CanSat 2024 Team Presentation

“You never fail until you stop trying” - Albert Einstein

TEAM MEMBERS

Andrei Țigan

Role: Team leader and software advisor. Coaching and coordinating the team.

David Chereches

Role: Software design, data analysis, outreach planning.

Daria Fologea

Role: Recovery system, ground station, data analysis and interpretation.

Alin Lupău

Role: Software design and high-level programming, Mechanical design.

Andrei Costea

Role: Electronics design & integration.

Mark Trefi

Role: Mechanical design, outreach projects, and computer modeling.

CANSAT MISSIONS (PROPOSALS)

PRIMARY MISSION

Perform an atmospheric survey. A CanSat will be released from an altitude of roughly 1000 meters, and it will have to use its parachute to stabilize its flight and shall transmit data about:

- Air temperature
- Air pressure

SECONDARY MISSION

It consists of measuring other atmospheric parameters such as:

- Muons (heavy elementary particles)
- Humidity
- The amounts of CO/CO2
- UV Radiation
- Volatile Compounds

The main result we expect from the first mission is proof of an Earth-like atmosphere. The data received from the additional sensors for the secondary mission will provide evidence of a life-sustaining environment.

CANSAT CAPABILITIES

During the descent, the CanSat will record, store, and transmit the following data:

- Humidity and air temperature
- Barometric pressure
- Magnetic field
- UV Radiation
- GPS Location
- Orientation
- Position in space using a gyroscope
- CO_2 concentration

THE MISSION

For our secondary mission, we wanted to do more than just measure temperatures and barometric pressure. We wanted to extend the list of parameters that the CanSat will monitor, so we included sensors such as a UV radiation and a humidity one. We record multiple readings for the same parameters from different sensors.

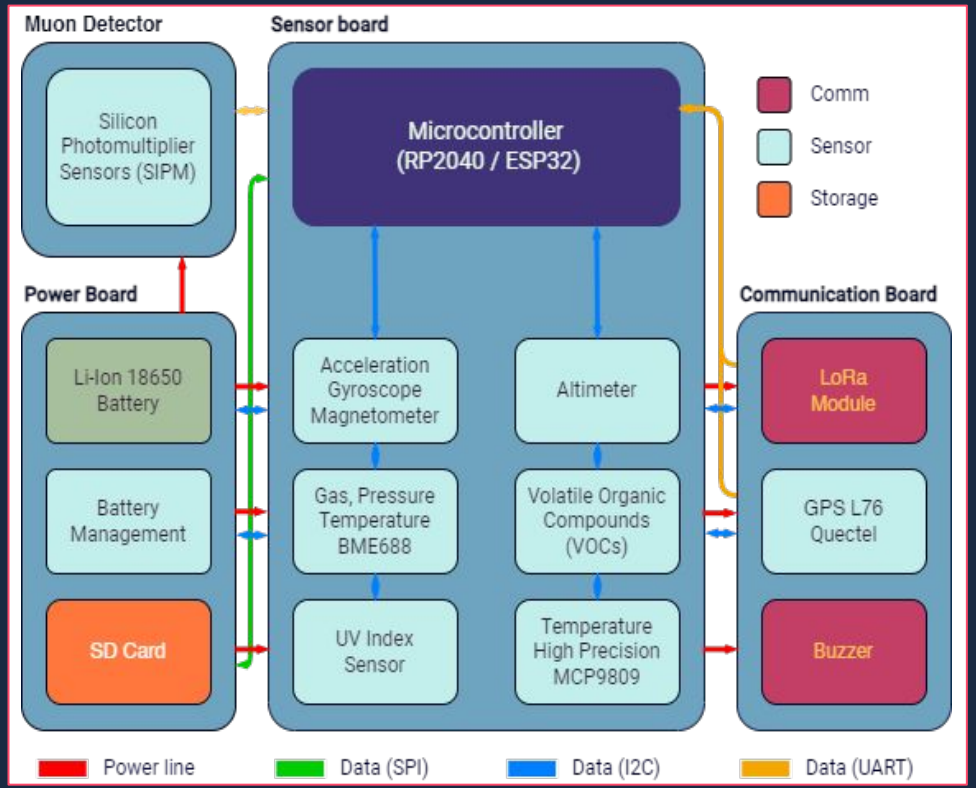
Although our CanSat will still be a stack of sensors, we wanted to give our team the freedom to explore new ideas. This wish is what ultimately led us to include an extended list of parameters that we would like to monitor, including muons. By collecting readings from multiple sensors, we can make more informed decisions about the environment the CanSat is landing in.

THE DESIGN

The CanSat core is composed of three boards, positioned into a frame, and is located in the upper part of the CanSat.

- One Power board, which assures the power for the microcontroller and sensors, also contains the buzzer;
- The Mainboard with an ESP32 chip runs the program during the mission. It also contains all the I2C connected sensors used by the CanSat for gathering precious data during the mission;
- The Communication Board (with LoRa capabilities) is the primary communication system of the CanSat and also the communication relay for transmitting telemetry and parameters during the flight time;

ELECTRICAL DESIGN



The Sensor Board contains the microcontroller (ESP32), the acceleration, gyroscope and magnetometer sensor (MPU-9250), the gas, pressure, temperature and VOCs sensor (BME688), the ambient light sensor (UVA and UVB) sensor (VEML6075), the altimeter (LPS25H) and the temperature high precision sensor (MCP9809).

The Communication Board (with LoRa and GPS L76 Quectel) is the primary communication system of the satellite. A buzzer can also be found in this category.

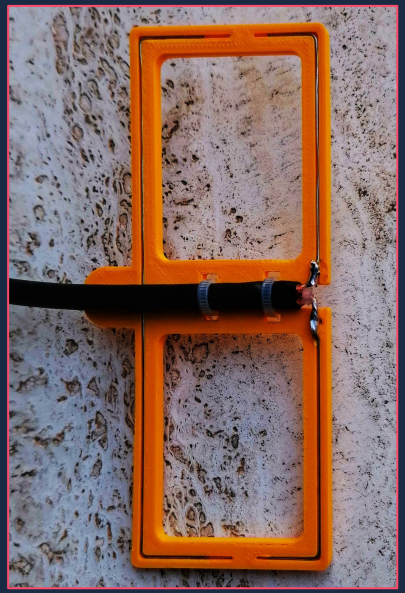
The Power Board contains the battery management sensor and the Li-ion 18650 battery.

THE GROUND STATION (PROPOSAL)

For the ground station, we intended to use LoRa based custom build PCBs, both connected to PCs.

We intended to use one antenna working on 868.1 MHz, designed to receive the GPS location of the can using JSON (after launch our CanSat sends the GPS coordinates continuously using this old radio protocol for an easier location identification).

Our main data transmission is on the 868.1 MHz and for this we are also intended to use a Moxon antenna. The soul purpose of this antenna system is to collect the packages transmitted from the CanSat, while in the air.

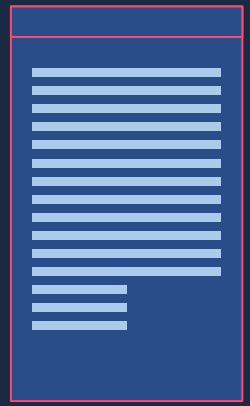


Moxon antenna

CANSAT DATA PACKAGES

The telemetry packages that are sent from the Cansat have the following form:

{'type': 'TLM', 'pid': 16, 'epoch': 770159459, 'valid': True/False, 'local': 'year-month-day time', 'data': {'acc': {'icm20948': {'accel_y', 'accel_z', 'accel_x'}}, 'pres': {'bmp280', 'lps25h', 'bme688'}, 'hum': {'bmp280', 'bme688'}, 'alt': {'bmp280', 'lps25h', 'bme688'}, 'gyro': {'icm20948': {'gyro_y', 'gyro_x', 'gyro_z'}}, 'temp': {'bmp280', 'lps25h', 'bme688', 'mcp9808'}, 'mag': {'icm20948': {'mag_x', 'mag_z', 'mag_y'}}, 'uv': {'uvb', 'uvidx', 'uva'}, 'air': {}, 'bat': {'volt', 'soc'}, 'gps': {'gps1': {'timestamp', 'latitude', 'longitude', 'altitude'}, 'gps2': {'magnetic_variation', 'mode', 'date'', 'speed', 'course'}}}, 'esp32': {'fmem', 'wss'}}



We are recording all these parameters on the flash memory of ESP32 on the Cansat and on the ground station (if the team is present at the launching site). The data saved on the CanSat is of higher quality, although we send a package with a complete set of data through radio (LoRa) every ten registrations. The received data is simultaneously saved on the station’s flash memory and sent through the serial connection to a PC for live monitoring.

DATA ANALYSIS

The data our cansat collects during its mission is processed and analyzed using Data Analysis and Data visualisation libraries in Python. The data will be analyzed statistically and mathematically modeled to determine the trajectory and position of the can on the descent, respectively to correlate the data between parameters and to plot the measured data and the interdependence of some of the parameters, if we can detect such relations between them (for example the pressure-altitude relationship, or the temperature-altitude relationship).

Success and failure conditions

Criteria for success:

- Successful launch
- Live data transmission and telemetry
- Successful parachute deploy
- All system nominal (reliable sensor and location data)
- Descent rate between 5-10 m/s
- Recovery of the undamaged can
- Data analysis
- Generating reports

Criteria for failure:

- Communication failure
- Power limitations
- Environmental factors
- Technical limitations

Conclusion

In conclusion, our CanSat’s objectives and mission are designed to fulfill the requirements ,achieve technical performance, to enrich us with the experience of projecting, understanding and building a CanSat, and our understanding of atmospherical parameters.

Thank you for your time!