Mission Space Lab Phase 4 report

Team name: Abyss

Chosen theme: Life on Earth

Organisation name: AstroCrew Bacau

Country: Romania

1. Introduction

We aimed to investigate the hypothesis that climate change and natural phenomena lead to water level changes. We think that it is interesting research by demonstrating and showing all the changes that have been going on all these years and helping us understand the consequences to the life-sustaining weather. We expected to detect the different landforms or contours and color nuances and compute the concrete size of sea levels and natural phenomena, and the location of land. We also wanted to find information about water levels, in different areas, so that we could compare it to the data that we compute using the RaspberryPi. We used known data about the albedo of water and we looked for the albedo of some pictures to be in the same range in order to classify them according to the appearance of water in them.

2. Method

In our experiment, we used the visible light camera to take pictures of the Earth and analyze the depth of the water to determine changes in water levels.

Our experiment collected image files, .csv files and log files.

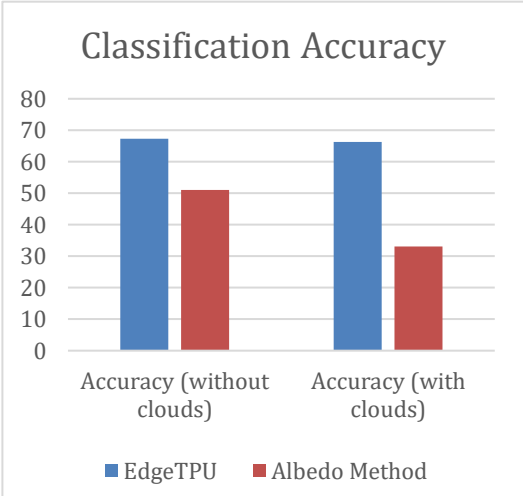
A couple of images (around 15%) weren't fully processed in space and as such we ran the code again on Earth to analyze them. We also went further in depth with a case study on a specific image which was very useful in our research.

We used the EdgeTPU module to identify whether each image had water in it or not.

We relied on images containing water most of the time, but this wasn't the case in our experiment's photos. Many of them had clouds covering the entire image, which we weren't able to use, although we did take some images which we were able to use to achieve our experiment's goals.

By using the EdgeTPU provided we were able to easily identify images based on the presence of water in them, however, the machine learning model we used wasn't trained very well to classify images containing clouds as not having water.

3. Experiment results



In our experiment, we used the EdgeTPU and a method based on albedo to identify images containing water. Both struggled with the abundance of fully cloud-covered photos and as such the EdgeTPU was about 66% accurate, while the albedo method was only 33% accurate. By sorting out images containing mostly clouds (114 out of 163 images), the accuracy of the EdgeTPU classification remains basically the same at 67%, while the albedo method's accuracy jumps up to about 51%.

To make key aspects of the images more discernable, our program adjusted the contrast of each image by stretching it more toward the 5th and 95th percentile. We also decided to use the Sobel operator to generate an outline of every image taken to analyse the boundaries present in them.

Photo taken by our code on the ISS of Aydar Lake, Uzbekistan | Uncontrasted

Photo taken by our code on the ISS of Aydar Lake, Uzbekistan | Contrasted

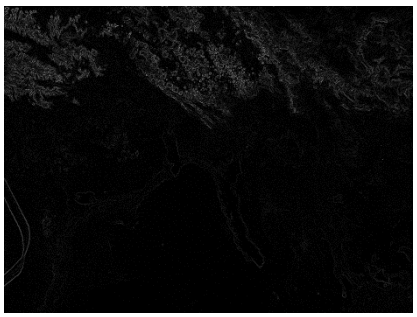


Photo taken by our code on the ISS of Aydar Lake, Uzbekistan | Outline

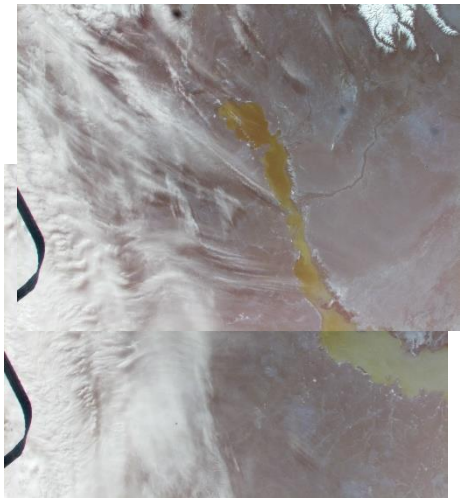
By using the information gathered from the coordinate and water content data, using Google My Maps we were able to map out the path the ISS took while our experiment was running and color code each image location based on the presence of water.

https://www.google.com/maps/d/u/0/edit?mid=18qgTMsBYQV9-Ps68P4lR33if0CYmUm4&usp=sharing

We found a few images that were particularly useful in our research, some of which were photos of Lake Balkhash, Kazakhstan.

Balkhash Lake, Nasa Worldview 2023

Balkhash Lake, Nasa Worldview 2003



Balkhash Lake, Images 74/75 from our project

In these photos, we noticed a drop in the amount of vegetation surrounding the lake and the rivers which feed into it, which can be attributed to the large-scale extraction of water from its feeders. The lake itself has also shrunk by a fair margin; currently, its surface area is estimated to be at about 16,400km2, while at its largest it was 23,400km2. The average albedo of image 74 was 0.377824686, and the value of image 75 was 0.371364329. These values are not perfect because of the presence of clouds in the photos, varying quite a bit from the 0.6-0.10 range expected of plain surface water.

4. Learnings

As a team, we approached the planning and organization with meticulosity and collaboration. In order to coordinate and communicate effectively we held regular team meetings, as they were really useful for exchanging information, research, addressing questions, and keeping everyone informed about how the project was progressing.

One significant challenge we faced during our Mission Space Lab project was the analysis of certain images that weren't fully processed in space, so we ran the code again on Earth to study them. Even if many of the images were covered entirely by clouds, a case which differed from the data our machine learning model has been trained with, we still managed to take some images that play an essential role in achieving our experiment's goals.

We learned how to use the Raspberry Pi and program it, the Coral accelerator, how to use Python in other areas of programming, and also got a deeper understanding of how the hardware elements are connected to the software.

In the future, we would use AI to identify photos that are and aren't containing clouds and exclude those containing clouds, as this would save time and improve our analysis by focusing on clearer photos.

5. Conclusion

Overall, we are content with the results we received and computed. They roughly matched our predictions of vegetation rate drops and water level changes.
We had some difficulties identifying the images because they were covered with clouds, which was a bit of a challenge for us in our experiment, however, we were able to do our investigation and complete our research.
We think that the margin of error in our neural network was too big due to the lack of diversity in the images which were used in its training, a point which we will keep in mind next time.
We are satisfied with what we achieved, but next time we will try to find other ideas where we can use these photos, considering things that are more often found in them.
We all have learned a lot from this experience and we strongly believe that the information and skills gained from working on this project will aid us in many more projects and events to come.