2023

2. Light-tracking servo motor

Project number: **2021-1-FR01-KA220-SCH-000031617**

Co-funded by
the European Union

SCRAPY Partnership

31/05/2023

Table of Contents

Experiment 2: Light-tracking servo motor

Short Description

To create a simple device that tracks a light source using a servo motor controlled by a potentiometer and an LDR photoresistor.

Extended Description

This project is a simple yet interesting DIY project that can be accomplished using a Raspberry Pi Pico, an SG90 servo motor, a rotary potentiometer, and an LDR photoresistor. The main objective of this project is to control the position of an SG90 servo motor using the rotary potentiometer and the LDR photoresistor.

The rotary potentiometer is used to control the position of the servo motor. When the potentiometer is turned clockwise or counterclockwise, the servo motor will rotate in either direction depending on the position of the potentiometer. The LDR photoresistor, on the other hand, is used to control the speed of the servo motor. When the photoresistor is exposed to light, the servo motor will rotate slowly, and when it's covered, the servo motor will rotate quickly.

The project can be built using a breadboard and jumper wires to connect the components. The SG90 servo motor is connected to one of the PWM pins on the Raspberry Pi Pico, and the rotary potentiometer and LDR photoresistor are connected to the analog input pins. The code for the project is written in MicroPython, and it uses the PWM and ADC libraries to control the servo motor and read the analog values from the potentiometer and photoresistor.

This project is an excellent way to learn about analog input and output, servo motor control, and using sensors to control the behavior of a device. Additionally, the project can be extended further by adding more sensors or other components to create more complex behaviors for the servo motor.

The basics of how a servo motor works

A servo motor is a type of motor that is commonly used in applications where precise control of angular or linear position is required. It consists of a small DC motor, a gear train, and a control circuit that regulates the position of the motor shaft based on incoming signals. The control circuit interprets input signals, usually in the form of PWM (Pulse Width Modulation) signals and adjusts the position of the motor shaft accordingly.

To control the movement of a servo motor, the user needs to provide PWM signals with a certain frequency and duty cycle. The frequency determines how often the PWM signal is repeated, while the duty cycle determines the width of the pulse. Typically, the frequency of the PWM signal is 50 Hz, and the duty cycle ranges from 5% to 10%. A duty cycle of

5% corresponds to a servo position of 0 degrees, while a duty cycle of 10% corresponds to a servo position of 180 degrees.

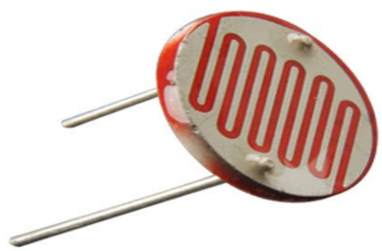
To interface a servo motor with Raspberry Pi Pico, the user needs to connect the signal pin of the servo to a GPIO pin of the Pico. They can then use the MicroPython code to generate the appropriate PWM signals to control the position of the servo motor. The user can also use a rotary potentiometer and an LDR photoresistor to create a light-tracking servo motor system, where the position of the servo is adjusted based on the amount of light detected by the LDR. This project can be a great way to learn about the basics of electronics and programming while creating a fun and interactive device.

Learning about rotary potentiometers (Linear B1k Ohm)

A rotary potentiometer is an electrical component that consists of a resistive element and a sliding contact. It is used to vary the resistance in a circuit by rotating a knob or dial. The resistance value changes according to the position of the contact on the resistive element. Linear B1k Ohm is a specific type of rotary potentiometer that has a linear taper, meaning the resistance changes at a constant rate as the knob is turned. This type of potentiometer is commonly used in audio applications, such as volume control for amplifiers, or in industrial settings to control the speed of motors. By using a rotary potentiometer in a project, you can provide a user interface that allows for precise and continuous adjustment of a parameter. Interfacing a rotary potentiometer with a Raspberry Pi Pico can be achieved using an analog input pin and the ADC (analog-to-digital converter) feature of the microcontroller.

Understanding the concept of photoresistors

A photoresistor, also known as a light-dependent resistor (LDR), is a passive component that exhibits a change in resistance in response to the intensity of light. When light falls on the photoresistor, its resistance decreases, and when it is in the dark, its resistance increases. This property makes photoresistors ideal for use in light-sensing applications, such as in cameras, automatic lighting systems, and solar panels.



The resistance of a photoresistor is typically measured in ohms and can range from a few hundred ohms to several megaohms, depending on the material used. The resistance-versus-light relationship of a photoresistor is not linear, but it follows a logarithmic curve. Therefore, photoresistors are typically used in circuits with a fixed resistance to create a voltage divider, which can be used to measure the light intensity.

In electronic projects, photoresistors can be used to control the brightness of LEDs, activate alarms or sirens, and adjust the speed of motors. They are easy to use and can be easily integrated into circuits using simple techniques such as voltage dividers and analog-to-digital converters.

Objectives:

Through this activity, the user will experiment with Raspberry Pi Pico and various electronic components including the SG90 servo motor, rotary potentiometer, and LDR photoresistor. The user will acquire knowledge on the following topics:

1. Understanding the basics of how a servo motor works, how to control its movement, and how to interface it with Raspberry Pi Pico.
2. Learning about rotary potentiometers, how they work, and how they can be used to control the servo motor's movement.
3. Understanding the concept of photoresistors and how to use them to detect changes in light levels, and how to incorporate this functionality to control the servo motor's movement.

Materials to be used:

- 1 x Raspberry Pi Pico
- 1 x Pico breadboard kit
- 1 x Full-size breadboard
- 1 x SG90 servo motor
- 1 x Rotary Potentiometer Linear B1k Ohm
- 1 x LDR photoresistor
- Jumper wires

Steps to be followed:

The main steps to realize the Light-Tracking Servo Motor:

Connect the SG90 servo motor:

1. Connect the brown wire (ground) of the servo motor to a GND pin on the Raspberry Pi Pico.
2. Connect the red wire (power) of the servo motor to the 3V3 pin on the Raspberry Pi Pico.
3. Connect the orange or yellow wire (signal) of the servo motor to GPIO pin 0 (GP0) on the Raspberry Pi Pico.

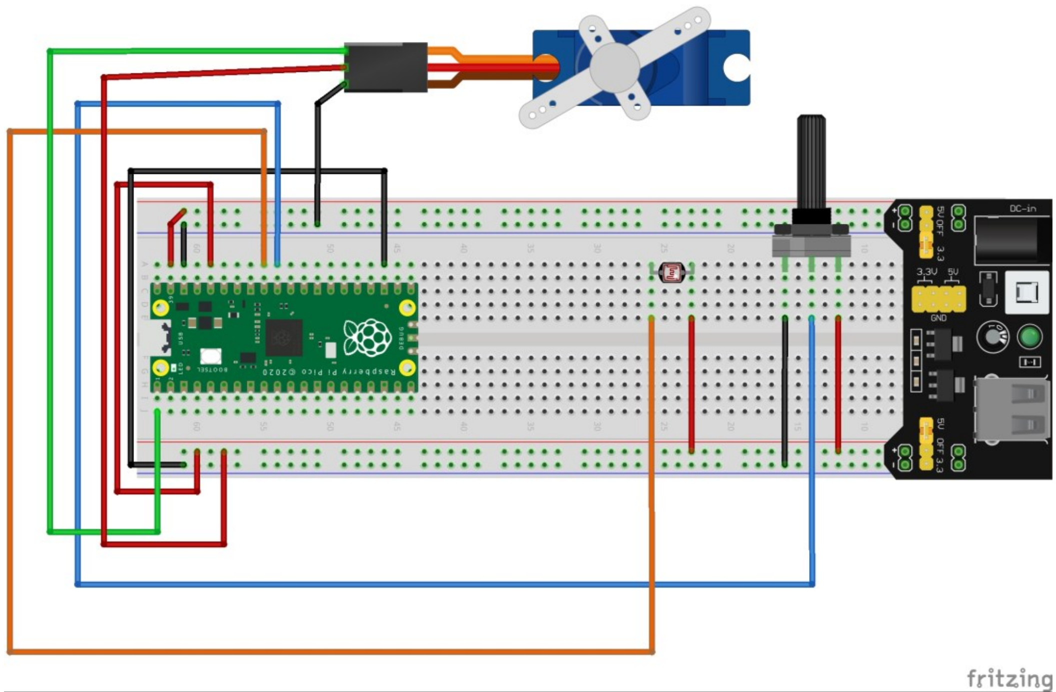
Connect the linear potentiometer:

1. Connect one leg of the potentiometer to a 3V3 pin on the Raspberry Pi Pico.
2. Connect the middle leg of the potentiometer to an analog input pin, such as GPIO pin 26 (GP26), on the Raspberry Pi Pico.
3. Connect the other leg of the potentiometer to a GND pin on the Raspberry Pi Pico.

Connect the LDR photoresistor:

1. Connect one leg of the LDR to a 3V3 pin on the Raspberry Pi Pico.
2. Connect the other leg of the LDR to an analog input pin, such as GPIO pin 27 (GP27), on the Raspberry Pi Pico.
3. Remember to double-check your connections and ensure that they are secure and properly seated.

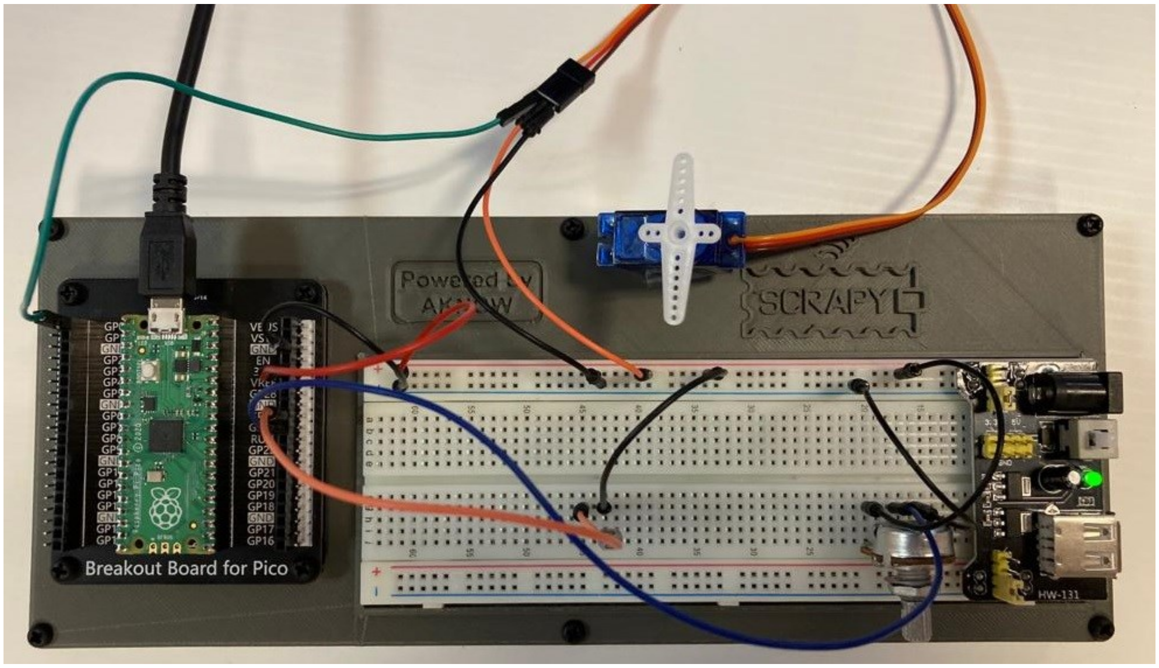
Wiring diagram

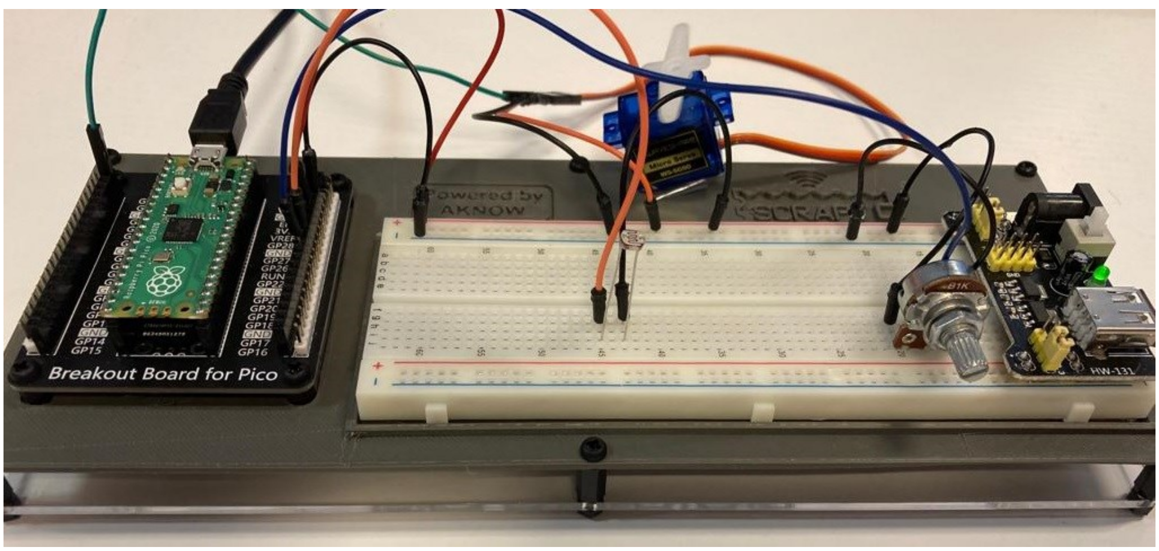


Code

```
import machine
import utime

servo_pin = machine.Pin(0)
servo = machine.PWM(servo_pin)

potentiometer_pin = machine.ADC(26)
ldr_pin = machine.ADC(27)

while True:
    potentiometer_value = potentiometer_pin.read_u16()
    ldr_value = ldr_pin.read_u16()

    # Map the potentiometer value (0-65535) to the servo angle (0-180)
    angle = int(potentiometer_value / 65535 * 180)

    # Map the LDR value (0-65535) to the servo speed (10-100)
    speed = int(ldr_value / 65535 * 90) + 10

    servo.freq(50)
    servo.duty_u16(int((angle / 180) * 65025))
    utime.sleep_ms(speed)
```

Example pictures





Conclusion

In conclusion, this project demonstrated how to use a Raspberry Pi Pico, a rotary potentiometer, an LDR photoresistor, and an SG90 servo motor to build a light-tracking servo motor. The project covered the following:

- How to connect the components and wiring diagram.

- How to write a Python program to read the values from the LDR and the potentiometer and control the SG90 servo motor.
- How to use a PID algorithm to improve the servo motor's performance in tracking the light source.
- How to troubleshoot common issues that may arise during the project.

Overall, this project provides a hands-on learning experience that can help students to understand the basics of microcontroller programming, servo motor control, and sensor interfacing. Students can further explore this project by:

- Using different sensors such as ultrasonic sensors, infrared sensors, or color sensors to detect and track objects.
- Experimenting with different PID algorithm settings to improve tracking accuracy.
- Implementing advanced features such as web server control, remote control, or voice control using additional sensors or modules.