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.

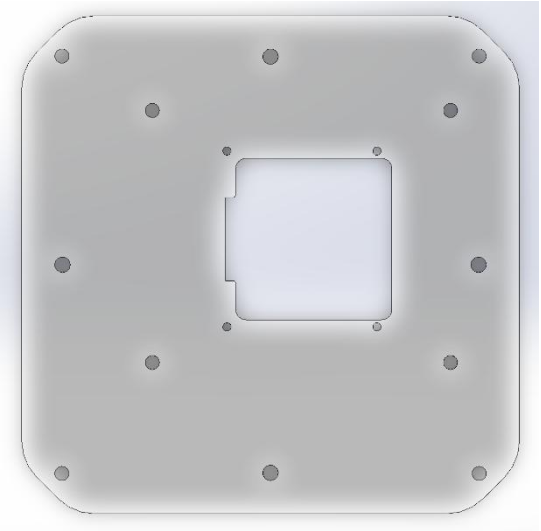
Description

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

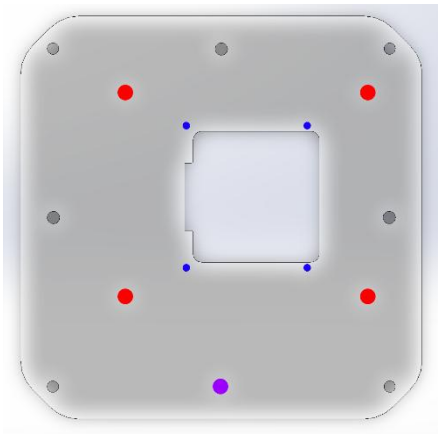
Bottom Panel	1x
Raspberry Pi (with SD card)	1x
Camera	1x
Camera case & hardware	1x
IMU	1x
Raspberry Pi power supply	1x
Jumper Cables	1x
M2.5 Standoff, 25mm	4x
M2.5 Standoff, 6mm	4x
M2.5 nut	4x
M2.5 x 5mm pan head screw	9x
M2 x 6mm thread forming screw	4x



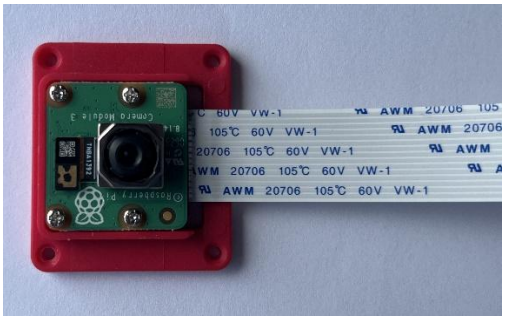
Bottom Panel

Flat Sat Assembly

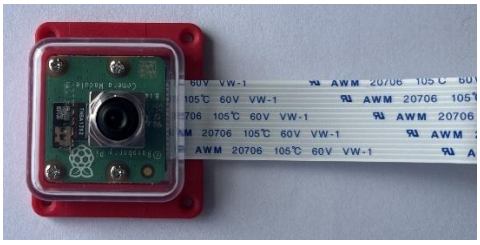
Align your bottom panel as shown to the right to ensure the Flat Sat is built the right way up. Consider the view the “top” of the plate. The colored holes will be used to indicate which type of screw needs to be used.



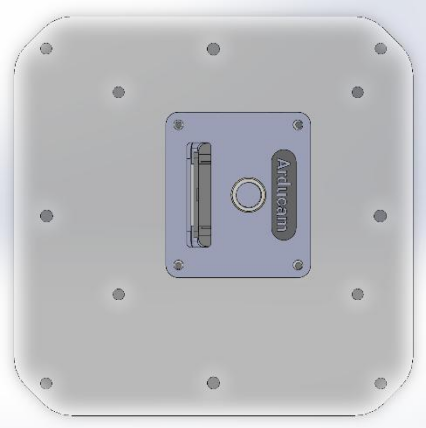
1. Camera:
    a. Pop the camera mount apart and insert the camera so the screw holes align. Install the included screws to secure the camera in the mount.



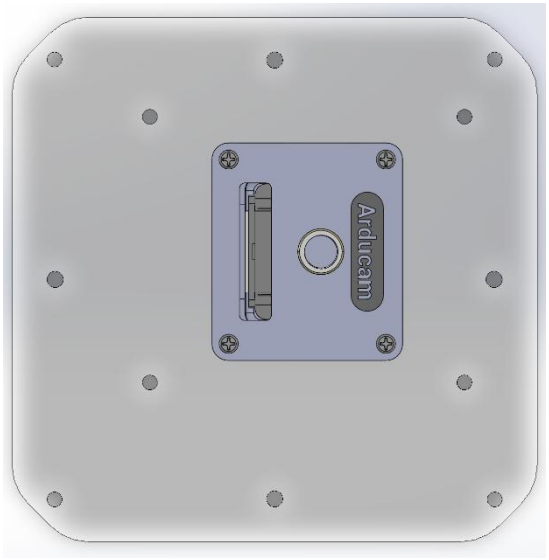
    b. Attach the cover so the camera hole aligns and the notch goes over the flex cable



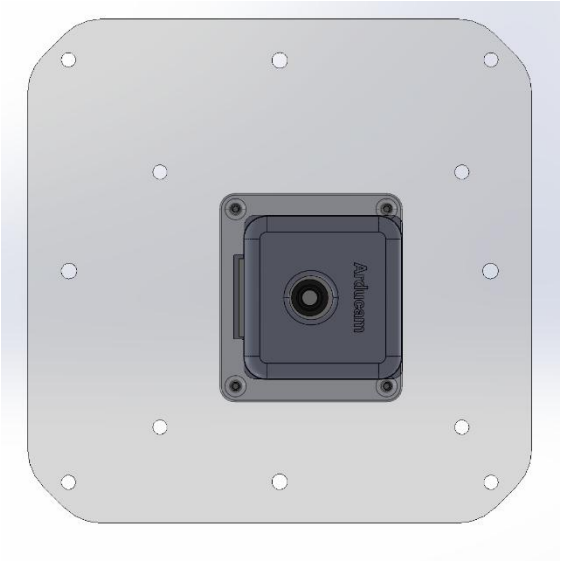
    c. Set the camera in the square hole with the flex cable slotting into the notch and so the blue screw holes align with the holes in the camera mount.



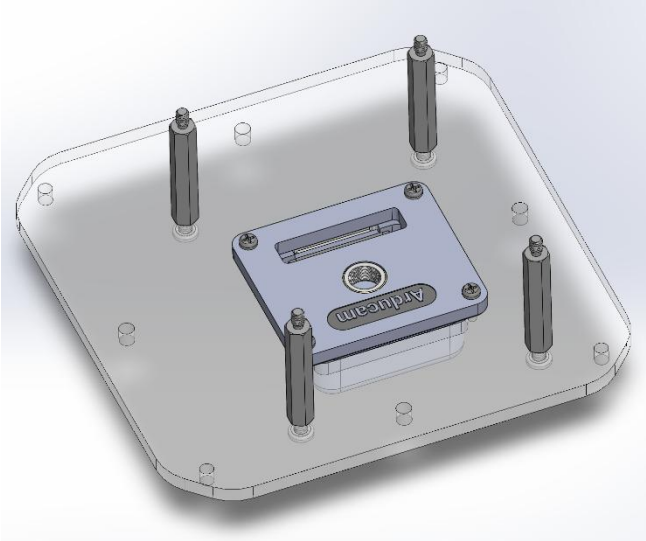
d. Install four M2 x 6mm thread forming screws into the blue holes through the camera mount.



e. Flip the plate over and the final product should look like this:



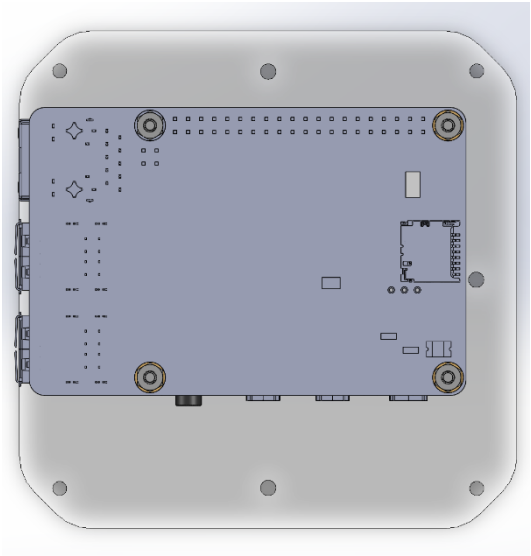
2. Raspberry Pi:
    a. Install 25mm aluminum standoffs onto the bottom plate using four M2.5 x 5mm pan head screws using the red holes, the standoffs should installed on the top side as shown.



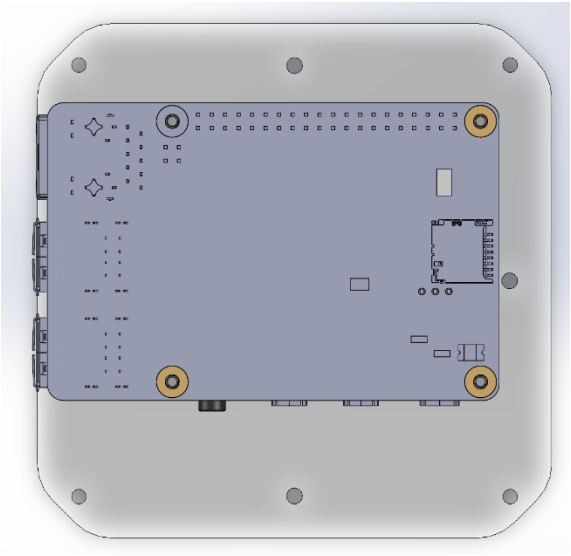
    b. Connect the camera cable to the Pi in the strip labeled CAMERA next to the HDMI ports (lift the edges of the black plastic piece, slide the cable in, and push the piece down.) Make sure that the contacts on the camera cable are facing away from the black piece, and that the camera cable is not twisted 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.

c. Connect four jumper cables to the following pins on the Pi, we will use them to install the IMU later:
   - Pi 3v3 (#1)
   - Pi GND (#6)
   - Pi SCL (#5)
   - Pi SDA (#3)

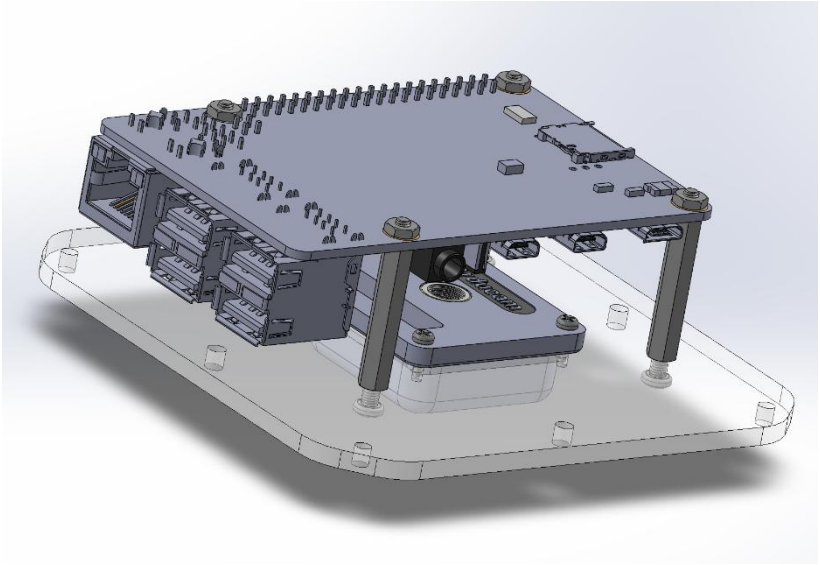
d. Install the Pi onto the standoffs upside down with the ports facing left



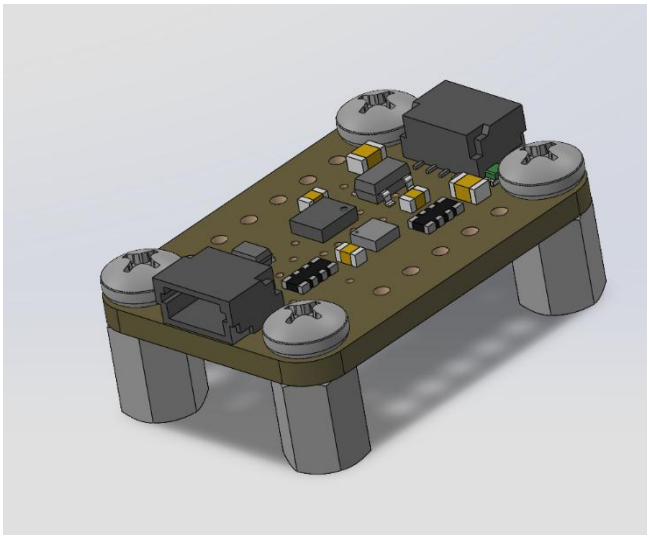
e. Fasten the Pi onto the standoffs using four M2.5 nuts



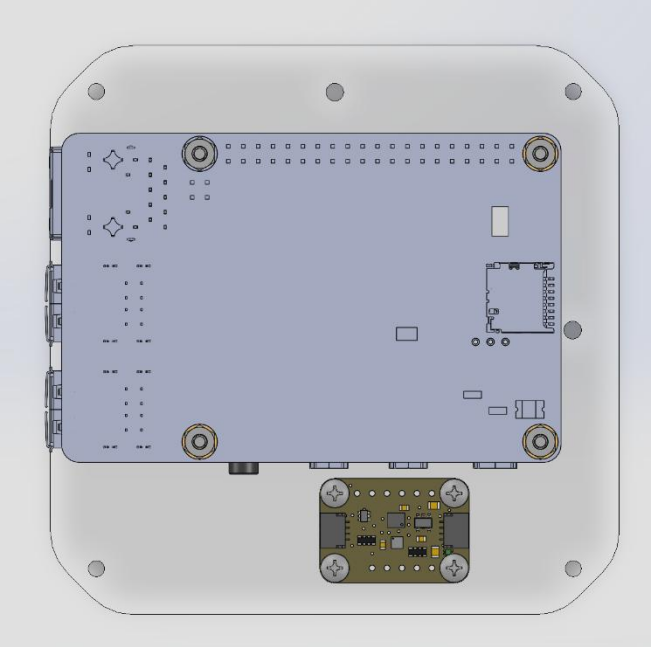
f. The final product should look like this:



3. IMU:
    a. Install 6mm aluminum standoffs onto the IMU using four M2.5 x 5mm pan head screws, the standoffs should installed on the flat side as shown



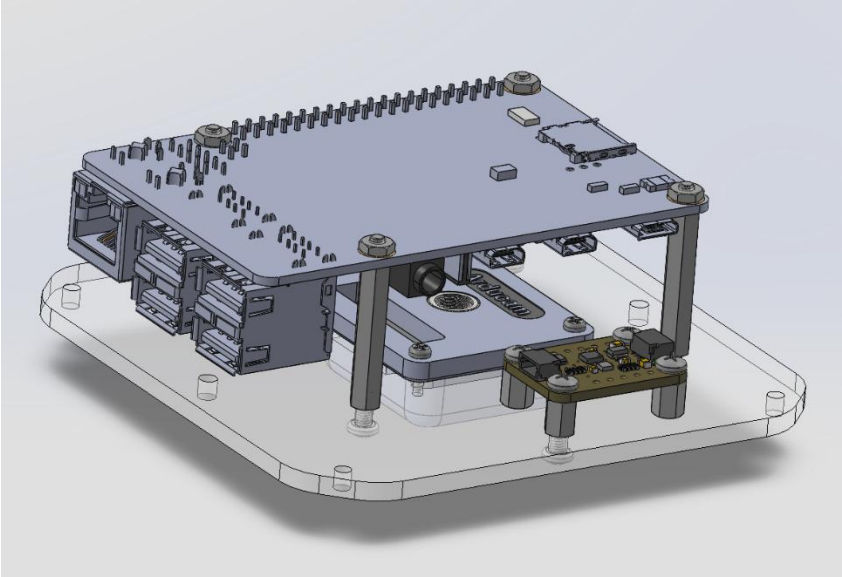
b. Attach the bottom left standoff to the bottom plate at the purple hole using a M2.5 x 5mm pan head screw, check the orientation to make sure it matches the image below.



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:



4. 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