Team Name: Space Quixotes

Chosen theme: Life on Earth

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Introduction

Several researches have shown that near infrared (NIR) can be used to measure turbidity in oceans (1). Our hypothesis is that coastal areas should show a bigger signal in NIR than sea regions far away from the continent. This turbidity may be produced not only by inorganic materials but by plankton, algae and marine animals.

There are indeed some studies of the giant kelp forests using NIR(2). Giant kelp is the largest marine plant, that usually grows up to 35 m in cold and nutrient-rich waters. These forests have a great diversity of plant and sea animals. The research began in the 1970s and Landsat satellite data are managed by the U.S. Geological Survey. These marine forests have high reflectance in the near infrared, so they can be detected and monitored.

In our project we have two objectives:

- to develop a software that takes pictures of the Earth and analyzes if it is a sea or land view.

- to look for NIR signal in coastal areas and compare our images with others taken by different satellites.

(1) https://www.researchgate.net/publication/276001955_Ocean_reflectance_spectra_at_the_red_near-infrared_and_shortwave_infrared_from_highly_turbid_waters_A_study_in_the_Bohai_Sea_Yellow_Sea_and_East_China_Sea

(2) https://earthobservatory.nasa.gov/features/FloatingForests

Method

We have written a software that shot a picture every 5 minutes with Izzi's NoIR Picamera. Theoretically, 36 photographs should had be taken, but in fact we received only 31. As we wanted to detect IR radiation, we have used the blue filter. At the same time the software took a picture, it got and saved in a text file the coordinates of the Earth's surface below ISS.

We have also developed a simple code to analyze the photographs and to write in a text file it they correspond to land or sea.

This code automatically converts the image into a pixel map and measures and adds the value for red, green and blue of ten pixels selected not too far from the middle of the picture to avoid the window frame. Finally, it calculates the ratio blue/red in each picture and if it is higher than 1.1 writes SEA, otherwise it writes LAND. We got the value of 1.1 analyzing photographs of past projects.

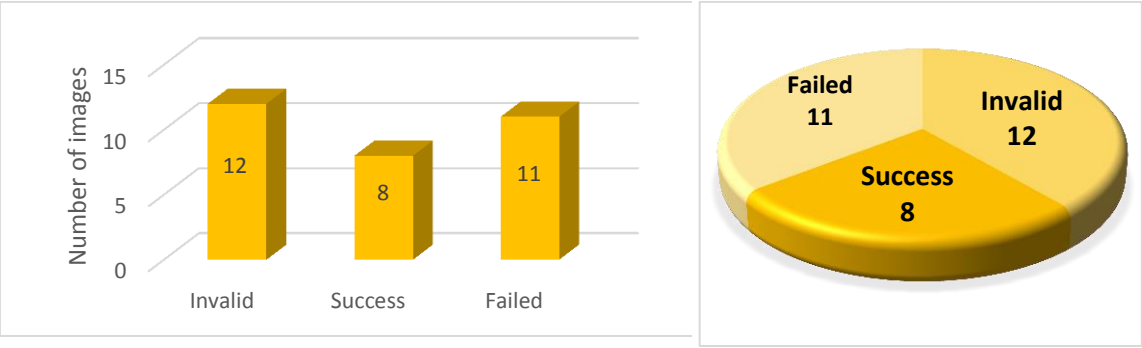
The pictures have been later compared with others from EO – browser to check if the software works.

A message and an icon were also shown in the LED Matrix of Sense Hat during the experiment.

Results

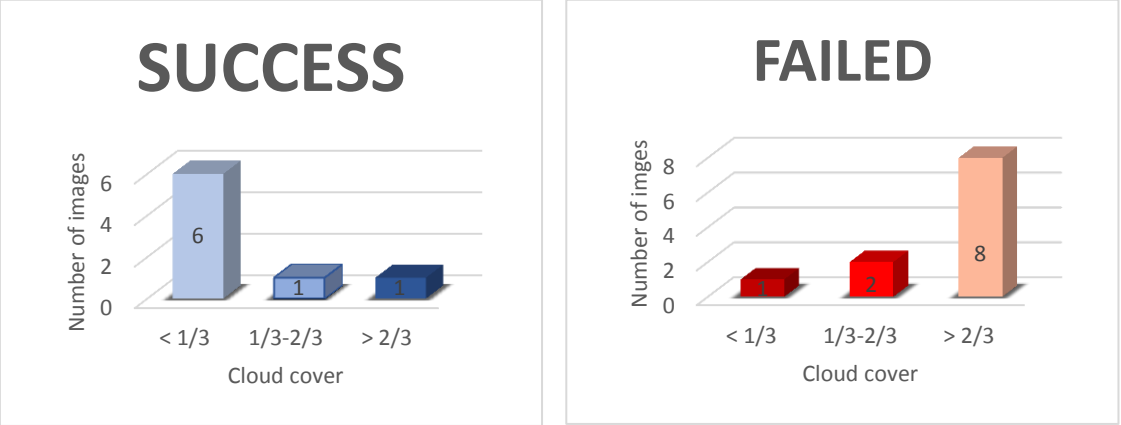
1. Code checking

Graph 1 shows the number of pictures which have been identified correctly as SEA or LAND (Success) and the number of them wrongly identified (Failed). It is also shown the number of photos that cannot be used (Invalid) because they are completely black or out of focus.



Graph 1. Result of the identification process

The number of wrong classified pictures is higher than we expected. As clouds appear in most of the photos, we can assume they may have an influence on the identification. In Graph 2 we can see the correspondence between the correct or wrong identification and the cloud cover in the picture. We have defined three degrees of cloud cover, lower than one third of the image, between one third and two thirds and higher than three thirds.

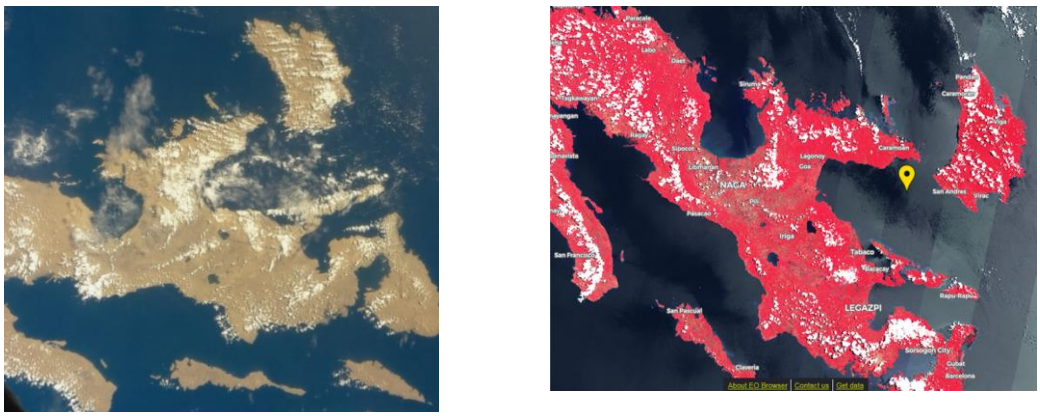


Graph 2. Correspondence between the identification of the pictures and cloud cover

2. Coastal areas images

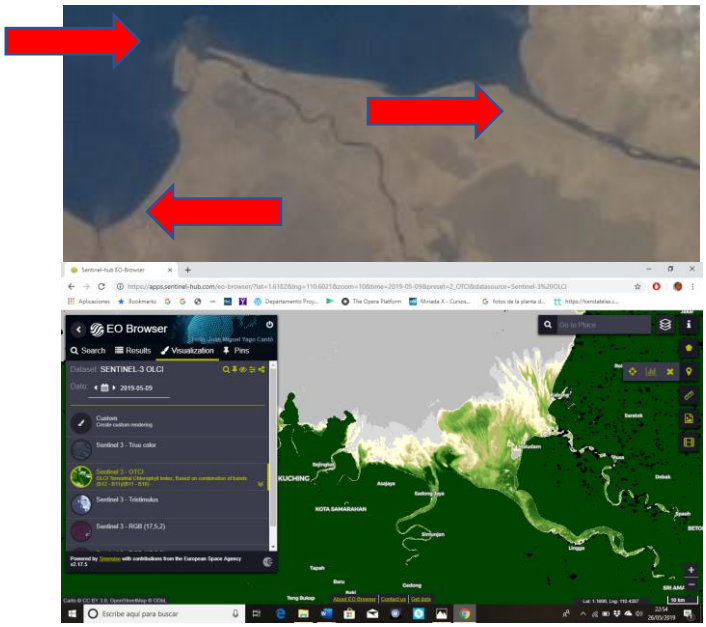
Firstly, we have tried to identify the place of the picture using the coordinates of the text file. Secondly, we have looked for other satellite images of the same place in EO – browser. We have selected those in false colour or with a measure of Chlorophyll Index because they allow to identify the presence of vegetation. As an example, we show two of them in this report.

The first image taken with our code (Graph 3 left) correspond to Philippine Islands. As we have used the blue filter, the green of vegetation appears as brown. In this picture we have found no spot in this colour in the sea. The Sentinel picture (Graph 3 right) in false colour does not show any signal of vegetation in the sea too.



Graph 3. Left, picture taken with our code. Right, Sentinel image

The second image (Graph 4 Top) is a view of the coast of Malaysia. Hear we show only an amplification of it. There are clearly brown spots in the mouths of rivers. The Sentinel picture (Graph 4 Down) shows a Chlorophyll Index around 2 in rivers of the same coast.



Graph 4. Top, picture with our code. Down, Sentinel 3 OCTI image

Conclusion

1. Code checking

Our code has succeeded in taking the photographs (31 from 36) However it has failed to distinguish if they are a land or sea view in many cases (see Graph 1). It might due to the cloud cover, as it is shown in Graph2. For these reasons we are thinking to improve our software:

- Taking more than ten points to measure their RGB values, and allowing the software to select them randomly
- Using another ratios than blue/red to improve the identification of the photographs
- Classify the images as SEA, LAND or CLOUDY

2. Coastal areas images

Using the NoIR Picamera with the blue filter we have been able to detect brown spots in a picture near the mouths of rivers (Graph 4) However, we have seen no sign of them far away from the coast. Comparing our picture with satellite images that measures the Chlorophyll Index, we can assume that the spots in our photograph are probably due to algae and to the turbidity produced by the solids carried by the rivers.

Finally, as we have seen these spots in only one of the images, we should have more of them in the next experiment.