Can we use the Astro Pi as an emergency astro-navigational system?

**Introduction**

Malfunctions in any system are virtually inevitable, but in the case of systems operating in space – like the ISS (international space station) – they can be especially dangerous. This year, the ISS was destabilised after an [error caused the Nauka module’s thrusters to fire](https://www.bbc.co.uk/news/science-environment-58021394). The issue was only resolved a full hour later. Had something else also gone wrong, for example if the ISS also lost power, the results could have been disastrous.

This is what inspired us to investigate whether the Astro Pi could be used as an emergency Astro-navigational system. The Astro Pi is small and does not require much power (a battery of around 6 V would be more than sufficient) which makes it convenient to power in times of disaster.

We could use the Astro Pi’s sensors, along with known data to calibrate the parameters, to calculate the velocity, altitude, and the orbital period of the ISS. This, in times of catastrophe, could help map a predicted path of the ISS, as well as serve as a general alarm system that detects anomalies in its movement (which could help detect and diagnose situations similar to the recent Nauka incident fast.)

We would use the experiment time to make sure the readings are accurate enough to use as an emergency navigational system and we would also calibrate the system so that it can detect anomalies in the space-craft’s movement.

**Method**

**Chart

Description automatically generated**Our experiment would be split into two parts – finding the accuracy of our measurements and calibrating our system to be able to accurately track the ISS’s movement.

Figure 1

The orbit of the ISS is almost circular and is depicted in *figure 1* as the outer circle, with point C being the Earth. ISS is also constantly rotating to maintain its orientation to Earth. We would measure angle α by taking a reading on the gyroscope at points A and B. We would then use the formula and secondary data from the [heavens-above 10 day predictions](https://www.heavens-above.com/PassSummary.aspx?satid=25544&lat=0&lng=0&loc=Unspecified&alt=0&tz=UCT) to see if our gyroscope data is accurate enough to calculate *r* and *l* precisely.

In a real-life emergency situation, the Astro Pi would have access to the most recent GPS readings / calculations of hopefully either *r* or *l*, which would allow it to keep track of the ISS’s location even if the power is down, using those parameters to calibrate it (instead of using secondary data as we will be).

After we collect our data, we would use the results to run a simulation that can predict where the ISS would be at any time using the parameters collected.

Furthermore, the gyroscope can also be used to make sure the rotation of the spacecraft remains stable, and it doesn’t rotate more than it should like the Nauka did (it rotated 540 ֯), and if that was to happen, to send an alert that something is wrong. **Preliminary Ideas**  
One of our original ideas was to calculate the deceleration caused by atmospheric drag using the accelerometer, and then use the formula to derive (where is the first reading and is the second)andcalculate the increase in velocity depending on the increase in drag. This could then – when calibrated –have been used to calculate the velocity, and the altitude (calculating the altitude would’ve used the same method as seen in *figure 1*, but it wouldn’t have used secondary data like we are planning on doing).

Unfortunately, after checking the IMU sensor’s specifications, we discovered that it was not sensitive enough to detect the deceleration caused by drag (it was over 1000 times too small to detect).

We also considered measuring the magnetic field strength using the magnetometer at different points in the orbit and then averaging them after the ISS completes a full orbit of the Earth, and then using that data to calculate the altitude of the spacecraft, but we decided that the magnetic field varied too much at different points of the Earth to be able to calculate it accurately.