- 5 x Male-to-Female jumper wires
- 1 x 1kΩ resistor (and some more resistors to try different values in the circuit)
- 1 x breadboard
- 1 x sample equipment to power (for example a battery pack with LED and resistor)

1.1.5 Duration

The duration of this lesson plan is estimated to be about 45-60 mins, i.e., one classroom hour.

1.2 Lesson plan

The lesson plan is divided in four phases, which are introduction, preparation, investigation and conclusion. As a follow-up there is also an optional exercise at the end.

1.2.1 Introduction

Photoresistors are often used as dusk sensors, for example to power battery-based garden lightning. For appliances that require more power, we are not able to deliver the required power directly from Raspberry Pi that we are going to use in this example. Instead, we have to use a so-called relay which is a circuit that can switch on and off external power lines by using a 5V-triggered switch.

Within this lesson Scratch will be used to demonstrate the sample code that can be used to track this simple circuit.

1.2.2 Preparation

The preparation phase requires to perform a basic assembly of the circuit on a breadboard and setting up the code in Scratch. Let us start with the breadboard first.

Place the photoresistor on a breadboard with its one leg sitting in the positive voltage rail. The other leg should be connected to the ground rail through a 1kΩ resistor. The sensing jumper wire that will read the value of a photoresistor should be connected to the leg that connects to the ground rail with the use of a resistor. The sensing pin should be connected with a jumper wire to GPIO pin number 19 on Raspberry Pi.

The relay requires to be connected with the use of three jumper wires. The positive voltage and ground can be taken from a breadboard. The triggering pin of the relay should be connected directly to Raspberry Pi on GPIO pin number 26. Connect any external circuit of your choice to the relay that will simulate the real appliance. An example can be a simple battery pack with an LED that will be turned on and off by Raspberry Pi.

Finally, the breadboard needs to receive the power from Raspberry Pi. For this purpose, you can use +5V rail from Raspberry Pi (pin 4) and GND (pin 6). Use jumper wires to power up the breadboard. The hardware setup is done, so now we can move to Scratch.

The code in Scratch is going to be very simple, so we will present it in one go and later describe it.

Image 1. Scratch environment with the code
Source: STEMKIT4Schools project

The code will start executing once the green flag is clicked. The first step is to set GPIO number 19 as an input pin that will provide the readings from the photoresistor. Then the code will enter in a *forever* loop that will read the value of the GPIO number 19 where the photoresistor is connected. If the reading is *high*, this means that we can set the GPIO number 26 with the relay to *low* and to *high* if the reading is *low*. In other words, we want to control the behaviour of the relay based on the amount of light that the photoresistor is receiving. In real-world example, that would correspond to day and night.

If you would like to slow the speed of how fast the loop is being executed, you can do so by adding a *wait* instruction just before the place where the loop ends.

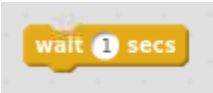

Image 2. Pause execution of the code for 1 second just before leaving the loop
Source: STEMKIT4Schools project

1.2.3 Investigation

It is time to test the code. Please be advised that it might not work at the first try! This is because the value of a resistor on the breadboard can require small adjustments due to external factors such as the ambient light there is available. On the other hand, if the relay does not turn off, you can use the torch to put some more light on the photoresistor to see if that helps.

Collection of data

Make sure that the circuit works properly. If the external circuit connected to the relay is off in ambient light, that is a good sign. Try to cover slightly the photoresistor to cut off some light reaching the sensor. The relay should turn the external circuit on, and back off if you restore the access of the light to the photoresistor.

Analysis of data

Based on the data observed, can you confirm that the circuit works in line with the design? Can you notice the trigger point where the amount of light is low enough to engage the relay and power the external circuit? How is the situation if you change the resistor on the breadboard to one with a different value?

Presentation of results

At this stage we are invited to share the results of our work with other groups. Has everything worked fine? Were there any difficulties in setting up the entire circuit? Were there any changes introduced to the code? If so, what kind of? Which resistor worked best in your case and how was it in different groups?

1.2.4 Conclusion

We have succeeded in creating a very simple circuit that can serve as a demonstration of a simple dusk sensor that uses a relay to power on and off external appliances. At this stage we can exchange ideas with other groups, what was done in which way and in what order and to clarify any questions that might appear.

1.2.5 Follow-up exercise (optional)

The follow-up exercise can include a multimeter, measuring the reading from the photoresistor. This way we will be able to tell at what voltage the Raspberry Pi considers the input to be in the *high* state. We can also experiment with different resistors to modify the cut-off point, or even include a potentiometer of an appropriate range to ensure more flexibility in our circuit.

1.3 References or Resources

References / resources related to this lesson plan:

- https://www.kth.se/social/files/54ef17dbf27654753f437c56/GL5537.pdf
- https://components101.com/sites/default/files/component_datasheet/5V%20Relay%20Datasheet.pdf