Nunchuck Controlled Laser Cat Toy

Created by Melissa LeBlanc-Williams

https://learn.adafruit.com/nunchuck-controlled-laser-cat-toy

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Overview

With CircuitPython, you can read the information from a Nunchuck controller, control servos, and turn pins on and off, so why not combine those and control a laser. Sure, you could always get a regular old laser pointer and just use your hand to move it, but that lacks the fun factor.

This project uses the ESP32-S2 Feather and one of the reasons for choosing it was due to the built-in STEMMA QT port, but another great reason is because of the WiFi support. This means you could expand the project with another ESP32-S2 Feather and control it over WiFi. Try doing that with a laser pointer!

Parts

Mini Pan-Tilt Kit - Assembled with Micro Servos
This fully-assembled pan-tilt kit is the perfect way to give your project full range motion with two micro servos. The pan-tilt can rotate roughly 180° from side-to-side and...
8-Channel PWM or Servo FeatherWing
Add-on For All Feather Boards
A Feather board without ambition is a Feather board without FeatherWings! This is the 8-Channel PWM or Servo FeatherWing, you can add 8 x 12-bit PWM outputs to...
https://www.adafruit.com/product/2928

Adafruit ESP32-S2 Feather - 2 MB PSRAM and STEMMA QT / Qwiic
What's Feather-shaped and has an ESP32-S2 WiFi module? What has a STEMMA QT connector for I2C devices? What has your favorite Espressif WiFi microcontroller and lots of Flash and...
https://www.adafruit.com/product/5000

Adafruit Wii Nunchuck Breakout Adapter
Dig out that old Wii controller and use it as a sleek controller for your next robot if you like. The Adafruit Adafruit Wii Nunchuck Breakout Adapter fits snugly into the Wii connector...
https://www.adafruit.com/product/4836

FeatherWing Doubler - Prototyping Add-on For All Feather Boards
This is the FeatherWing Doubler - a prototyping add-on and more for all Feather boards. This is similar to our
https://www.adafruit.com/product/2890
<table>
<thead>
<tr>
<th>Item Description</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x <strong>M2.5 Nylon Standoff Set</strong></td>
<td>Black Nylon Machine Screw and Stand-off Set – M2.5 Thread</td>
</tr>
<tr>
<td></td>
<td><a href="https://www.adafruit.com/product/3299">https://www.adafruit.com/product/3299</a></td>
</tr>
<tr>
<td>1 x <strong>Servo Extension Cable</strong></td>
<td>Servo Extension Cable - 30cm / 12&quot; long</td>
</tr>
<tr>
<td>1 x <strong>STEMMA QT Cable</strong></td>
<td>STEmma QT / Qwiic JST SH 4-pin Cable - 100mm Long</td>
</tr>
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<td><a href="https://www.adafruit.com/product/4210">https://www.adafruit.com/product/4210</a></td>
</tr>
<tr>
<td>1 x <strong>5V Power Supply</strong></td>
<td>5V 2A (2000mA) switching power supply - UL Listed</td>
</tr>
<tr>
<td>1 x <strong>2.1mm Barrel Jack w/ Terminals</strong></td>
<td>Female DC Power adapter - 2.1mm jack to screw terminal block</td>
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<td><a href="https://www.adafruit.com/product/368">https://www.adafruit.com/product/368</a></td>
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<tr>
<td>1 x <strong>Male/Male Jumper Wires</strong></td>
<td>Premium Male/Male Jumper Wires - 20 x 3&quot; (75mm)</td>
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<tr>
<td>1 x <strong>2.1mm Barrel Jack to USB-C Adapter</strong></td>
<td>2.1mm 5VDC Barrel Jack to USB C Adapter</td>
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<tr>
<td>1 x <strong>2.1mm Barrel Jack Splitter</strong></td>
<td>TTL Laser Diode - 5mW 650nm Red - 50KHz Max</td>
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<td></td>
<td>You have some frickin' sharks at your lair, and you're thinking &quot;it would be really great if I could attach some lasers to them&quot; and then you see these little laser... <a href="https://www.adafruit.com/product/1056">https://www.adafruit.com/product/1056</a></td>
</tr>
<tr>
<td>1 x <strong>Wii controller (Nunchuck / Wiichuck)</strong></td>
<td>This is a generic Wii Nunchuck controller, we haven't tried it with a Wii but it does work great with the Video Game shield, and all the microcontroller code we tried. May come in... <a href="https://www.adafruit.com/product/342">https://www.adafruit.com/product/342</a></td>
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</tbody>
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3D Printing

CAD Parts List

STL files for 3D printing are oriented to print "as-is" on FDM style machines. The laser holder is designed to 3D print without any support material, but supports are recommended on the project base. Original design source may be downloaded using the links below:

- Project Base
- Laser Holder

Download STLs.zip
https://adafruit.it/XcX

Download CAD Source
https://adafruit.it/XcY

Download 3MF.zip
https://adafruit.it/XcZ

Build Volume
The parts require a 3D printer with a minimum build volume.

75mm (X) x 95mm (Y) x 30mm (Z)
Slicing the Base
For best results, supports are suggested with printing the base because of the overhangs.

Slicing the Laser Holder
This can be printed vertically without any supports or add a brim if you are having trouble with it not sticking to the bed.

Circuit Diagram
This circuit takes advantage of the PWM FeatherWing to not only move the servos, but to also dim the laser. In order to connect the laser to the PWM FeatherWing easily, you will need to solder a 3-pin servo connector to the laser module.

The easiest way to do that is to get a [Servo Extension cable](https://adafruit.it/CnV), cut the cable in half, solder the end that plugs into the PWM FeatherWing onto the laser, and insulate the solder joints with some [heat shrink tubing](https://adafruit.it/dIK) or [tape](https://adafruit.it/yex).

After that, everything can be connected by plugging it in or using screw terminals.
For the PWM FeatherWing, use the following connections:

- Plug the servo that controls the horizontal motion PWM channel 0
- Plug the servo that controls the vertical motion PWM channel 1
- Plug the laser into PWM channel 2

The Nunchuck Adapter should be connected directly to the Feather ESP32-S2’s STEMMA QT port.

A 5V Power adapter should be connected to the 2.1mm terminal adapter and is used to power the servos and the laser.

CircuitPython

CircuitPython (https://adafruit.it/tB7) is a derivative of MicroPython (https://adafruit.it/BeZ) designed to simplify experimentation and education on low-cost microcontrollers. It makes it easier than ever to get prototyping by requiring no upfront desktop software downloads. Simply copy and edit files on the CIRCUITPY drive to iterate.

CircuitPython Quickstart

Follow this step-by-step to quickly get CircuitPython running on your board.
Download the latest version of CircuitPython for this board via circuitpython.org

https://adafruit.it/WZd

Click the link above to download the latest CircuitPython UF2 file.

Save it wherever is convenient for you.

Plug your board into your computer, using a known-good data-sync cable, directly, or via an adapter if needed.

Click the reset button once (highlighted in red above), and then click it again when you see the RGB status LED(s) (highlighted in green above) turn purple (approximately half a second later). Sometimes it helps to think of it as a "slow double-click" of the reset button.

Once successful, you will see the RGB status LED(s) turn green (highlighted in green above). If you see red, try another port, or if you’re using an adapter or hub, try without the hub, or different adapter or hub.

If double-clicking doesn’t work the first time, try again. Sometimes it can take a few tries to get the rhythm right!
A lot of people end up using charge-only USB cables and it is very frustrating! Make sure you have a USB cable you know is good for data sync.

If after several tries, and verifying your USB cable is data-ready, you still cannot get to the bootloader, it is possible that the bootloader is missing or damaged. Check out the Install UF2 Bootloader page for details on resolving this issue.

You will see a new disk drive appear called FTHRS2BOOT.

Drag the adafruit_circuitpython_etc.uf2 file to FTHRS2BOOT.

The BOOT drive will disappear and a new disk drive called CIRCUITPY will appear.

That's it!
Coding the Nunchuck Laser

Once you have CircuitPython installed on your device, you can access the code and necessary libraries by downloading the Project Bundle.

To do this, click on the Download Project Bundle button in the window below. It will download as a zipped folder.

```python
# SPDX-FileCopyrightText: 2021 ladyada for Adafruit Industries
# SPDX-License-Identifier: MIT

import time
import board
import digitalio
import simpleio
import adafruit_nunchuk
import adafruit_pca9685
import adafruit_motor.servo

PITCH_OFFSET = 45  # The offset for the pitch
PITCH_RANGE = 90   # The range the servo can rotate up and down in degrees
YAW_RANGE = 90     # The range the servo can rotate side to side in degrees
INVERT_PITCH = False

# STEMMA QT 3V needs to be activated
i2c_power = digitalio.DigitalInOut(board.I2C_POWER)
i2c_power.switch_to_output(value=False)
i2c = board.I2C()
wing = adafruit_pca9685.PCA9685(i2c)
wing.frequency = 50
servo_yaw = adafruit_motor.servo.Servo(wing.channels[0])
servo_pitch = adafruit_motor.servo.Servo(wing.channels[1])
laser = wing.channels[2]
nc = adafruit_nunchuk.Nunchuk(i2c)

# Pre-calculate the angles
min_yaw_angle = YAW_RANGE / 2
max_yaw_angle = 180 - (YAW_RANGE / 2)
min_pitch_angle = PITCH_OFFSET + (PITCH_RANGE / 2)
max_pitch_angle = PITCH_OFFSET + 180 - (PITCH_RANGE / 2)

pitch_inputs = [0, 255]
if INVERT_PITCH:  # Swap the Min and Max Values
    pitch_inputs[0], pitch_inputs[1] = pitch_inputs[1], pitch_inputs[0]

brightness = 0xFFFF  # Initial brightness value

while True:
    x, y = nc.joystick
    servo_yaw.angle = simpleio.map_range(255 - x, 0, 255, min_yaw_angle, max_yaw_angle)
    servo_pitch.angle = simpleio.map_range(0, pitch_inputs[0], pitch_inputs[1], min_pitch_angle, max_pitch_angle
    ax = nc.acceleration[0]

    if nc.buttons.Z:  # Z-Button sets laser PWM to current brightness
        laser.duty_cycle = brightness
    elif nc.buttons.C:  # C-Button sets laser brightness to value of the nunchuck roll position
```

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brightness = \texttt{int(simpleio.map\_range(ax, 250, 750, 0, 0xFFFF))}
laser.duty\_cycle = brightness

\textbf{else:} \hspace{1em} # No button pressed sets laser to off
laser.duty\_cycle = \texttt{0}
time.sleep(0.01)

Upload the Code and Libraries to the ESP32-S2 Feather

After downloading the Project Bundle, plug your ESP32-S2 Feather into the computer USB port. You should see a new flash drive appear in the computer's File Explorer or Finder (depending on your operating system) called CIRCUITPY. Unzip the folder and copy the following items to the ESP32-S2 Feather's CIRCUITPY drive.

- lib folder
- code.py

Your ESP32-S2 Feather CIRCUITPY drive should look like this after copying the lib folder and code.py file.

![CIRCUITPY drive content](image)

Settings

There's a few variables you can adjust in code.py which will be covered in this section.

\textbf{PITCH\_OFFSET} is the offset of the pitch range from the horizontal axis. Increasing this will tilt the servo more vertical and decreasing will make it more horizontal.
**PITCH RANGE** is the full range of motion that the vertically tilting servo will move. If you want to increase the range of motion, you can increase this value and if you want to decrease it to make the laser easier to control, you can decrease it.

**YAW RANGE** is the full range of motion that the horizontally panning servo will move. This should be close to the **PITCH RANGE** setting so the pointer moves in a circle instead of an ellipse.

**INVERT_PITCH** will invert the direction that vertically moving the stick on the nunchuck causes the laser to tilt. This is useful if you mount the laser so it is pointing down.

**Usage**

The usage is pretty straightforward, but this section will go over it so you can understand everything it can do.

Moving the joystick on the nunchuck causes the laser to move where it is pointing.

To cause the laser to show, just hold the Z-Button on the nunchuck and let go to turn it off. It is off by default for safety reasons. When the laser appears, it will be at the last brightness setting.

To adjust the brightness, hold the c-button down and twist your wrist. The laser will show while doing this so you can see how bright it is. Currently the brightness setting isn’t saved, so resetting the feather will put it back at full brightness.

**Ideas for Extending the Project**

This project has a lot of possibilities, but here are a few ideas to take it to the next level.

You could build a second one and then have the two communicate over WiFi so it could remotely be controlled.

You could hook a [PowerBoost 1000C](https://adafru.it/f9N) up so you could make the project battery powered.

You could edit the code to store the last brightness value by using the nvm module ([https://adafru.it/Xdt](https://adafru.it/Xdt)).
It might be a bit too slow, but perhaps you could try and use the pan and tilt mechanism as a XY driver to draw patterns with the laser.

Store a series of movements and then have it play those back in a loop so your pet can play for hours unattended.

Assembly

Be sure to remove any supports from the 3D printing first.

You will need 4 x M2.5 6mm long M-F Hex Standoffs, 4 x M2.5 10mm long M-F Hex Standoffs, and 8 x M2.5 Hex Nuts.
Place the 10mm long standoffs in the holes of the smaller rectangle and the 6mm long standoffs in the larger rectangle. Use the nuts on the underside to secure them in place.

Next you will need 8 x 4mm long M2.5 screws, the wii nunchuck adapter, and an assembled FeatherWing Doubler.
Secure the doubler in place in such a way that the USB port of the feather is towards the outside edge of the base.

For the Nunchuck adapter, the connector should face away from the doubler and can otherwise be secured with the STEMMA QT ports facing either up or down.

Place the Feather and PWM FeatherWing into the doubler with the Feather in between the PWM Wing and the Nunchuck Adapter.

Slide the Pan and Tilt Assembly into the slot. It can fit in either way, but you will need to update the firmware to invert the pitch if you have it pointing downwards.

Plug the panning servo into PWM channel 0 and the tilting servo into PWM channel 1.
Next take the laser module with the connector soldered on and the laser holder. If the laser is a bit tight, you can apply some pressure to open the gap a bit.

Insert the laser holder and laser into the top of the pan and tilt assembly and the two clips should hold it in place.

Plug the laser into channel 2 on the PWM FeatherWing.
Use a screwdriver to connect the 2.1mm barrel connector adapter to the PWM FeatherWing. Make sure the polarity of the wires is correct!

Connect the STEMMA QT cable between the Feather and the Nunchuck adapter.

Connect the Nunchuck to the adapter board with the notch facing the direction indicated on your board.
In order to power the Feather in addition to the motors and servos with a single power supply so that you don't need to be plugged into a computer, you can use a 2.1mm barrel jack splitter along with a 2.1mm barrel jack to USB-C adapter.

That's it! Everything is assembled.