CamJam EduKit Sensors Worksheet Four

Project Light Sensor

Description In this project, you will learn how to detect how bright it is in your room.

Equipment Required

- Your Raspberry Pi
- 400 point breadboard
- Light Dependent Resistor (LDR) or Phototransistor Sensor (PT)
- 3 x M/M jumper wires
- 3 x M/F jumper wires
- 1uf capacitor

Notes

At the time of writing, the LightSensor function in GPIO Zero does not work on all Raspberry Pi computers and operating systems. You will therefore be using a different way of accessing the GPIO pins.

The Parts

Two of the parts you will use may not be familiar to you.

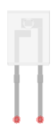
Light Sensor

Depending on when you bought your CamJam EduKit 2, it will contain either a Light Dependent Resistor (LDR) or a Phototransistor Light Sensor (PT).

Light Dependent Resistor (LDR)

A Light Dependent Resistor – or LDR – is a device whose resistance changes depending on how much light is falling on its surface.

Phototransistor Sensor (PT)



A phototransistor light sensor – or PT – is a sensor that detects ambient light. When light enters the chip on top, it creates a flow of current from the long to the short pin. When there's no light there's almost no current going across the pins at all.

They do not measure the light accurately, but just measure the change in light falling on the sensor. For example, it could be used to see whether it is light or dark in a room.

Capacitor

A capacitor is an electronic device that stores electric energy. It is similar to a battery, but is smaller, lightweight and charges up much quicker.

Capacitors are usually made with two metal plates that are on top of each other and near each other, but that do not actually touch. When powered, they allow energy to be stored inside an electrical field. Because the plates need a lot of area to store even a small amount of charge, the plates are usually rolled up into some other shape, such as a cylinder.

The capacity of a capacitor is measured in Farads. Because a Farad is a large number, capacitors are often labelled in micro (µ) Farads, or µF.

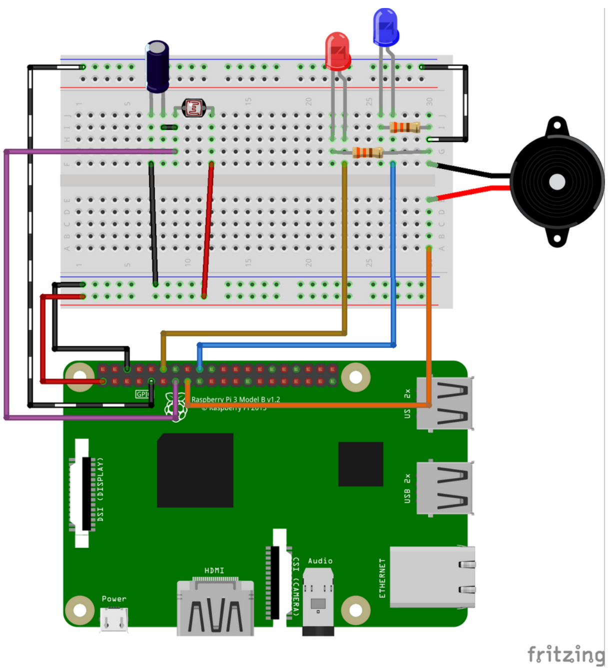
As with batteries, there is a negative and a positive leg. The negative leg is the one that is usually marked – in this case with a white bar.

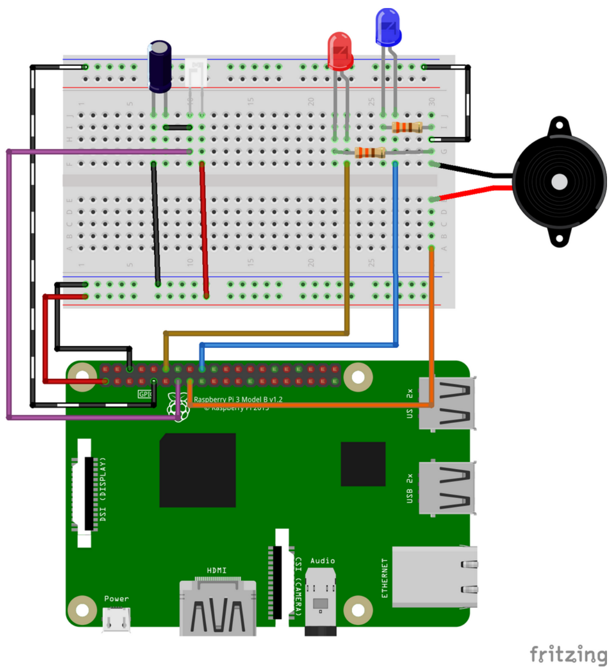
In this circuit it is being used as a way to convert an analogue signal (the amount of energy the LDR/PT lets flow into the circuit) by timing how long it takes to charge the capacitor to a level which will be detected by the GPIO pin.

Building the Circuit

Turn the Raspberry Pi off before building this circuit.

Build the circuit as shown in either of the diagrams below, leaving the buzzer and LED circuit from previous worksheets in place. Use the diagram on the left if you have the LDR in your EduKit, or the diagram on the right if you have the PT.





The left leg of the capacitor in the diagram is the negative leg, marked by the white bar. The negative leg of the capacitor is connected to 'ground' on the Pi, and the positive leg is connected to the 3.3v of the Pi via the LDR/PT.

It does not matter which way around you put the LDR, but if you are using the PT you will notice that one leg is shorter than the other. This is the 'positive', or 'Collector' leg. It is also marked by a flat spot in the plastic. This leg is the one on the right in the circuit diagram, and is connected to 3.3v.

Note the wire between the positive leg of the capacitor and the LDR/PT. This is a jumper with a pin at each end.

Code

Open the Thonny editor and type in the following code:

```
# CamJam EduKit 2 - Sensors
# Worksheet 4 - Light

# Import Libraries
import time
from RPi import GPIO

# Set up the GPIO Mode
GPIO.setmode(GPIO.BCM)
GPIO.setwarnings(False)

# The Light Sensor pin number
PIN_LIGHT = 27

def read_ldr():
    ldrcount = 0 # Sets the count to 0
    GPIO.setup(PIN_LIGHT, GPIO.OUT)
    GPIO.output(PIN_LIGHT, GPIO.LOW)
    time.sleep(0.1) # Drains all charge from the capacitor

    GPIO.setup(PIN_LIGHT, GPIO.IN) # Sets the pin to be input

    # While the input pin reads 'off' or Low, count
    while GPIO.input(PIN_LIGHT) == GPIO.LOW:
        ldrcount += 1 # Add one to the counter

    return ldrcount

while True:
    print(read_ldr())
    time.sleep(1) # Wait for a second
```

Save the file as `4-light.py`.

Running the Code

Select the Run Module menu option, under the Run menu item. Alternatively, you can just press the F5 key.

Change the light intensity by covering up the light sensor, or shining a light at the sensor. Watch the readings change.

How the Circuit Works

How does the circuit measure how much light is falling on the light sensor?

The measurement pin (27) is set to be an output pin and is set to 'low', or 0 volts, for a short time. This empties the capacitor of charge.

The measurement pin will then be set as an input pin, which will then detect the voltage across the capacitor. Because the Raspberry Pi GPIO input is digital only, it only knows when the input is either 'off' (0v) or on

(3.3v). The Pi actually considers any voltage on an input pin that is between 0 and about 1.4v to be 'off' (or 0), and anything between 1.4v and 3.3v to be 'on'.

As the capacitor charges up, the Pi is able to time how long it takes for the input pin to change from 'off' to 'on'. The brighter the light, the more energy the light sensor allows to flow in the circuit, and therefore the quicker the capacitor charges.

LDRs/PTs are not accurate pieces of electronics. Each one will differ. Therefore, they cannot be used to accurately measure how bright the light falling on them is. In addition, if other programs are running on the Pi, the counter loop may run a little slower.

Challenge

Extend the code above to turn on the LEDs under chosen conditions. As mentioned above, each LDR measures light brightness differently, therefore you are free to choose at what light level you turn the LEDs on and off.

By taking some code from Worksheet 2 (LEDs and Buzzer), add 'if' statements to:

- Turn on the red LED when the light falling on the LDR is bright, and turn it off when it is not as bright.
- Turn on the blue LED when it is dull, and off when it gets brighter.
- If the light gets really bright, sound the buzzer.