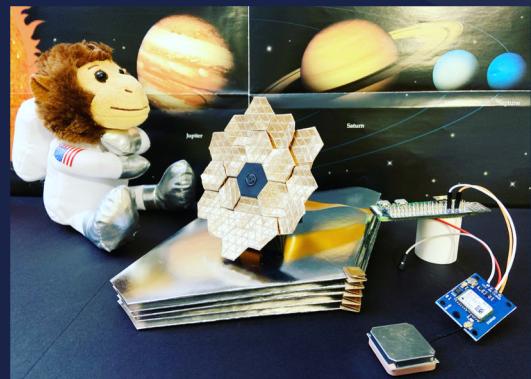


Jimmy in the Box:

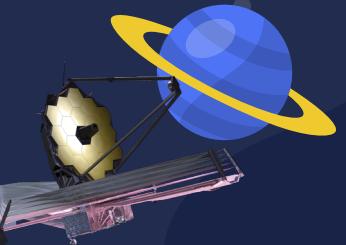
Where Paper Crafting Meets Electronics and Coding

Team motto: “Craft, code, and play to learn!”



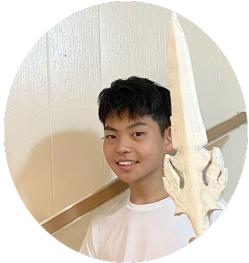
Webb Origami Design Challenge
Boston, MA, USA

Oct 2 - 3, 2021





Team Members



Takeshi

9th grader
at Belmont high
Love making origami or any
other craft, table tennis,
video games, watching
youtube, and anime

Created the cardboard
sword/ spear (in the icon),
origami dragon, Infinity
cube



Hanna

6th grader
Plays the piano, ukulele
and tennis. Likes cooking,
camping and Roblox.
Runs 2 businesses.

Did a science project
about “Miura fold,” which
was used in a Japanese
space mission.



Yuto

5th grader at Chenery
Middle School.
I love playing soccer,
gaming and camping!



Misaki

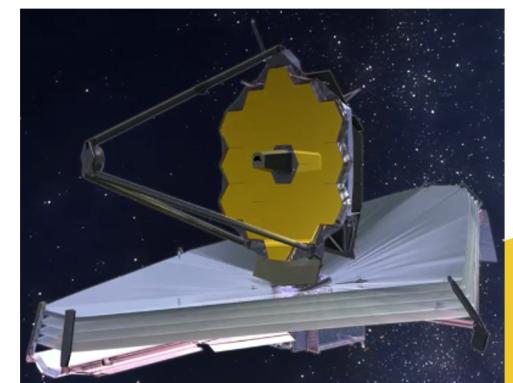
11th grader
at Belmont high
Love Track and field,
genshin impact, anime,
and reading,

Volunteered at
binnovative.
Created origami
christmas tree, flowers,
paper toy



Our Background

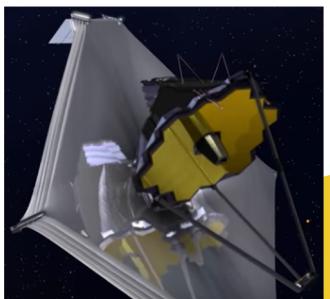
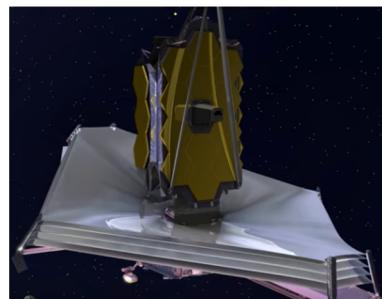
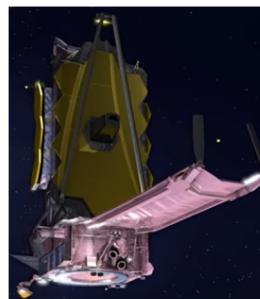
- We have diverse skills and experience.
 - Origami crafting
 - Internet-of-Things (IoT) programming with Raspberry Pi
- We all are WOW-ed by how the James Webb Space Telescope (JWST) uses origami-like folding and unfolding.



Sources: <https://www.flickr.com/photos/nasawebbtelescope/>, <https://svs.gsfc.nasa.gov/>

Our Project: Jack Jimmy in the Box

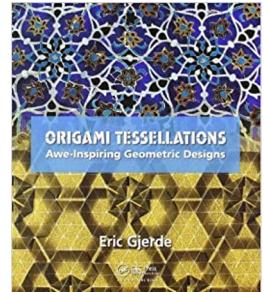
- Our goal: Making computerized origami models for JWST
 - By the way, JWST's "deployment" process looked like a Jack-in-the-box for us!
 - So, we decided to replace "Jack" with "Jimmy" for our project name, respecting Mr. Webb, who supported many science projects at NASA.



Sources: Northrop Grumman's YouTube channel

Origami Crafting for the Primary Mirror

- Started with Eric Gjerde's famous hexagonal tessellation to model JWST's primary mirror.
 - Elegant, but not that similar because hexagons overlap to spread.
- Customized the folding strategy to better model primary mirror.



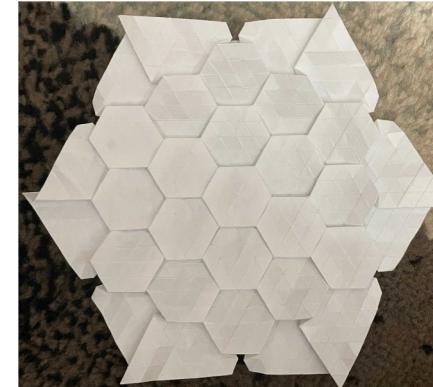
Eric's tessellation



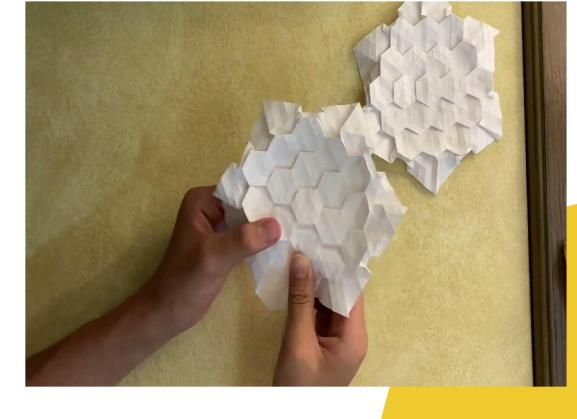
JWST's primary mirror



Our tessellation!!!



Demo Video



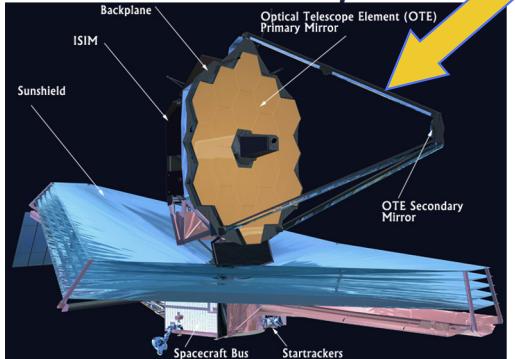
Origami Crafting for the Secondary Mirror

- Modeled JWST's Secondary Mirror Support Structure (SMSS), which uses 3 arms to deploy the secondary mirror.
 - The arms are modeled with bamboo skewers, which are attached to the primary mirror with the hinges made with paper tape and plastic straws.
 - They fold toward the primary mirror and unfold to form a tripod

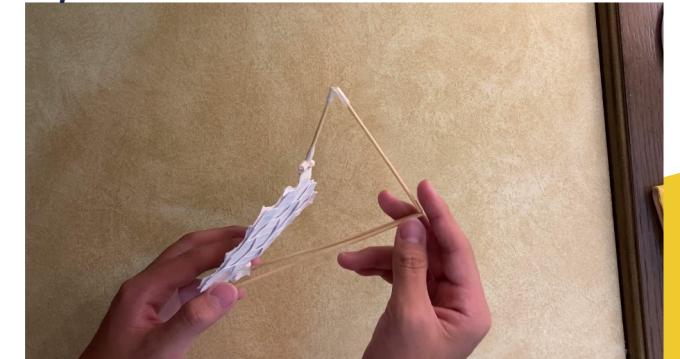
Door hinge



JWST's secondary mirror



Our secondary mirror!!!



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 bars with strings.

JWST’s Sun Shields



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

How to make Our Sheild



Our Prototype Model #1

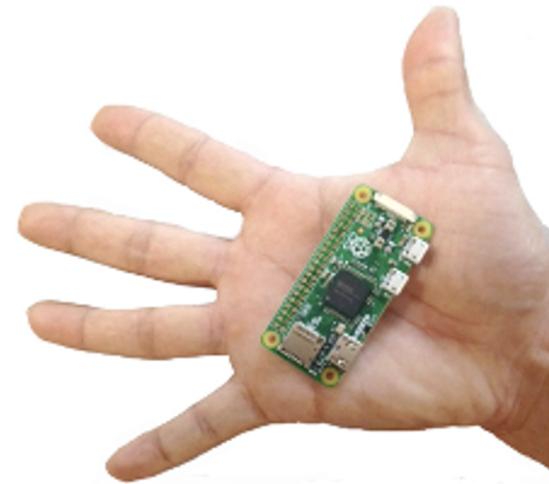
By Takeshi & Misaki



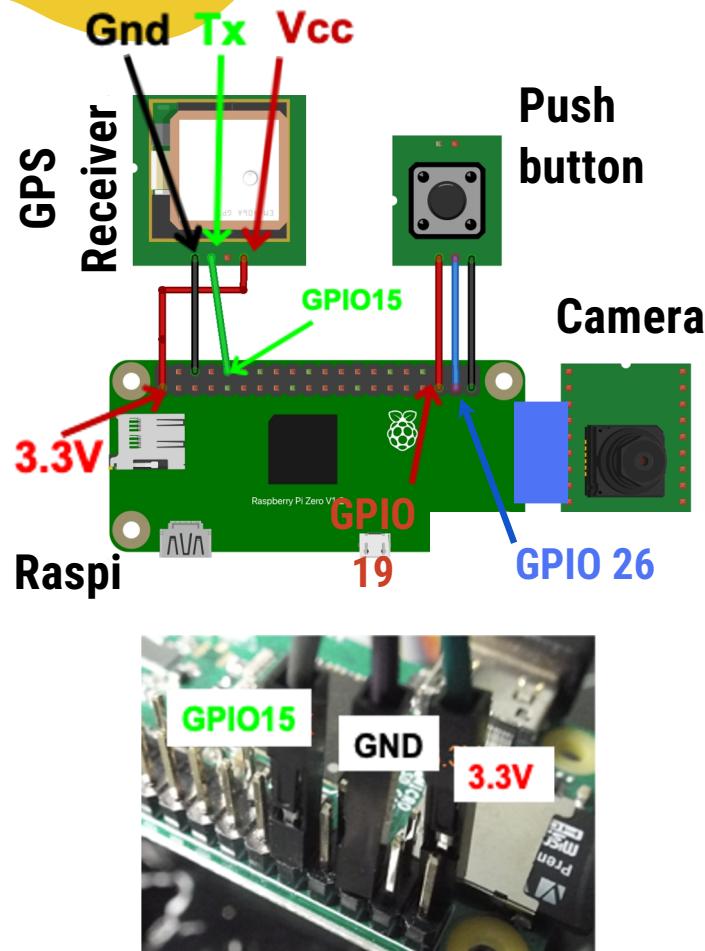
The best thing while creating is to find out what's related to thing in our life!

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

- Wanted our telescope models to actively do something, not only being watched passively.
- Integrated a Raspberry Pi (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
 - Keep track of the current location (latitude, longitude and elevation) with GPS receivers.



Circuits and Kintone App



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

The screenshot shows the "Jimmy in the Box" Kintone app. At the top, there is a map with a red marker indicating a location. Below the map is a search bar with the placeholder "View". To the right of the search bar are filter and sort icons. The main area displays a table with the following data:

	Created datetime	Photo	City/Town	State	Elevation (m)	Elevation (ft)	Latitude	Longitude	Google Maps Link
1	Oct 02, 2021 5:11 PM		Bedford	Massachusetts	63.7	208	42.49	-71.27	https://www.google...
2	Oct 02, 2021 5:10 PM		Bedford	Massachusetts	63.0	206	42.49	-71.27	https://www.google...

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 upload 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(decimalLat) + "," + str(decimalLon)
        print("Decimal latitude: " + str(decimalLat) + ", Decimal lon: " + str(decimalLon))

        ### 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
    except Exception as e:
        print(e)
```

```
button = 19
buttonSwitch = 26

GPIO.setup(button, GPIO.OUT)
GPIO.setup(buttonSwitch, GPIO.IN)

GPIO.output(button, GPIO.HIGH)

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

while True:
    try:
        if GPIO.input(buttonSwitch) == GPIO.LOW:
            print("Button Pushed!", end=" ")

        timeStamp = getCurrentTimeStamp()
        picFile = "pic/" + timeStamp + ".jpg"
        command = "raspistill -t 500 -rot 180 -w 800 -h 600 -o " + picFile

        status = os.system(command)
        if(status==0):
            print(timeStamp, end=" ")
            print("Photo captured.")
        else:
            print("Failed to capture a picture")

        fileKey = kintone.uploadFile(subDomain=sdomain,
                                     apiToken=token,
                                     filePath=picFile)
    except Exception as e:
        print(e)
```

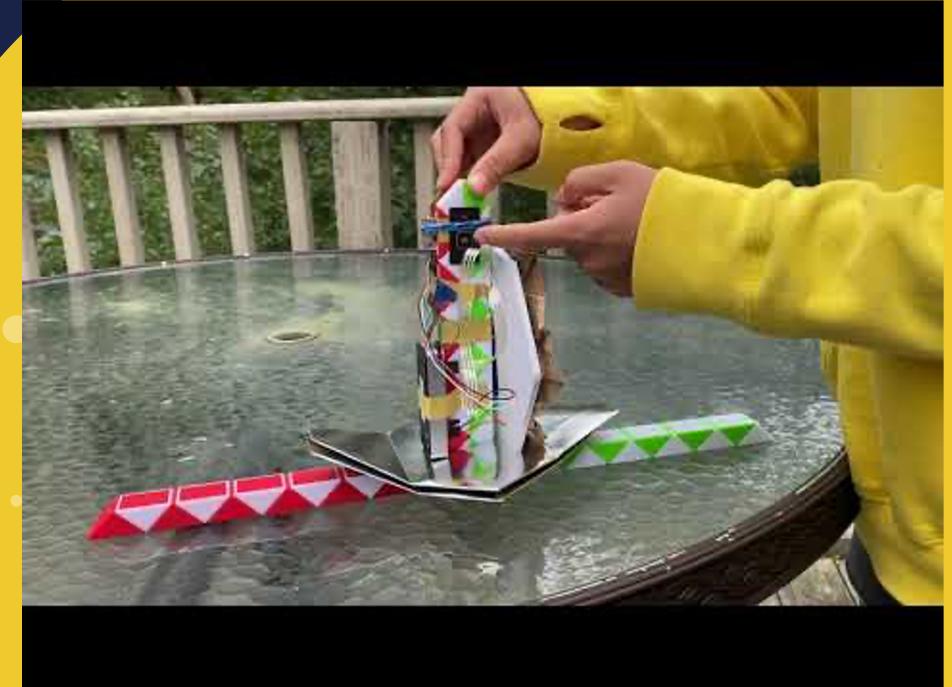


Our Prototype Models #2 and #3

Yuto's Demo



Hanna's Demo



Future Work



- Set up a Web page with instruction videos, circuit diagrams and ready-to-run code to help anyone interested reproduce our origami crafts and IoT telescope models.
- 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.
- Study how origami techniques can solve other challenges; Can we fold and unfold ISS modules, complex satellites or



THANK YOU!

Presented by **JIMMY IN THE BOX:**
Takeshi, Hanna, Yuto and Misaki

