Mission Space Lab Phase 4 Report

Team Name: SPACEPi2
Chosen theme: Life on Earth
Organization name: Zanneio Model High School
Country: Greece

Introduction

Our mission is to
1. Collect and analyze photos from various places on Earth using **Izzy's infrared camera**.
2. Write a **color-identification computer code** to analyze each photo and give **automatically** the percentage in Cloud, Urban, Vegetation, and Water elements that are present in the photo.
3. Produce NDVI images for the most interesting IR photos, and check vegetation's health.
4. Compare older satellite images with the ones from our experiment, and try to find evidence of extreme urbanization.
5. Use **Izzy's magnetometer** to analyze Earth's Magnetic Field variations.
During our research, we came upon a very interesting phenomenon over the west Indian Ocean, which we also tried to explain.
In this report we present our findings in all of the above.

Method

Using our code we took IR photos and we measured the temperature inside the ISS, and the earth's magnetic field along ISS path during our experiment. We used the following sensors of the Raspberry Pi: a. IR camera module, b. Temperature sensor, c. Magnetometer.
Our experiment started 30/04/2021 at 07:19:08 and ended at 10:09:01 the same day.
We collected

- 646 IR photos (one every 15 seconds),
- 6 text files: 1 data file and 5 control files

We collected 1.33 GB data in total
The photos were processed to NDVI with the Infragram online tool https://infragram.org/ .They were also processed for color-identification with our python code.

Results

1. COLOR IDENTIFICATION

For this part of the project we attempted to study the effects of climate change and urbanization by analyzing each picture captured during the experiment. We achieved this by writing a program that can break a picture down and show a pie

chart of each individual color. This was done using external code that we ran after receiving the images. For this purpose we used chunks of Kharan Bhanot's color identification algorithm.

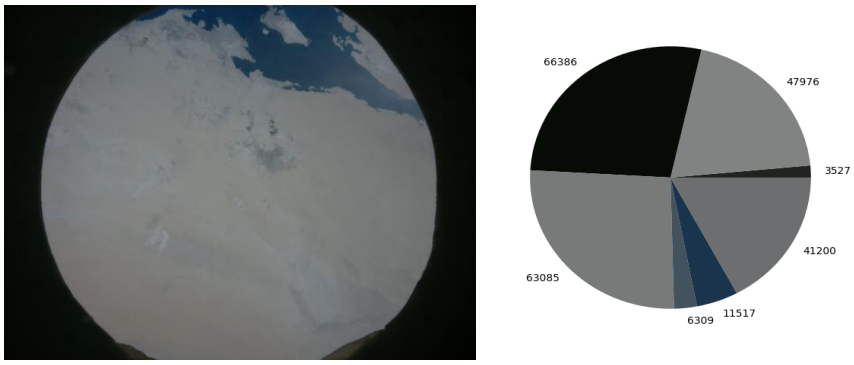


Image 1. Left image: One of 646 photos captured by Izzy's IR camera, taken above Bahrain. Right image: Color identification of the left image using our python code. The pie chart compiles every color into a graph. The numbers correspond to the pixel count of that color.

We managed to make some interesting observations regarding extreme urbanization and human interference in the environment. Comparing the images to older satellite pictures from Google Earth, we stumbled upon this land mass.

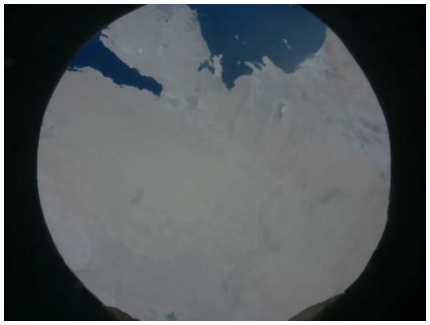
Image 2: The "Northern City Islands" on the left and the "Nurana Islands" right above

Image 3: A satellite photo from 1984, notice that the islands are nowhere to be seen

At first, we assumed this was caused by the rising sea levels and, by extension, climate change. However, upon further research, this archipelago is actually made up of artificial islands, designed for housing and tourism.

2. NDVI

As regards the NDVI analysis of the photos, each left image is the original IR photo while each right is the processed NDVI. Green and deep green represents healthy vegetation, blue is body of water and cyan is unhealthy vegetation, urban areas or deserts.



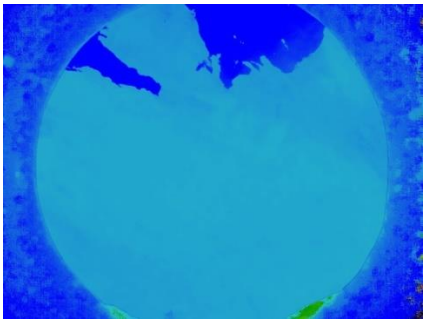
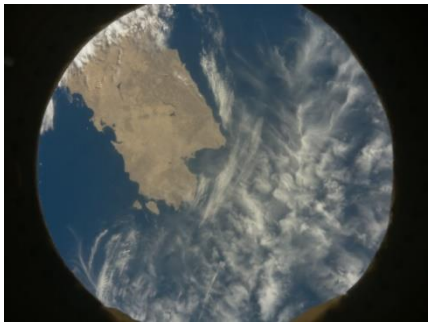


Image 4. The state of Qatar in Saudi Arabia and the desert near it and the United Arab Emirates. In this area, as we would expect, the land is completely parched due to its own nature which is a dry desert. As a result the vegetation is non-existent and there is no potential for photosynthesis.



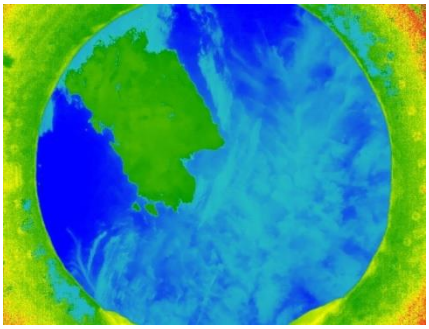
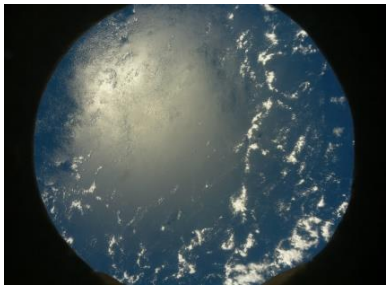


Image 5. The island of Sardegna. This island near the Italian peninsula seems to have healthy vegetation. With a closer look in the Google Maps we discovered that the hole area is covered by huge tracts of land fields.

While taking a look at our photos we noticed an unusual haze over the Arabic sea and the western side of the Indian Ocean that was only visible with the deflection of the sun. After a lot of research we discovered that this could be attributed to a phenomenon called the "Indian Ocean Dipole" and could only be noticed in the Indian Ocean.



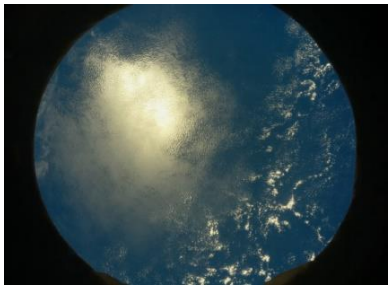


Image 6: The strange haze over the western Indian Ocean.

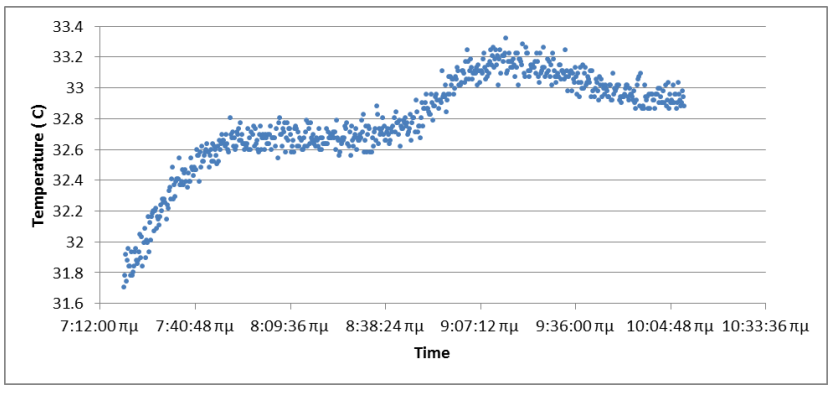


Image 7: Temperature variation inside the ISS during our experiment. There's an overall increase as the astronauts gradually are engaged with their work, modified by the day-night cycle of the ISS orbit.

3. EARTH'S MAGNETIC FIELD

Image 8. Earth's magnetic field intensity, color coded along ISS trajectory.

From our magnetic readings in x, y, z vectors, we extracted the magnitude using the following formula:

$$m = \sqrt{m_x^2 + m_y^2 + m_z^2}$$

where magnetic intensity m at the left side of the image is in $100 \cdot gauss$.

Then, we depicted our results color-coded on the ISS trajectory during our experiment.

Conclusions

1. Automated color-identification can be done successfully using our python code.

2. Extreme urbanization has been done in many places around the globe, as we have shown in the case of Bahrain, comparing our images with older satellite photos.

3. With the help of the NDVI procedure, we can accurately detect vegetation's health and photosynthesis from orbit.

4. The Earth's magnetic field presents asymmetries of different magnitudes. There are two points of interest: a. A significant asymmetry over the north-western Europe and England, where the magnetic field is weaker than the corresponding area over northern America, and b. Erroneous large readings over Saudi Arabia, easily explained by the fact that this was the beginning of our experiment and the sensors were not initiated yet. Our findings seems to be in accordance with SWARM data.

5. There's a quite interesting phenomenon over the western Indian Ocean which could probably be explained by the Indian Ocean Dipole.