Mission Space Lab Phase 4 report outline

Team name: BOWLING

Chosen theme: Life in Space

Organisation name: IES LEVANTE

Country: SPAIN

1. Introduction

In space it is very important to control the orientation and the movements of the spaceship. For this purpose, there is an IMU (Inertial Measurement Unit) sensor which measures all kind of movements in order to control the orientation of the spaceship at all moments. The Sense Hat has an IMU to detect movement. The main objective of the experiment is to check if there are vibrations in the ship that can be appreciable by the astronauts, and to evaluate their quality of life on board.

2. Method

We have written a python code that measures acceleration, rotation and orientation (yaw, pitch and roll) (*see Figure 1*), with the accelerometer and the gyroscope sensors of the IMU every 10 seconds. The date, time and coordinates (longitude, latitude and altitude) of the ISS were also be recorded. The code main.py and all these data can be seen in our GitHub repository: https://github.com/davidpamos/Bowling.

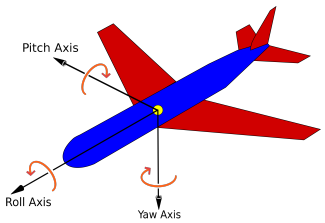

Figure 1: Yaw, pitch and roll in a spacecraft[1]

(1) *Image taken from: https://en.wikipedia.org/wiki/Aircraft_principal_axes*

3. Experiment results

In *Figure 2* we have plot the trajectory of the ISS during the code run, encoding the **altitude** using a colorbar.

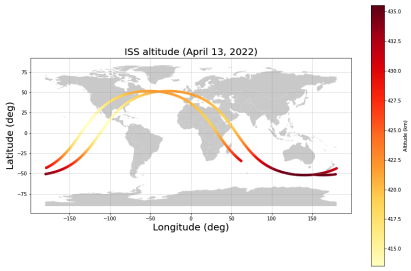

Figure 2: ISS Trajectory during our experiment, encoding the altitude (km)

The maximum altitude variation was around 20 km, a 4.7% of the median value. We think this variation in altitude is not due to the movement of the spaceship, it is due to variations of the topography of the Earth. Note that altitude above Pacific Ocean, in the South Hemisphere is larger than above the continents of the North Hemisphere.

In *Figure 3* we have plot the **rotation** and **acceleration** measured by the IMU sensor.

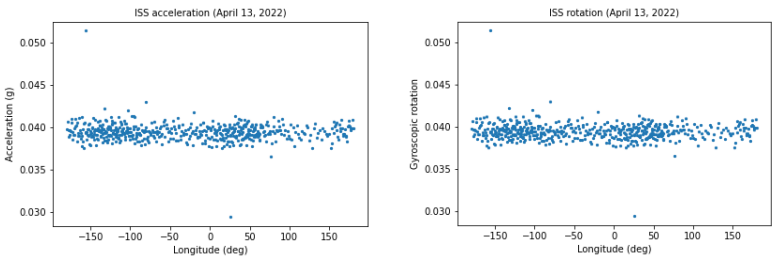

Figure 3: Left: Acceleration during the ISS experiment. Right: Rotation during the ISS experiment.

Neither acceleration nor rotation, in gravity units, are very significative, around 0.040 (g) in both cases.

In *Figure 4* we have plot the three parameters of the orientation: **yaw**, **pitch** and **roll**. As it can be seen in *Figure 1*, yaw is the angular orientation in a plane that is perpendicular to the vertical axis. To plot the corresponding values in *Figure 4* (*left*), we have rested the values above 180º to 360º, to provide continuity to the graph. Otherwise, values above 0º and values below 0º (i.e., below 360º) form a step that would imply that the orientation changes abruptly, and it is not the case. Pitch is the angular orientation in a plane that is perpendicular to the wing-to-wing axis of the spaceship. As it can be seen in *Figure 4 (center)*, the values are very grouped around a median value of 325º. Roll is the angular orientation in a plane perpendicular to the head-to-tail axis of the spaceship. Except at the beginning of the experiment, where we can see values much below of the median value (*Figure 4, right*), the roll has a value

very near the median one, around 60º. Maybe this anomalous value at the beginning is due to a sensor start-up error.

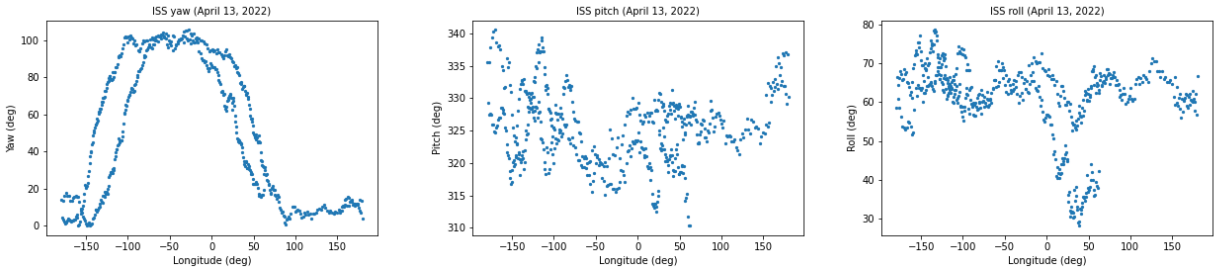

Figure 4: Left: Yaw during the ISS experiment. Center: Pitch during the ISS experiment. Right: Roll during the ISS experiment.

Regarding altitude, acceleration and rotation results, it seems that the ISS orbit is very stable. There are no high variations with respect to the median values, as it can be seen in *Figure 2* and *Figure 3*. Regarding the orientation, it seems in control at all times.

4. Learnings

This project have allowed us to work as a true team, where we have all learnt from each other. Our teacher explained to us the main goal of the project. After a discussion of topics that our experiment could deal with, many of these ideas taken from other winners projects in past editions, we decided on this topic. At the beginning, we had no idea of writing code with python. The teacher gave us the basic details of the language. Two of the team members developed the code with the help of the teacher. Two other team members analyzed data, once received, and the other two members, those who better write in English, wrote the report.

It has been a pleasure to obtain data from the ISS just for us. It has been an unforgettable experience to take part of this project.

We have learnt basic python coding, and techniques for data analyses. But above all, working as a true team on a one-year project has been the most important learning.

5. Conclusion

The results have been what we expected. Being the ISS the most important space laboratory where the most important countries of the world take part with a big budget, we have obtained a negative result, in order to the security and comfort of the astronauts. Maybe, in order to improve our experiment, the code could be run in two different raspberries at the same time, or twice in the same unit on different dates. Then we could be more sure of our conclusions.