

Mission Space Lab Phase 4 Report

Team Name: SpaceChain

Chosen theme: Life on Earth

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Country: Austria

Introduction

Blockchain technology is called the "most disruptive technology since many years". Will it be used in the area of space research soon? Based on this question the idea for this experiment was born.

The project "SpaceChain" will bring together the topics "space research" and "blockchain technology".

In the first part of the experiment, pictures from earth were taken, the hash value of an image was written into the meta-data of the next image, so the images were "chained together" – like the blocks in a Blockchain.

In the second part (back on earth) the data (positions, timestamps and images) was used to visualize the experiment on a map and publish it on a webpage.

In an upcoming phase the data will be used to create so called "Space Tokens" – digital twins of the images, living on a Blockchain.

So this experiment is a memento for the first blockchain activities in space, happening in the ISS and using Rasperry Pi technology.

Method

During the flight phase the images and data were collected by our program, using the following algorithm:

Every 'loop_interval' (i.e. 15 seconds) the 'main loop' was called, executing the following steps:

Step 1: Calculate ISS position and height (using lib ephem) and write position and height to the EXIF data of the (next) image.

Step 2: Build the string "image_infos" and calculate the md5 hash of it, this will be used as the EXIF tag "ImageUniqueID", build "annotate_text", this will be written to the image as overlay text.

Step 3: Write step 2 information plus the sha256 hash value of the last image to EXIF data of the (next) image. This is "chaining" the images together (similar to a blockchain) and allows to detect, if an imagefile has been changed later.

Step 4: Capture a new image and write it to disk, calculate the sha256 hash value of the new image and keep it for next loop.

Step 5: Write all relevant infos to the CSV data file.

Step 6: Check, if max duration (3 hours) is reached or max diskspace (3GB) is exceeded; if yes, exit, else wait until next loop_time is reached.

Result

The results of the flight phase were:

- 715 images including all recorded and calculated data as EXIF infos (viz. Figure 2) as well as some data as overlay text (viz. Image 1).
- A datafile including all data for later processing, also showing the chaining of the images with hash values (viz. Figure 3).

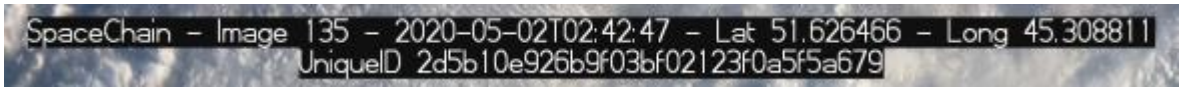

Image 1: Infos as overlay text

```
Filename - SpaceChain_img_135.jpeg
ImageWidth - 2592
ImageLength - 1944
ImageDescription - SpaceChain: Hash value of previous image (sha256): c5d240f9b5f01b429d3312c53f33cb8e1552f402ff1c32042b86863dc5615473
Make - RaspberryPi
Model - RP_ov5647
Software - APMSL20 V1.1 Team SpaceChain
DateTime - 2020:05:02 02:42:47
Artist - https://spacetoken.at/
ExposureTime - 1/189.4 seconds
FNumber - 2.90
ISOSpeedRatings - 100
DateTimeOriginal - 2020:05:02 02:42:47
DateTimeDigitized - 2020:05:02 02:42:47
ShutterSpeedValue - 1/189 seconds
ApertureValue - F 2.90
BrightnessValue - 2.26
MaxApertureValue - F 2.90
MeteringMode - Center weighted average

GPS information: -
GPSVersionID - 2.0.0.0
GPSLatitudeRef - N
GPSLatitude - 51  37  35.299999 (51.626472)
GPSLongitudeRef - E
GPSLongitude - 45  18  31.700001 (45.308806)
GPSAltitudeRef - Sea level
GPSAltitude - 425125 m
```

Figure 2: EXIF data

Loop	DateTime	Latitude	Longitude	Height	eclipsed	uniqueID	lastHash	currentHash
1	2020-05-02T02:09:10	-30.513668626451448	-63.94882772697079	427986.09375	True	62764bcf574948e6277d15	n/a	fc588aac428ea212143fd9
2	2020-05-02T02:09:25	-29.84008903088313	-63.20831910772552	427737.40625	True	f7d9df2d2731862b5020dc	fc588aac428ea212143fd94c	dc0907c5e6ea65db59b0e
3	2020-05-02T02:09:40	-29.16169073685537	-62.478602187368864	427488.875	True	6ed7036961399ecf1e2c1a	dc0907c5e6ea65db59b0e7a	87ef51721112645f0b0e2c
4	2020-05-02T02:09:55	-28.478663282117633	-61.75932179606399	427240.6875	True	0d4979b6ad28b8bbe4d09	87ef51721112645f0b0e2c04	208d883666abd62fc948fc
5	2020-05-02T02:10:10	-27.7911927893248	-61.05010910359572	426993.09375	True	6a60f04b9c4d86ae59b421	208d883666abd62fc948fcfb	1acff5b5a9dc9667fd2297
6	2020-05-02T02:10:25	-27.099461966037175	-60.350622600505545	426746.3125	True	a2bd51a7fa91d70aedc7e8	1acff5b5a9dc9667fd2297c9	e7b36a269ad3cebbe1e2f
7	2020-05-02T02:10:40	-26.40364498207859	-59.660513947145795	426500.5625	True	2a4ca54117f099baf8d670	e7b36a269ad3cebbe1e2f5	4adfb40329e3b1e8d63ec
8	2020-05-02T02:10:55	-25.703907469536414	-58.97944163405798	426256.0625	True	9559c9da9b669af588b18a	4adfb40329e3b1e8d63ec6(	f3b254be69711ee2a59cc:
9	2020-05-02T02:11:10	-25.00041676804532	-58.30708464235109	426013.03125	True	01eac967da3106300fef63	f3b254be69711ee2a59cc10	cad2b15443418b0c21f859
10	2020-05-02T02:11:25	-24.29332826440892	-57.64310146256664	425771.6875	True	719cf2f4f907e52d7ee89c	cad2b15443418b0c21f8596	1942e1806f5351e256913:
11	2020-05-02T02:11:40	-23.58279563788354	-56.98718473619198	425532.28125	True	d464f0e10bcad67ba0a02(	1942e1806f5351e25691336	c162eb3a926475039fa487

Figure 3: Generated datafile

The processing of all data and images then resulted in a visualization on a map, presented on a webpage:

- The positions of the ISS when the pictures were taken are shown as red dots.
- When a dot is clicked an info window opens, showing the corresponding data and a thumbnail of the image.
- A click on the thumbnail then opens the image in original size.

The webpage (see also Image 4) can be viewed here: https://spacetoken.at/

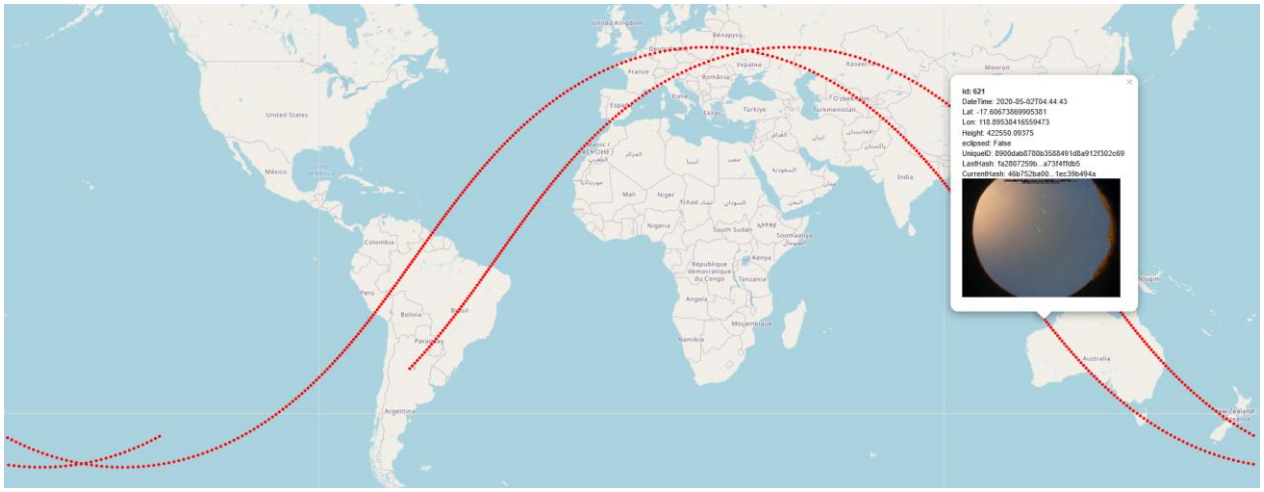

Image 4: Screenshot of the visualization

Conclusion

This experiment worked as planned during the flight phase as well as the processing of the results and generating the visualization.

In an upcoming phase the data and the images will be used to create "Space Tokens" as so called "non fungible tokens" – digital twins of the images, living on a Blockchain. This will happen using "smart contracts", programs which run decentralized on the Ethereum Blockchain and can never be stopped.

Each and every token will be unique - having one of the images assigned as well as the timestamp and the position when it was taken - and will be distributed to interested collectors.

So this experiment is a memento for the first Blockchain activities in space, happening in the ISS and using Raspberry Pi technology.

Finally, we would like to thank the European Space Agency for this great opportunity to take part in the 2019/2020 European Astro Pi Challenge!

2020-07-03, Team SpaceChain, Vienna/Austria