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Overview

CPX Drone Claw

In this project we’ll show you how to build a DIY Drone Claw.

We designed and 3D Printed a claw attachment for the DJI Mavic Pro. This doesn’t obstruct the vision sensors so we can fly safely with obstacle avoidance.

This build can be used for educational projects like the classic egg drop or even delivering small objects.

You can also use this to pick up the trash, carry objects to research sites or even camping grounds. There’s a lot of tasks that you can do with a claw attachment.
Light Pipes

The on board light sensor on the Circuit Playground Express activates the claw with a light pipe connected to the LEDs on the drone!

3D Printed Light Leak Proof Case

The Circuit Playground Express mounts inside our 3d printed enclosure to block out all light, so you can use it on any project that uses the light sensor!

The Claw

The claw is actuated using a micro servo and remotely triggered using the remote controller.

We’re using the Light Sensor on the Adafruit Circuit Playground to detect when the LEDs are on.

Trigger with Light Pipes

A light pipe tunnels the LEDs on the Drone into the 3D printed enclosure.

So the servo opens and closes when the LEDs are remotely turned on and off.

Payload Weight

The Mavic Pro has a maximum payload capacity of about 2 lbs or 990 grams.

This gives us enough lift for use in situations such as research, where you would need to move around small specimens or even something like beach clean up!
Parts

Listed below are all the components and hardware screws you'll need to build your own drone claw!

1 x 130mm 02.0/1.0 Heat Shrink
https://www.adafruit.com/product/344
130mm 02.0/1.0 Heat Shrink

1 x 1.75mm Taulman T-Glase Clear Filament (130mm long)
http://taulman3d.com/buy-direct.html
1.75mm Taulman T-Glase Clear Filament
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**Circuit Playground Express**

Circuit Playground Express is the next step towards a perfect introduction to electronics and programming. We've taken the original Circuit Playground Classic and...

https://www.adafruit.com/product/3333
Micro Servo - MG90D High Torque Metal Gear
Add more power to your robot with this metal-gear MG90D servo. The tiny little servo can rotate approximately 90 degrees (45 in each direction) and works just like the standard...
https://www.adafruit.com/product/1143

Premium Female/Male 'Extension' Jumper Wires - 40 x 6" (150mm)
Handy for making wire harnesses or jumpering between headers on PCB's. These premium jumper wires are 6" (150mm) long and come in a 'strip' of 40 (4 pieces of each of... https://www.adafruit.com/product/826

PLA Filament for 3D Printers - 2.85mm Diameter - Black - 1.0Kg
"Black is modest and arrogant at the same time. Black is lazy and easy – but mysterious. But above all black says this: 'I don’t bother you –...
https://www.adafruit.com/product/3751

Lithium Ion Polymer Battery - 3.7v 500mAh
Lithium-ion polymer (also known as 'lipo' or 'lipoly') batteries are thin, light, and powerful. The output ranges from 4.2V when completely charged to 3.7V. This...
https://www.adafruit.com/product/1578
Circuit Diagram

Take a moment to review the components in the circuit diagram. This illustration is meant for referencing wired connections - The length of wire, position and size of components are not exact.

Connections:

Servo

- The Middle RED wire connect to VOUT
- Yellow connects to A1
- Brown connects to GND

The 500 mAh battery connects to the JST port on the Circuit Playground Express
Wire length

- CPX: 110mm
- PETT: 130 mm (1.75mm)

Screws:

- CPX: Three M3x6mm + nuts

Case:

- Two M2x5mm

Cover:

- Four M3x12mm

Claw left:

- One M3x6mm + thread insert

Claw right:

- One M2.5x5mm

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**Code**

The Makecode activates the claw when the Circuit Playground Express detects light. Use the embedded code to run in a browser below:

Open this project code in MakeCode
WebUSB

Makecode can also pair with your Circuit Playground Express through the Google Chrome web browser by visiting this guide page.

Visit the project here: https://makecode.com/_WgrDeHKLf0RH

This means code edit will upload directly to the Circuit Playground Express without the need to drag and drop file onto it!

Follow the instruction to set up your board and you'll be able to quickly send code to Circuit Playground Express!

Mapping LEDs to Controls

We can easily map the "Head LEDs" to one of the customization buttons. These two buttons are located on the bottom of the controller.

First we'll connect our mobile device to the controller and then tap on the three dots on the upper right side of the screen.

We can edit the custom controls for the C1 and C2 button by tapping to the third icon shaped like a remote controller. Tap on one of the buttons and a drop down menu will show us all of the available options we can map.
3D Printing

What If I Don't Have A 3D Printer?

Not to worry! You can use a 3D printing service such as 3DHubs () or MakeXYZ () to have a local 3D printer operator 3D print and ship you parts to you. This is a great way to get your parts 3D printed by local makers. You could also try checking out your local Library or search for a Maker Space.

The Case parts must be in a black filament - other colors will leak light into the sensor!
Slice Settings

These settings are for a 0.4mm nozzle profile using CURA 3.3.1. Optimized for the Ultimaker 3.

- Layer Height 0.2mm
- Line Width 0.34mm
- Print Speed 50mm/s
- Retraction
  - Maximum Retraction Count - 10
- Build plate adhesion type – skirt
  - legs will require a brim
  - Brim Line Count – 8
- Bed 60c

Supports

We used Ultimaker Breakaway material for the supports with default profile settings, which are pretty much the same as standard PLA settings.

Read below for setting up custom supports on the Leg Claw and the CPX Case parts.

Fusion 360 files

Below are link to modify the design of the enclosure, claws and LED clips to fine tune them to adjust to your printers tolerances.
STL files

Below are the links to the STL file we used to slice and 3d print each file.

Download files from Thingiverse

Download files from Youmagine

Design Source Files

The enclosure assembly was designed in Fusion 360. This can be downloaded in different formats like STEP, SAT and more. Electronic components like the board, displays, connectors and more can be downloaded from our Fusion 360 CAD parts github repo.

Adafruit Part CAD files

Leg Claw Supports and Support Blocks

Overhangs on the servo mount portion of the Leg Claw will need supports to hold up the walls. We enabled supports in Cura 3.3.1 and then set two "Support Blockers" over both tabs on the sides.

Support Blockers will not calculate any supports in the area they are placed.
The tabs have 45 degree angles, so we won't need any supports here.

**Breakaway supports**

To make support removal painless, we recommend using dedicated support material like PVA, Polymaker’s PolySupport, or Ultimaker's Breakaway filament.

Using support material will help parts maintain dimensional accuracy and won't fuse supports into the main part.

**Circuit Playground Case Supports**

JST and USB ports on the enclosure protrude from the case to shielded and prevent any light from reaching the sensor. Unfortunately, we'll need to add supports to hold up the flat parts of the enclosure.
NinjaFlex Port Coverts

The JST, USB and Reset Button Extension is printed with NinjaFlex material. The covers require them to bend around the cylinder shape of the enclosure to help block out any lights that may enter in those areas.

Assemble

Prep Wires

We'll start by stripping our Female/Male 'Extension' Jumper to about 110mm long.

We can optionally tin the wires to keep them from fraying or just twist them. Next we'll mold them into a hook shape.
Connect wires to CPX

Instead of soldering, we can use three M3x6mm + nuts to connect the wires to VOUT, A1 and GND.

Insert the screw from the top of the board and then attach the nut from the bottom of the board. Use your finger or a screwdriver to hold the screw in place while attaching the nut.

Give the nut a turn or two, this way we’ll have enough room to insert each wire.

Hook each wire to its pin and then use pliers to securely fasten each nut.

Position the wires as shown in the picture, this will make threading wires through the enclosure easier later!
CPX case

Now we can move on to assembling the case. The case holds the Circuit Playground Express board and the 500mah battery.

The standoffs have enough clearance to allow the battery to sandwich in between the case and the CPX board.

Lipo

First we'll lay the battery inside the case positioned as shown, with the connections near the opening on the case. Pass the wires through the opening and then insert the battery.

The CPX board lays over the battery. Align the board so the bigger cutaways can align with the USB port.
Cover + Leg

The cover is attached to the Left Leg part using two M2x5mm screws. Insert the screws from inside between the standoffs. Fasten the two screws half in to help create the threads for the screws.

Next we can align the protruding screws to the holes on the side of the Left Leg part. Check that the mounting position is so that it leaves enough clearance on the bottom of the leg.

Reset Button Extension

We designed a rest button part, so we could still access it while the CPX is inside the enclosure. Insert the Reset Button between the standoffs, next to the light pipe hole.
Align case

Position the case and cover over each other so the bigger port cutaway aligns with USB port. Press fit the two parts and rotate them so both the JST and USB port opening align.

Use tweezers to ensure the holes on the CPX board align with the standoffs on both the case and cover.

With all of the holes aligned we can use a small drill to fasten the cover and case. To reach through the enclosure and CPX board, we'll need two or four M3x16mm screws.
Leg Claw

Now we can move on to assembling the leg claw! First we'll prepare the Left Claw part.

This part is driven by the rotation of the Right Claw. To stop the claw from getting loose, we'll need to add a lock nut or a threaded insert to keep the screws from unfastening itself.

Use tweezers to help position the the threaded insert inside the Leg Claw part.

The Left Claw will use one M3x6mm + threaded insert. Insert the screws until it sits inside the groove above the gear teeth.

Align the Left Claw to the threaded insert. We used flat pliers to hold the threaded insert in place while fastening the M3 screw. Don't tighten it all the way, leave a bit slack so the claw can freely rotate.
Right Claw - Servo Horn

The servo horn tightly press fits into Right Claw part, and is then secured with the included M2.5x5mm screw.

First, we’ll want to align the gears of the claws so they are both at the close position as shown in the picture.

Carefully rotate the horn until you feel where the gear teeth insert into the servo and then press fit the horn into the servo.

Test the close position by connecting the CPX to verify both claws align when opened and closed. Modify by moving the claw until the gears both align to the closed position.

Prep Light Pipe

To prevent light leaking into the sensor, we’ll need to cover the sides of the PETT filament by painting, plastic dipping or using a sheathing like a heat shrink tube.

We measured a heat shrink tube 130mm long and inserted it over the PETT filament.
Leg Install

With the CPX case and leg claw parts assembled, we can move on to installing the components.

Leg Claw Install

The two tabs on the Leg Claw part are attached to a tapered support to allow it to slightly bend. Apply a small amount of pressure to squeeze the supports to allow the tabs to fit inside of the slotted feet on the Mavic.
Front Legs

Rotate the leg parts so they align with shape of the Mavic legs. Make sure to clean and remove any overhangs left over after printing, as it could block the legs from fully seating into the parts.

Wire clip

The wires are held in place with the Wire clip part. The clip secures the servo wires to the side of the Mavics body, away from the sensors and propellers.
Attach wire clip

Route the wires as shown in the picture. The Leg Claw part has a bit of slack to allow the cable to sit underneath the LED on the back of the Mavics body.

Pull the wire taut against the Mavics body to ensure the wires are away from the propellers and the sensors.

Connect Jumper wires

Now we can go ahead and connect the servo wires to the Circuit Playground Express. Align the jumper wires and press them together until they are full connected.

Wire Slack Tuck

You can insert any wire slack into the wire port opening on the enclosure.
LED Cover Clip

To attach the PETT light pipe, we'll snap fit the LED Cover part onto the LED on the Mavics front propeller mount. Make sure you clean any retraction bits around the part and test fit inserting the light pipe into the clip before mounting.

Make sure the heat shrink completely covers the light pipe. If any light sources hit the light pipe it could trigger the sensor on the Circuit Playground.

Port Covers

The JST and USB covers are 3d printed in NinjaFlex Cheetah. This allows them to bend around wires and tightly fit around the enclosure to block out light.

The USB cover slides into place from the bottom of the Cover part. Two grooves on the sides will allow the cover to slip into place.

The JST cover will first attach to the cable. Slip the JST wires through the slit and then press fit the cover into the port after you've plugged in the JST connection into the Circuit Playground Express.
Fly

That's it! Now we'll double check that all of the components are secured, wires are away from the sensors and do a final check of the gears on the claws. You can continue to modify the code by removing the USB cover and connecting to you device. Once you have verified everything functions as expected, we are ready for lift off!