Squeeeze Team Mission Space Lab Phase 4 Report

Team Name:Squeeeze

Chosen theme: Life in Space

Organisation name: Emanuel School

Country: UK

Introduction

We aimed to find out to what extent astronaut presence and movement inside the space station could be monitored by the SenseHat. This topic interested us as it would test the ability of the Astropi's sensors, and potentially knowing when an astronaut came near our experiment was exciting.

We would attempt to correlate increases in humidity and temperature, which would indicate an astronaut was near the Astropi, with changes recorded by the accelerometers and perhaps gyroscopes. We expected to see the temperature and humidity levels increase when there was an astronaut in the module and decrease after astronauts left. We hoped to detect vibrations from astronauts if and when they entered the module, and perhaps if they were in adjacent modules, and we would corroborate our data with a published on-line information about what the astronauts were doing at the time of our experiment.

Method

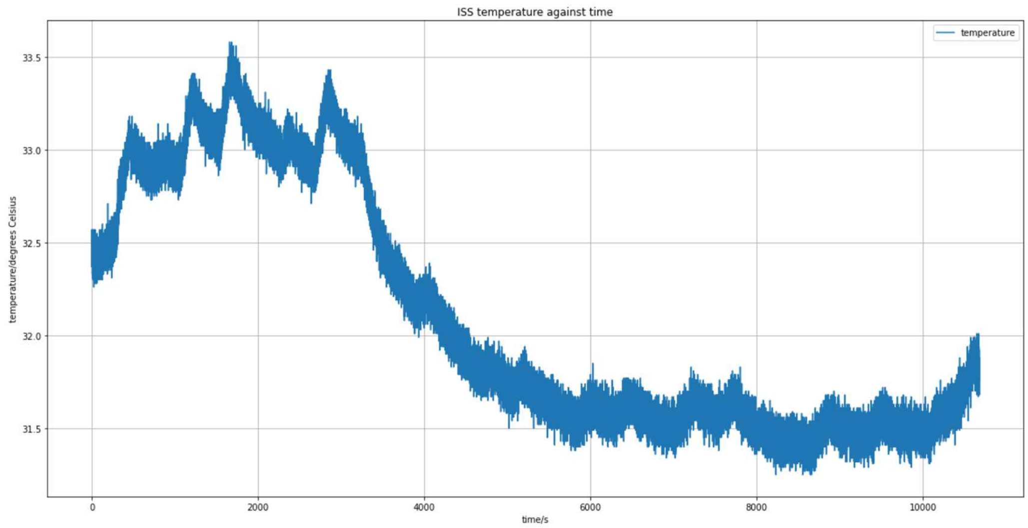
We measured both accelerations and rotations in three dimensions, as well as temperature and humidity. We chose a sample rate of about 5 measurements per second, expecting this would be sufficient to detect the motion we wanted to detect but not make us run out of allotted memory for the data. In terms of temperature and humidity, this sample rate was obviously overkill but it made the programming easier.

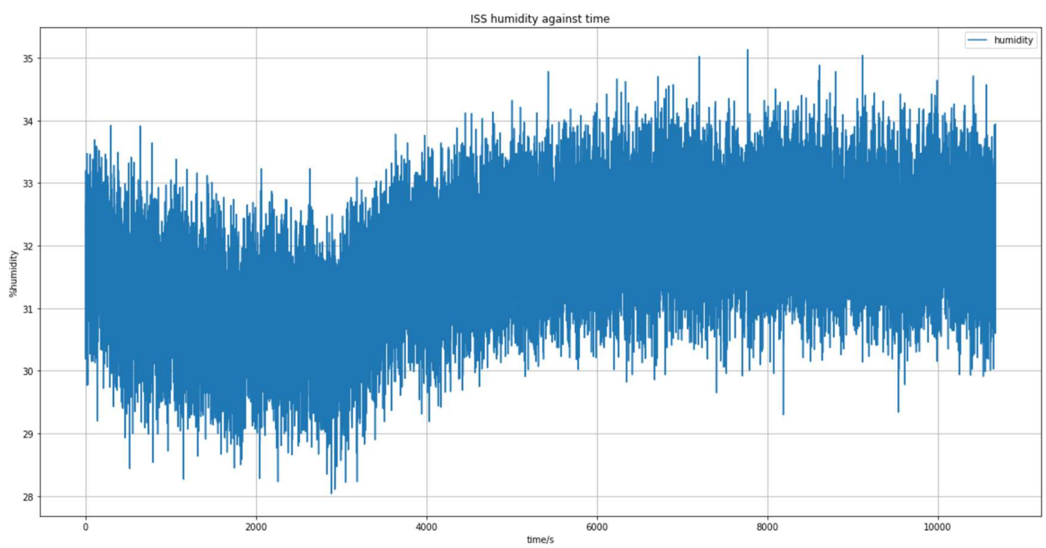
Data was collected as comma separated values. We used the Python Data Analysis Library Pandas to study the data and Matplotlib to produce graphs in order to compare variables which might show interesting a relationships. We later used the ephem library to determine latitude and longitude for the ISS at the time of each data point.

Results

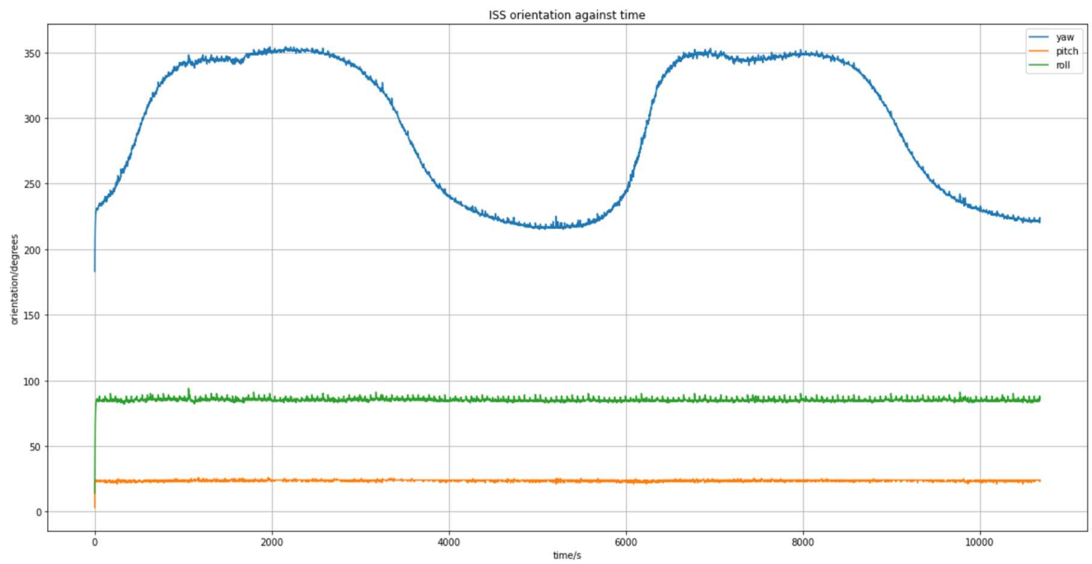
Our experiment ran for three hours mid-afternoon on 24^{th} April 2021. A new crew had arrived at 0715 that morning and there were 11 astronauts on the ISS that day. None of them, according to our data, ventured into the Columbus module. We saw no acceleration data that would indicate an astronaut pushing against a wall or panel near the Astropi and no temperature or humidity change as large as we would have expected from a breathing person.

Our data shows a small variation changes in both temperature and humidity, as shown. The change in temperature could potentially be caused by the opening of an airtight hatch causing a change of airflow. A decrease in temperature would, by itself, account for a rise in humidity.

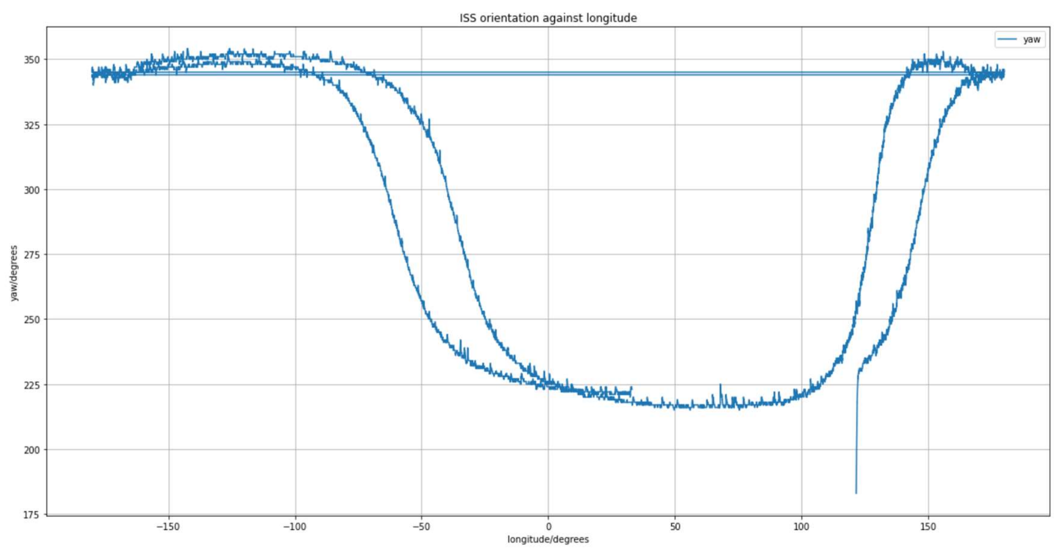




The data from the AstroPi gyroscopes is the most interesting and also the most perplexing. The yaw data shows an approximately sinusoidal variation with a period of about 95 minutes (compared to the expected 93 minutes) to tie in with the orbital period of the ISS which certainly indicates meaningful data. The pitch and roll values do not change to any significant degree after the first 20 minutes. All the gyroscope data seems to have a linear variation over this initial time which is never repeated. We did not find any explanation for this but it seems to be a feature of the sensor rather than anything real.



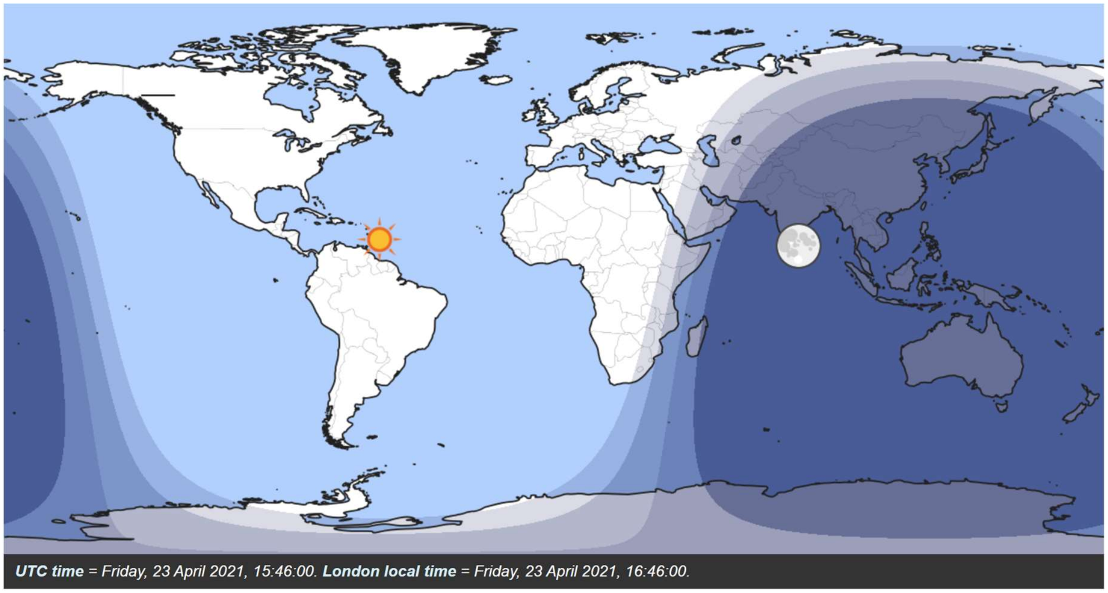
The yaw value varied through 170 degress, rather than 360. It changed rapidly twice each orbit and was more or less constant at other times. On a plot of yaw against longitude, the change is most rapid at about 145E and 40W on the first orbit and 125E and 60W on the second.



Conclusion

The pitch and roll data can be explained if the AstroPi is orientated with respect to the ISS so they do not change with orbit. It does not explain why the yaw does not vary from 0 to 360 degrees as the ISS orbits. If the ISS is orientated so that the same side of it faces downwards, then it will rotate around 360 degrees as it orbits.

Rapid change in yaw corresponds to times when the ISS is moving from day to night or vice versa (see diagram)



Research shows that the ISS solar panels are orientated to face the sun when it is in sunshine and to present the least resistance against air molecules when it is not. Thus at these times it is reasonable to suppose the solar panels are being moved, which would cause the rest of the station to rotate in the opposite direction.

Subsequent tests with an AstroPi show that slow changes in the orientation caused by the Earht's rotation do not show up well on the gyroscope data, so it would be reasonable to suppose that the yaw is only changing significantly while the panels are being moved.