CanSat Scientific article - June 2021

NEWT : Nifty Exoplanet Watching Tool

Development of a can-sized probe made for long-term atmospheric measurements

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Introduction

NEWT is an associative project developed by a team of Sorbonne Université students, in the context of the C'Space 2021 contest. The main objective of this project is to design a miniaturized lander, therefore to make the CanSat as light and small as possible. Despite these two constraints, it must also carry out several conventional missions for a lander: it has to be able to land on the ground without damaging the on-board electronics, then analyse its environment and transmit this information by telemetry.

I. CanSat Team

Top Aero is an association of Sorbonne University created in 2018. It brings together students from different fields of engineering (about 60 members this year) to carry out projects related to aeronautics and space. This year, in addition to Newt, it is working on an experimental rocket, a transonic rocket and a mini-rocket, as well as a solar drone and a wing with a deformable profile.

The team working on our Cansat has undergone several changes since the project began in October 2019. The members currently in charge of the mechanics joined us only 1 month ago, during which they learned about the project and its stakes, and found and implemented new solutions.

Name	**Role**	**Studies**
Ninon Carmignac	Project management	M1 Physics
Nikolaï Birolini	Electronics	L3 Electronics
Walid Dahmani	Mechanics	L3 Mechanics
Jim Heng	Mechanics	L3 Mechanics

Table 1: Team members

II. CanSat missions

A. Mandatory mission : data transmission

The arduino needs to transmit the received data with a radio communication system to an Arduino Mega in the control center. Moreover, it has to detect his drop and send a confirmation of it. The detection is realised with the BME680 sensor, it will send this message if it detects a change of 5 meters in the detected altitude.

The 16 bits frame used to transmit these data:

Temperature ; humidity ; pressure ; altitude

0 5 9 12 16

Figure 1: diagram - the 16 bits frame used to transmit the data

This arduino mega will send these data with a serial port in a personal computer. The software in the computer will decrypt these frames and save it on a txt file.

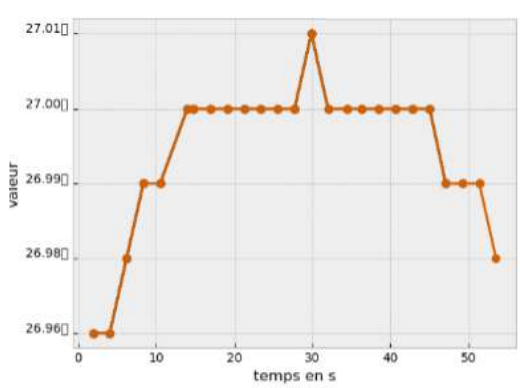

Figure 2: plot - temperature versus time

To make it more visual, we have a program that can print in real time the data transmission. In this test without the telecommunication part, we can clearly see that we can decode frames and print the temperature measurement of the CanSat.

B. 1st optional mission : atmospheric measurements

Our scientifical experience is to measure these different physical parameters:

- The temperature
- The relative humidity
- The altitude
- The pressure

Before the measurement, we must first calibrate the initial temperature and the initial pressure. We will then compare our results with the measurements made on site by Planète Sciences.

C. 2nd optional mission : legs deployment

The role of the legs is to support both the solar panels and the CanSat when landing.

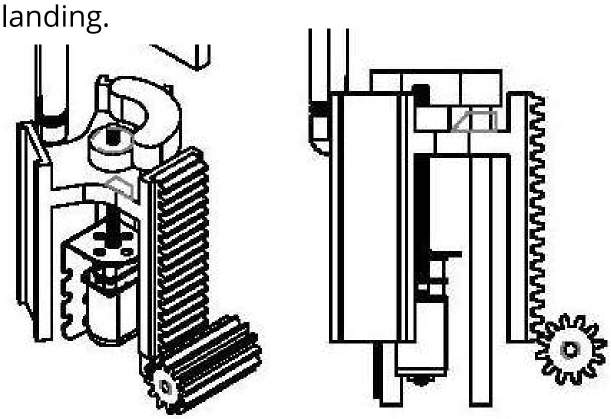

Figure 3 : plan of the leg opening system

We developed an opening controlled by a central engine. It rotates a screw, which makes a nut go up. It is attached to a rack per leg, which each rotates a pinion, triggering the opening of the legs. The legs and the pinions are slid around a 2mm metal axis, around which they both rotate. The racks will be equipped with limit switch sensors to stop the opening of the legs around 120°. We can thus control the speed and angle of opening of the three legs, with a single central system in order to gain mass and volume occupancy.

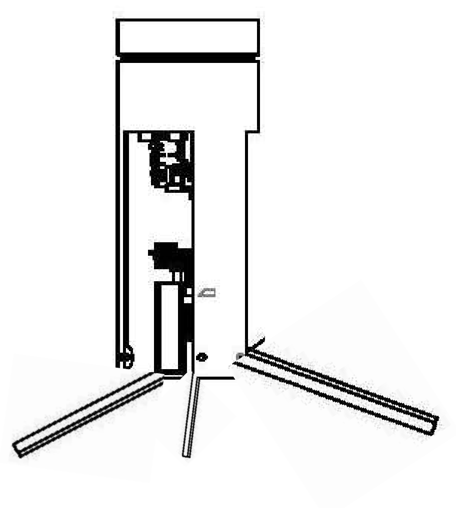

Figure 4 : plan of the overall design of the legs once opened

D. 3rd optional mission : solar charging

Our last mission but not least is to make an autonomous CanSat. On its three legs there will be solar panels. The aim of this mission is to supply its batteries with those.

The completion of this mission will be given by the switch on of a led, visible from the outside of the CanSat.

III. CanSat design

A. Mechanical design

We decided to design most of the components of the CanSat ourselves (body, cap, legs, racks, pinions, using SolidWorks), and then print them in PMMA plastic. This allows us to have custom pieces, which are light and adapted to the small volume of our cansat.

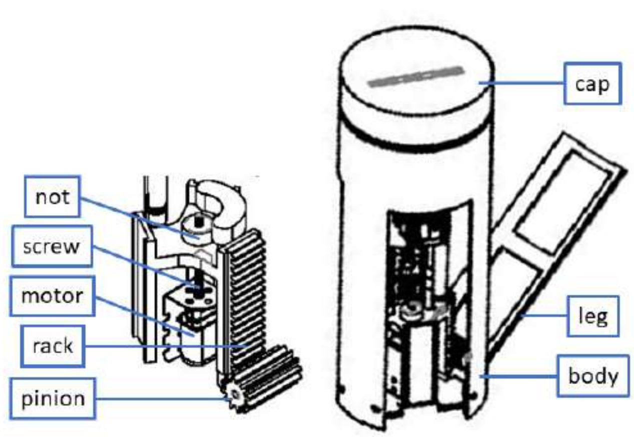

Figure 5 : main mechanical pieces of the CanSat

Most of the electronic components are attached to the cap, which is screwed to the body. All printed parts weigh 200g in total, and the electronic is about 100g, giving us a total of 300g, for a height of 20cm and a diameter of 8cm.

B. Electrical design

The electrical design can be separated in two parts :

- The sensor's and teletransmission's part
- The supply part

a. List of components :

Components	Position	Number
Solar shield Seeduino	interior	1
Arduino uno	interior	1
BME680	interior	1
Motor	interior	1
Antenna	interior	1
Batteries	interior	2
Solar panel	interior/exterior	1 per legs
Interruptor	exterior	1
Led	exterior	1

Table 2: electrical components

b. The sensor's and teletransmission's part

All these components are controlled by the arduino UNO. The BME680 is the sensor that receives the data. It works with an i2C protocol. The arduino creates a frame of data and sends it with the antenna to the arduino mega on the ground control.

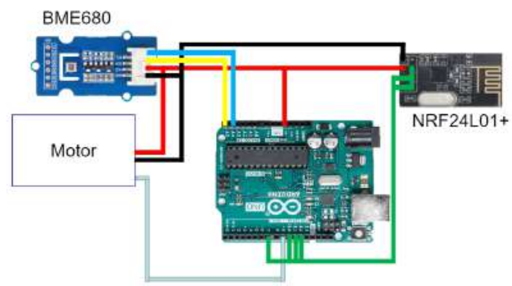

Figure 6: electronic diagram of the sensor and teletransmission

The antenna has a scope of 1,1 km and it works in 2.4 GHz. All these components were chosen for their sizes and their consumption.
Furthermore, we chose the Arduino UNO card because it's simple and it has lots of documentation.

c. The supply part

The Arduino UNO will be supplied with two batteries of 3.8 v. Moreover these batteries will be attached to a seeduino solar shield because we want to use solar panels to supply them.
The interruptor controls the supply chain like it was required in specifications and the led will indicate if solar panels are working after the deployment.

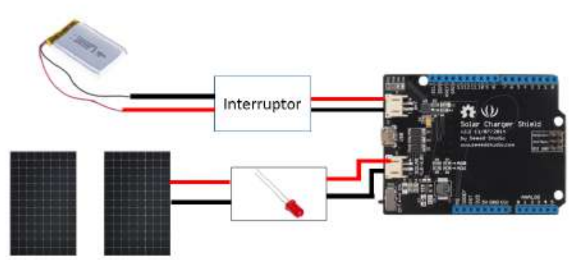

Figure 7: electronic diagram of the power supply

IV. Discussion and conclusion

As we have seen, the main problematics of this project is miniaturization. To this end, we have tried to combine two functions into a single element: the legs that carry the solar panels. We had to find an efficient system to open the legs without the risk of damaging the solar panels, while also minimizing its weight and size. We considered many solutions such as torsion springs, or a system of rod and notch to block the legs in the low position. However the constraints imposed on the opening system were too strong, due to the large angle of opening of the legs. That's why we had to come up with an opening controlled by a rotating motor. We can thus control the opening, and ensure that the legs are not subjected to too strong constraints.

There are two main areas that we think could be improved. The leg opening system is very cumbersome, taking up almost half the volume of the CanSat. We would like to find a more miniaturized opening system to be able to place more sensors or on-board experiments.

The second area of improvement is the damping system. We had started working on a vertical springs system for this purpose, but they made the structure of our CanSat complicated. We therefore considered torsion springs at the legs openings but, as seen earlier, this was ultimately not possible. As it stands, our CanSat has no damping at the time of landing. We would like to add one, so we have several ideas to explore, ranging from silent blocks to a spring around the center screw.

When we launch, we hope to see our missions function to carry out the atmospheric study of the Earth as if it were an exoplanet. We will therefore pay particular attention to the accuracy of the measurements, and to the operation of telemetry. Finally, even if the speed is difficult to control, which does not make the landing easy, we hope that our CanSat will land standing, in order to collect a maximum amount of sunlight, and recharge as expected.

V. Acknowledgement

We would like to warmly thank Pr. Jean-Philippe Ferbeyre for his help as an internship tutor for Jim. This past month, he has brought us many ideas and support in the mechanical realization of our project.