Flat Sat Challenge

Objective

Build a Flat Sat to get familiar with your hardware. Implement a Python script that takes a picture when the IMU is shaken.

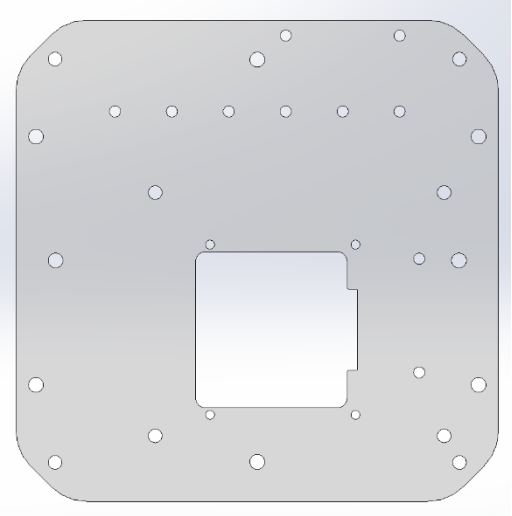
Description

Before you dive into assembling the 1U CubeSat in its entirety, you need to test your setup and get comfortable with the components. Building a Flat Sat is a great way to ensure that all systems are working and makes preliminary testing and configurations much easier. This Flat Sat will feature the Raspberry Pi, Camera, and IMU mounted on the bottom acrylic plate.

The Python code you will write for this module should read acceleration data from the IMU. When a reading comes in that surpasses an acceleration threshold (indicating a shake), your Pi should pause, trigger the camera to take a picture, then save the image with a descriptive filename. Optionally, you can automatically upload photos to your GitHub repository.

Parts Required

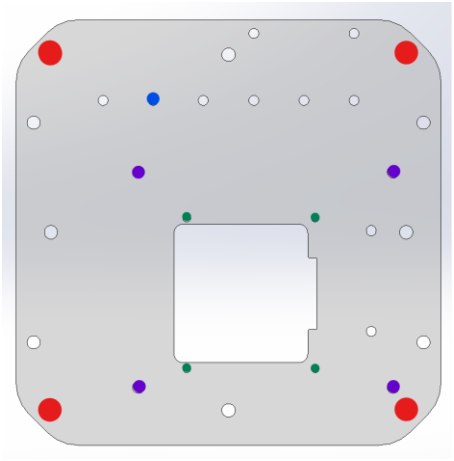
Bottom Panel	1x
Raspberry Pi (with SD card)	1x
Camera	1x
Camera case & hardware	1x
1” nylon standoffs	4x
½” nylon standoffs	4x
IMU	1x
4-40 x ½” screws	4x
4-40 x ¼” screws	8x
4-40 nuts	4x
2-56 x 3/16” screws	5x
2-56 x ¼” screws	4x
Battery Pack or Raspberry Pi power supply	1x
Jumper Cables	1x



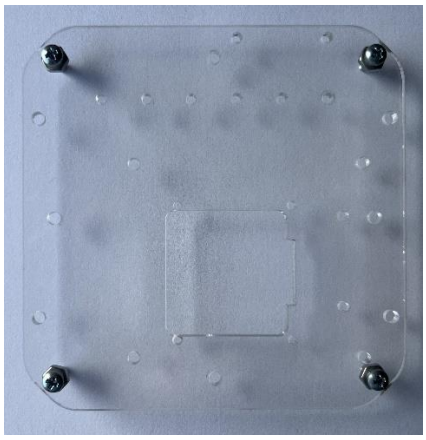
Bottom Panel

Flat Sat Assembly

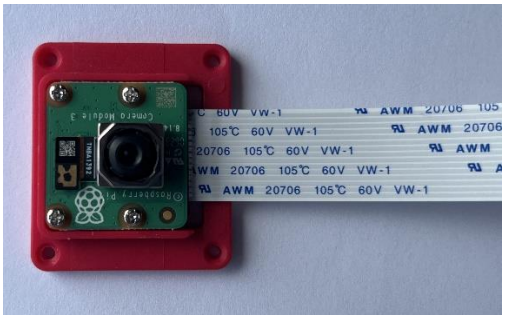
1. Base:
    a. Take the paper protective coating off the bottom panel.
    b. Take four 4-40 x ½” screws and four 4-40 nuts and screw them into the red holes. Make sure you have the bottom panel oriented like in the diagram below to make sure your camera is facing the right direction.



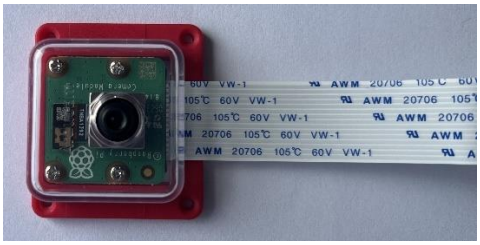
    c. The final product should look like this:



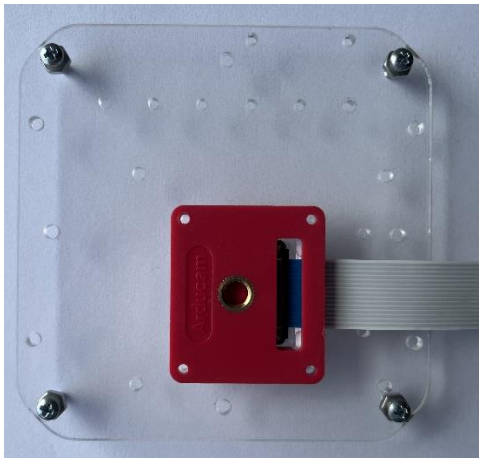
2. Camera:
    a. Pop the camera mount apart and insert the camera so the screw holes align. Install the included screws to secure the camera in the mount.



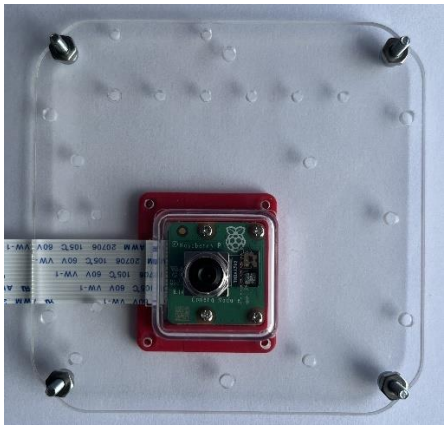
b. Attach the cover so the camera hole aligns and the notch goes over the flex cable



c. Set the camera in the square hole with the flex cable slotting into the notch and so the green screw holes align with the holes in the camera mount.



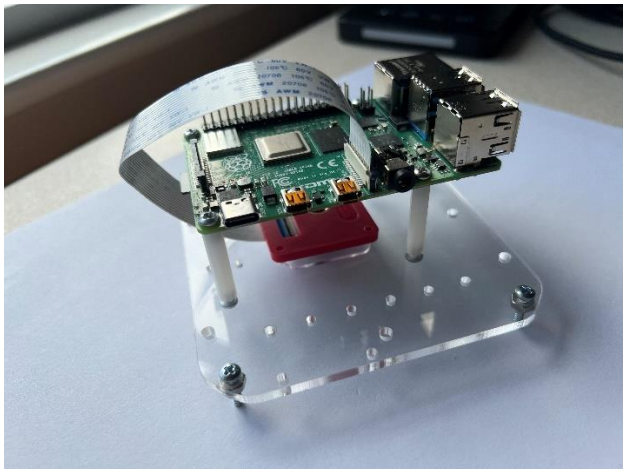
d. Install four 2-56 x ¼” screws into the green holes through the camera mount.
e. The final product should look like this:



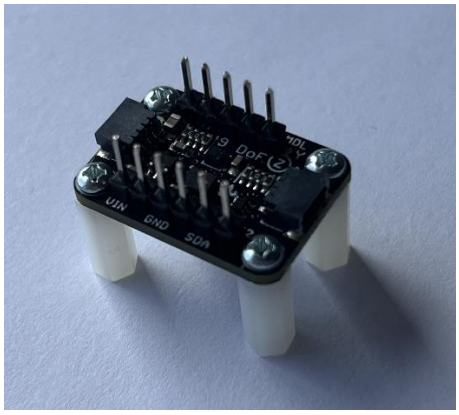
3. Raspberry Pi:
    a. Install 1” nylon standoffs onto the bottom of the Pi using four 4-40 x ¼” screws.
    b. Fasten the Pi assembly onto the bottom panel using the purple holes and four 4-40 x ¼” screws. Make sure the HDMI and power ports are facing inward as shown below instead of outward so the camera can be plugged in correctly.

c. Connect the camera cable to the Pi in the strip labeled CAMERA next to the HDMI ports (lift the edges of the black plastic piece, slide the cable in, and push the piece down.) Make sure that the contacts on the camera cable are facing away from the black piece, and that the camera cable is not twisted or stretched.
Make sure the Raspberry Pi is disconnected from power before connecting your camera. The Raspberry Pi cameras are very prone to failure if touched while power is connected. Once you have connected the camera to the Raspberry Pi, never adjust the camera cable or case the Raspberry Pi power connected.

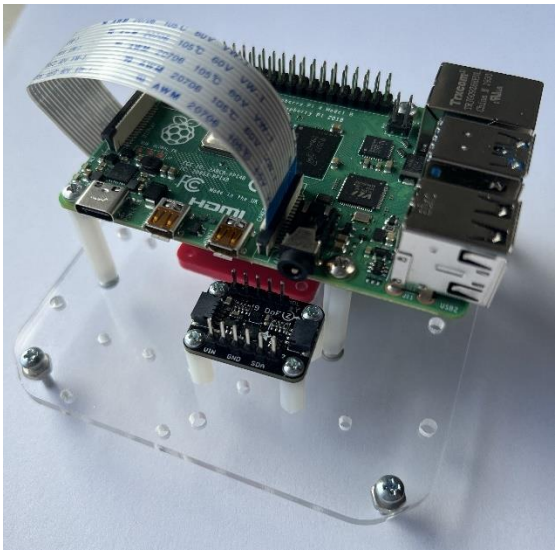
d. The final product should look like this:



4. IMU:
   a. Install ½” nylon standoffs on the bottom of the IMU using four 2-56 x 3/16” screws.

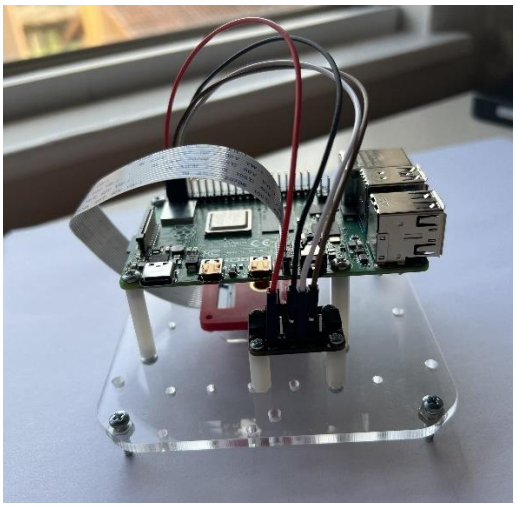


   b. Mount the IMU next to the Raspberry Pi using the blue hole and one 2-56 x 3/16” screws. Make sure your IMU is in the orientation shown below so you can plug in your jumper cables.



c. Use four jumper cables to connect the following pins on the IMU (labeled next to pins) to the Pi:
Make sure the Raspberry Pi is disconnected from power before wiring the IMU. Get a teammate/coach to check your wiring before plugging in power.
   - Pi 3v3 (#1) to IMU VIN
   - Pi GND (#6) to IMU GND
   - Pi SCL (#5) to IMU SCL
   - Pi SDA (#3) to IMU SDA

   (For more detailed Raspberry Pi Pinout use this site)
d. The final product should look like this (note your jumper wire cables may be different colors:



5. Congratulations, you have built your Flat Sat!

Startup and Python Template

1. Connect the USB-A output on the battery pack with the USB-C input on the Pi using the short white cable. Alternatively, use the Raspberry Pi Power Supply to plug into a wall outlet or power strip.
2. Access your Raspberry Pi via SSH.
3. At the command line, enter these commands to install the Python libraries for your camera and IMU.

```
sudo apt install -y python3-picamera2

sudo pip3 install adafruit-circuitpython-lsm6ds --break-system-packages

sudo pip3 install adafruit-circuitpython-lis3mdl --break-system-packages
```

Note- a recent Linux changes means Pip cannot install system wide packages from the command line anymore, **--break-system-packages** is a way around this. You may also use Python environments by following this guide, but it is not required.

4. You may want to read the documentation for these libraries, the links are provided below:
    a. https://datasheets.raspberrypi.com/camera/picamera2-manual.pdf
    b. https://docs.circuitpython.org/projects/lsm6dsox/en/latest/
    c. https://docs.circuitpython.org/projects/lis3mdl/en/latest/
5. Use FlatSat_student.py as a starter code for this activity. Pseudocode is provided but you must complete the code yourself.
    a. To start you need to copy the starter code to your Pi. If you are using GitHub, you can just upload the file to your repo and clone it to your Flat Sat. If not, you can learn about several copying options here.
6. Enable I2C on your Raspberry Pi. Instructions can be found here.
7. Run your code! In the Terminal, navigate to the folder containing your code and enter the following:

    ```
    python3 FlatSat_student.py
    ```

    You can force a Python script to stop running by pressing ctrl+c