Group Project

Satellite Ground Station

Sławomir Figiel Tomasz Mrugalski Ewelina Omernik

Technologie Kosmiczne i Satelitarne

Supervisor: prof. M. Moszyński, Ph.D D.Sc.

Technical supervisor: W. Siwicki, Ph.D.

2019-10-31



## Project participants

* **Tomasz Mrugalski** (TM) – project lead, orbital mechanics specialist, logistics, reliability engineer
* **Sławomir Figiel** (SF) – geospatial data engineer, programmer, Raspberry Pi, OS specialist
* **Ewelina Omernik** (EO) – low-level software developer, integrated circuits specialist

## Project Schedule

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Task** | **Deadline** | **Coordinator** |
| 1 | **Feasibility study** Research of available satellites, capabilities of existing SDR hardware, necessary SDR, antenna and LNA capabilities. | 2019-10-17 | SF |
| 2 | **Hardware acquisition** Selection of specific hardware type, vendor selection, purchasing process, shipment, hardware delivery. | 2019-11-07 | TM |
| 3 | **System integration** Hardware (computing unit, SDR, antenna, wiring), assembly, base software installation (OS, SDR drivers, SDR software) | 2019-11-14 | EO |
| 4 | **Software automation design**  Design of the automated data acquisition, processing pipeline, data deployment | 2019-11-21 | SF |
| 5 | **Software implementation**  Implementation of the design specified in task #4, developed software deployment | 2019-12-05 | TM |
| 6 | **Test campaign**  Test specification, experimental assessment of the system performance, test report, improvement suggestions, conclusions | 2019-12-19 | EO |

## 

## Progress report

Task 1: Feasibility study.

The first task conducted was a determination whether the data reception from satellites is feasible by a group of students with modest budget. The key concern was whether the hardware required to reliably and repeatedly receive transmissions would be within our budget. Several existing projects were identified with reported repeated successes [1], [2], [3]. The typical radio hardware used was an inexpensive SDR (software defined radio) running on a PC, connected to VHF antenna. In some projects additional components, such as LNA (low noise amplifier) or more advanced directional antenna with tracking mechanism, were used.

Our team looked at various embedded computing platforms. The leading solution available on market is a Raspberry Pi. Its popularity comes from several factors – affordability (cost around 50-70 EUR), high performance (1.5GHz CPU, comparable to mid-level laptops), availability (sold by many vendors, hardware available in stored, including those in Poland), and extensibility (4 USB sockets for data, powered over USB, Ethernet, some models have PoE, some models have WiFi integrated, GPIO, HDMI output). Our earliest experiments used Raspberry Pie 1B+ model, which is 5 years old. While it has proven the general approach, it was difficult to work with due to low performance. We decided to use the latest RPi 4B model. For more details, see Gitlab #4.

Another researched aspect was the radio bands. Two most popular bands are VHF and UHF. We decided to use VHF due to being used by several Polish sats, available antennas and other factors. For more details, see Gitlab #2.

The third researched problem was the choice of antenna. We had to balance several factors here. First concern was he antenna availability. Since the project has strict deadlines imposed, we wanted to get the antenna as soon as possible. Second, the antenna should be reasonably simple to construct. The final aspect was financial. There are many high performance antennas, but their price is often prohibitive. Two final candidates were Winkler turnstile antenna and WiMo TA-1. The latter was slightly more expensive (90EUR, compared to 40EUR), but offered much better delivery options (shipment within 4 days rather than 28 working days).

The deliverable for this task is an analysis with set of specific hardware selected for purchase.

Bilbiography

1. Satnogs project website, <https://satnogs.org>, retrieved on 2019-10-14
2. Perun Rockets website, <http://perunrockets.net/posluchajmy-satelitow.html>, retrieved on 2019-10-14
3. Pobieranie zdjęć ziemi z satelity za pomocą anteny DIY i… tunera TV, <https://majsterkowo.pl/pobieranie-zdjec-ziemi-z-satelity-za-pomoca-anteny-diy-i-tunera-tv/>, retrieved on 2019-10-30.