NASA SPACE APPS CHALLENGE

Jimmy in the Box:

Where Paper Crafting Meets Electronics and Coding

Motto: “Craft, code, and play to learn!”




Webb Origami Design Challenge

Boston, MA, USA

Team Web Site: https://bit.ly/3D7Tcar

Project Web Site: https://github.com/HSSBoston/jimmy-in-the-box

Our Project

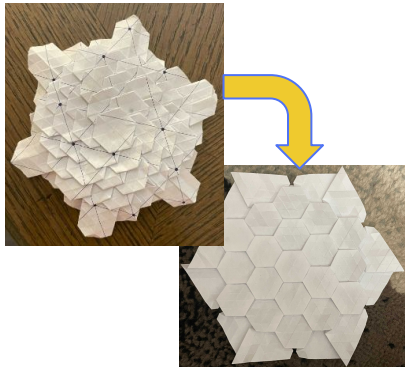
- Our team members have diverse skills and experience:
  - Origami crafting
  - Internet-of-Things (IoT) programming with Raspberry Pi
- We all are WOW-ed by how the James Webb Space Telescope (JWST) uses origami-like folding and unfolding.
- Our goal: Making computerized origami models for JWST
  - JWST's deployment process looked like a Jack-in-the-box for us!
    - So, we decided to replace "Jack" with "Jimmy" for our project name, respecting Mr. Webb, who supported many science projects at NASA.

Source: https://www.flickr.com/photos/nasawebbtelescope/

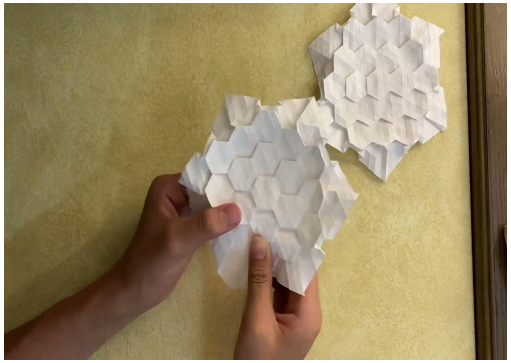
Origami Crafting for Primary & Secondary Mirrors

- Customized an existing hexagonal tessellation strategy (by Eric Gjerde) to make our model more similar to JWST's primary mirror.
- Made a hinge-inspired craft to model the secondary mirror's folding and unfolding mechanisms, w/ a tape, plastic straw, glue and bamboo skewer.

Hex tessellation as the primary mirror

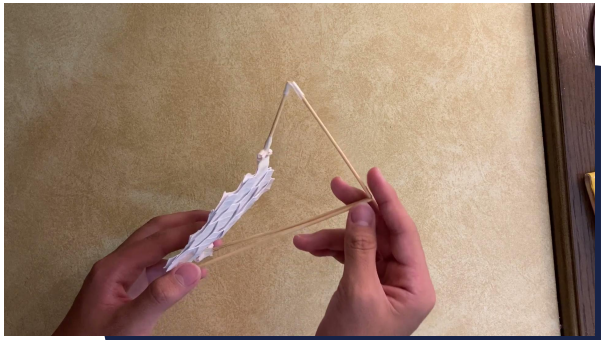


Demo Video



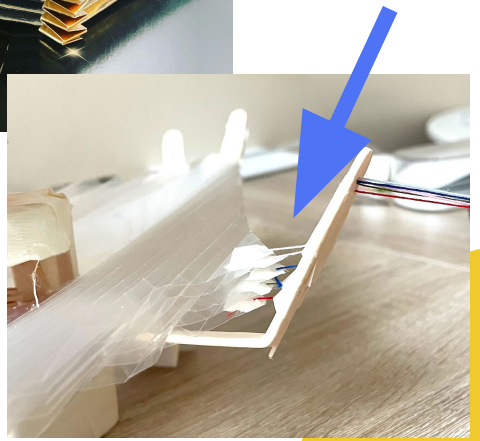
Hinge-inspired model for the secondary mirror

Demo Video

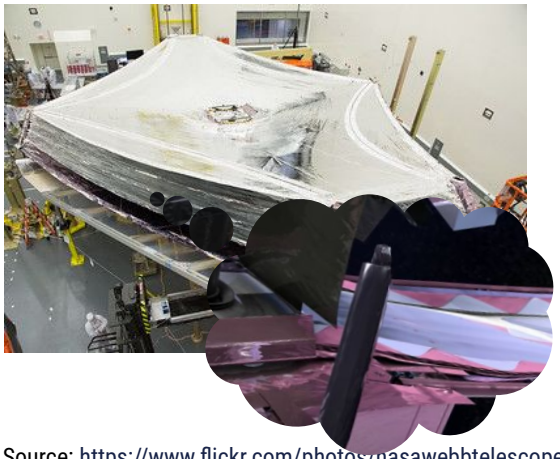


Origami Crafting for Sun Shields

- Folded “long” hexagons and stacked them to model JWST’s sun shields.
- Used sheet protectors as origami papers and slung five layers of them between foundation parts with strings.



JWST’s Sun Shields



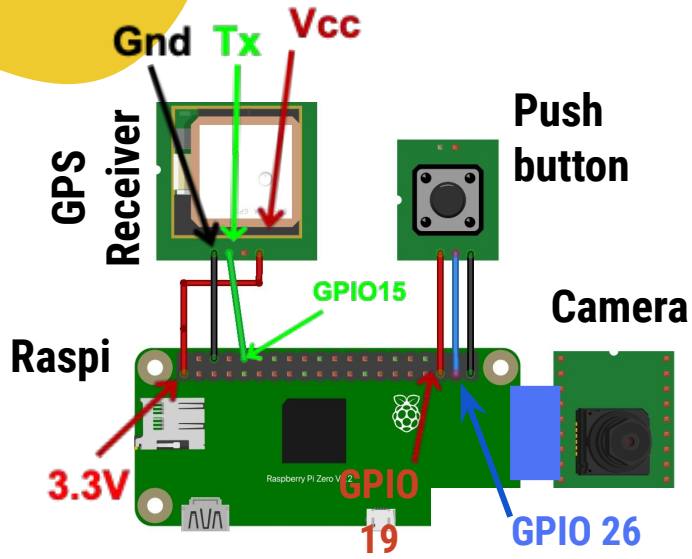
How to make Our Shield

Source: https://www.flickr.com/photos/nasawebbtelescope/

Turning Origami Crafts to Internet-of-Things (IoT) Device

- Wanted our telescope models to *actively* do something, not only being viewed passively.
- Integrated a Raspberry Pi (or Raspi; credit card sized computer) with origami crafts, so our model can do what the real telescope does.
- Our computerized origami models
  - Take pictures with cameras and push buttons.
  - Keep track of the current location (latitude, longitude and elevation) with GPS receivers.

Circuits and Cloud DB App



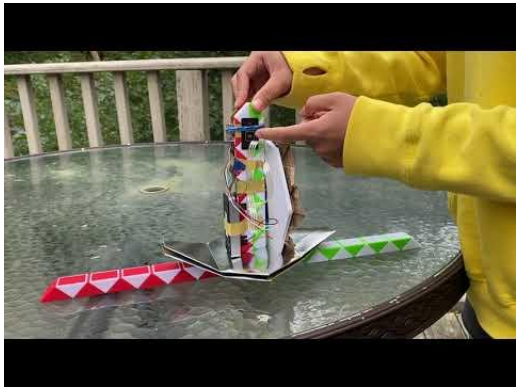
- Made 3 circuits to wire up a camera, a push button and a GPS receiver.
- Set up a cloud database (Kintone) app to store data from a Raspi, convert meters to feet and show a stored location on Google Maps.

Python Apps

- Periodically takes a picture, gets the current location (latitude, longitude and elevation) and uploads those data to Kintone.
- Detects that a push button is pressed, takes a picture and uploads it to Kintone.

```
gpsSerialPort = gps.init(serialPort)
geolocator = Nominatim(user_agent=appName)

while True:
    try:
        ### Get the current location with GPS
        gpsData = gps.getData(gpsSerialPort)
        print(getCurrentTimeStamp())
        print(gpsData)

        decimalLat = gps.getDecimalLatitude(gpsData)
        decimalLon = gps.getDecimalLongitude(gpsData)
        gMapsLink = "https://www.google.com/maps?q=" + str(decimalLa
        print("Decimal latitude: " + str(decimalLat) + ", Decimal lo

        ### Get the current address with reverse geocoding
        location = geolocator.reverse( query=(decimalLat, decimalLon
        locationDataset = location.raw
        address = locationDataset["address"]
        if "city" in address:
            cityTown = address["city"]
        if "town" in address:
            cityTown = address["town"]
        county = address["county"].split(" ")[0]
        state = address["state"]
        print("Address: " + cityTown + ", " + county + ", " + state)

        ### Measure temp and humidity
```

Prototype Models #1, #2 and #3



Future Work

- Come up with extra tessellation strategies for origami crafting.
- Use extra sensors such as gyroscope and magnetometer to measure the telescope model's attitude and direction.
- Explore potential applications of our origami techniques to solve other challenges; Can we apply them to deploy more complex structures such as ISS modules, complex satellites and houses?