Short Project Description

Nordic CanSat Competition 2021

Team ATLAS

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1 Introduction

For this year's CanSat competition, a team of nine students and teachers have come together to create a CanSat with the intent of learning more about astrophysics, electronics, programming and other subjects related to the project. The team has decided on a secondary mission where the goal is to create a colour-coded image that represents the underlying terrain of the CanSat's descent path. In order to cover more ground and gather more accurate data, the CanSat will be split in two parts, a challenge that requires carefully planned mechanical design as well as twice as many components. The electrical and software design ensures the CanSat can perform the primary and secondary mission, while the ground support and recovery systems make sure that the launch and recovery of the CanSat succeeds. All the necessary aspects of the CanSat project are described in this report.

2 The Team

Team ATLAS is a CanSat team from Thora Storm upper secondary school in Trondheim, Norway. The team name is an acronym of All-Terrain Landing Analysis Satellite, as the secondary mission focuses on analysing a landing site for a future expedition. The team consists of four third-year students, all enrolled in the educational programme Sciencelinja, which focuses on physics and mathematics. The team's interests range from gymnastics, disc golf, painting, programming, Rubik's cube, TaeKwon-Do and stargazing. Below, are the team members.

Role	Team Member
Team Captain	Andreas Ødegård
Lead Intelligence Technician	Fiona Brose
Lead Software Developer	Tormod Geving
Booster Aerospace Engineer	Simonas Strasunskas
Deputy Project Manager (teacher)	Sebastian Kalland
Deputy Project Manager (teacher)	Tobias Domaas
Deputy Project Manager (teacher)	Aasmund Nørsett
Project Manager (teacher)	Adrian Heyerdahl
Project Manager (teacher)	Annik Riise

3 Mission Objective

3.1 Primary Mission

The Team ATLAS CanSat includes sensors with the capability to measure ambient air temperature (and hull temperature), and air pressure. The CanSat will follow the primary mission as is obliged, but will also be able to split into two equal parts, both including the sensors necessary for primary mission measurements. This includes a radio antenna to establish a telemetry up-link with the ground station, capable of transmitting data each second. With temperature and pressure measurements, the satellites' altitudes are calculable, which is relevant when analysing sensor data from both the primary and secondary mission sensors.

3.2 Secondary Mission

Team ATLAS' secondary mission is mapping the CanSat's underlying terrain in the form of a colour-coded, two-dimensional image. The mission is executed with the use of an on-board camera that takes downward-facing photographs during descent. These photographs will then be analysed and processed with software to render a simplified colour-coded image that represents the terrain and landscape in the CanSat's area of descent. This is done in order to map a suitable landing site for a future aeronautical operation, with the intent to land a bigger capsule or vehicle. To increase the area of data gathering, the CanSat has the capability to split into two equal parts (SplitSats). Additionally, since both parts have a camera, the splitting serves for better redundancy and as a failsafe.

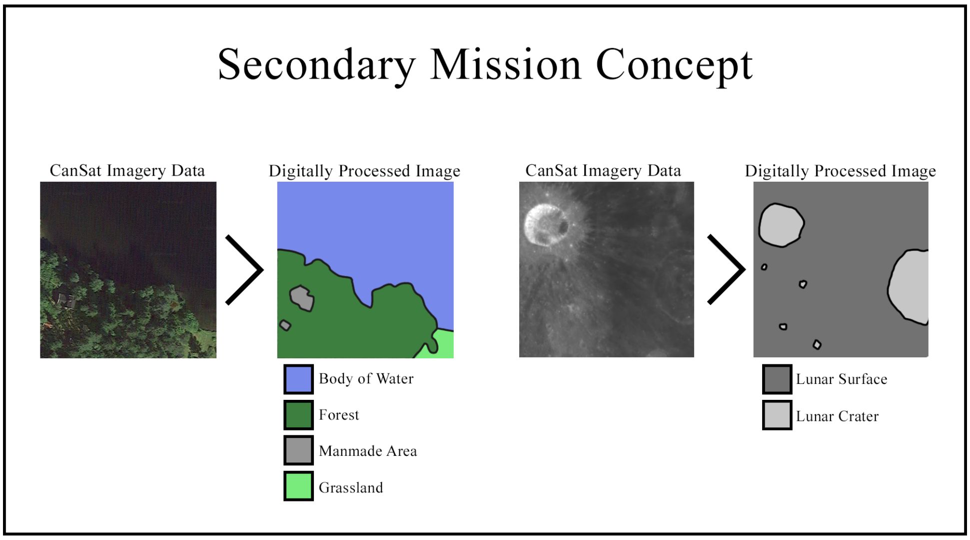

Figure 1: Visualisation of Team ATLAS' secondary mission objective. CanSat imagery data is analysed with the use of digital software. Satellite imagery courtesy of Google Maps and Google Moon.

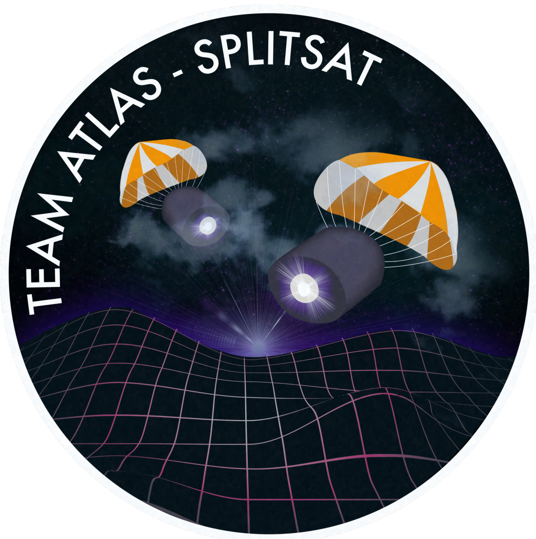

Figure 2: The Team ATLAS SplitSat mission patch.

4 Components

Microcontroller: Due to the SplitSats' spacial limitations, a microcontroller such as the Teensy 3.2 or Arduino Nano is used because of their small size. The microcontroller is the on-board computer and will be powerful enough to handle all data processing.

Temperature Sensor: Each SplitSat utilises a temperature sensor such as the MLX90614 or an NTC-thermistor to fulfill the requirements of the primary mission. The MLX90614 is an infrared thermometer that measures ambient and object temperature. Such, the sensor may be used to determine the CanSat's hull temperature and the air temperature as the CanSat descends to the ground. Since the MLX90614 is situated inside of the CanSat's hull, the temperature readings may differ from the actual outside temperature. Therefore, an NTC-thermistor might be used to measure the air temperature outside the satellite as well.

GY-91: For the purpose of collecting air pressure data, each SplitSat uses a GY-91 pressure sensor. Additionally, the GY-91 has a three-axis accelerometer, gyroscope and magnetic field sensor. The GY-91 is the sensor chosen to meet the remaining requirements to complete the primary mission.

Antenna: An antenna is used in order to establish communication between the ground station and the SplitSats. This will be the APC220 radio antenna, that operates at the frequency spectrum between 433MHz and 434MHz.

Camera: The chosen secondary mission relies on the usage of a camera. Due to limitations in available space, a compact microcontroller-based camera such as the ones made by ArduCam is needed to successfully execute the secondary mission.

SD-card: Each SplitSat will have an SD-card. It is primarily used as a data backup for the obtained sensor data and to store images taken by the on-board camera.

Locking and Separation Mechanism: An electrical locking and separation mechanism is utilised to hold the two SplitSats together so that they can endure the forces of high magnitude during take-off.

5 Mechanical Design

As the CanSat will be split into two separate parts, the mechanical design is intricate and specialised for the separation. The limited size forces the two parts of the CanSat to optimise space utilisation, by tailoring each compartment for specific purposes. A 3D-printed shell is therefore the best suited method of encapsulating the components, as 3D-printing allows for sublime freedom of design. The CanSat is designed to split at its centre, along the horizontal axis. During launch and early parts of the descent, a locking mechanism is utilised in order to keep the two parts of the CanSat from splitting. At a certain threshold height, the separation mechanism is initiated.

Each SplitSat is further designed with two compartments separated by a plastic floor. This plastic floor is designed to prevent dust and water from entering the SplitSat and damaging the electronics during operations. The upper compartment contains the parachute and the locking mechanism, while the lower (and larger) compartment contains all of the electronics needed to perform the primary and secondary missions. To ensure the structural integrity of each SplitSat, the printed circuit board (PCB) and its attached sensors will be held in place by a metal bracket. The bracket is also anchored to the bottom of the lower and upper compartments, keeping them affixed to one another.

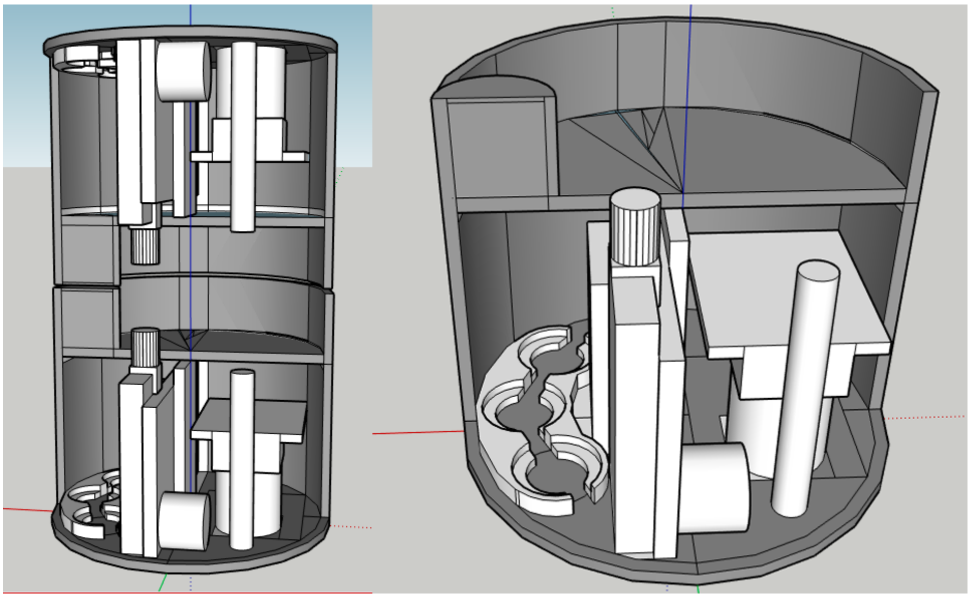

Figure 3: The left picture depicts a concept design of the entire CanSat. The picture to the right shows a concept design for one SplitSat, with half of its Shell cut away to reveal the interior. There are three small circular grooves on the left, which are meant to keep the batteries in place. The middle section is taken up by the PCB, fastened to the floor of the SplitSat, while the right side is occupied by the camera. A lager area is left empty at the top for parachutes to fit inside the CanSat, as the SplitSats lock together as shown in the picture to the left.

6 Electrical Design

The TeamATLAS CanSat has to operate with two PCBs, one for each SplitSat, that are tailored to fit all the necessary components and size requirements. Each board will be designed using KiCad, a free PCB development software. These are two-layered PCBs, which is to say both sides of the board are utilised for maximum space efficiency. A small microcontroller such as a Teensy 3.2 or an Arduino Nano powers the PCBs as the limited space in the SplitSats requires the use of small scale microcontrollers and components. The microcontroller is a small computer that controls the CanSat components and manages its sensor data.

7 Software Design

The CanSat's microcontrollers are programmed using the Arduino IDE. To optimise the code, as well as to make it substantially more comprehensible, a custom-made library is used to tidy the code. This library is programmed using JetBrains' professional CLion editor. Images captured by the cameras during the execution of the secondary mission will be analysed and processed by digital software.

8 Recovery System

Each SplitSat is equipped with a parachute that keeps it in an upright position during descent and ensures a safe landing. This is so that the cameras are able to capture the underlying terrain at all times as well as maintain ideal antenna orientation. Calculations suggest that the parachutes will have a diameter of approximately 20 cm.

The CanSat features two buzzers which make a distinct noise to help locate the SplitSats after landing. In order to have a higher chance of recovering the SplitSats, they are programmed to enter a “hibernation” mode where they limit the power consumption to almost all components except the buzzers. This makes sure that the buzzers have enough power to operate for an extended period of time.

9 Ground Support Equipment

The ground station consists of a computer, an antenna and a microcontroller to manage data transfer. To increase mobility, durability and resistance to harsh conditions, all components are securely packaged in a durable plastic-and-foam hard-case.

10 Outreach

In order to connect with those who are interested in the CanSat competition and the team's preparations, the team has created public accounts on Instagram, Facebook and YouTube. Through these social media platforms, others are able to get both updates and information about the project. The media accounts are tailored to different target audiences in order to develop a better social media presence.

In addition to social media platforms, the team has chosen to develop a website. The website, which is still in development, has varying elements specifically designed for different audiences. Friends and classmates are able to access the website to view a photo gallery, read about the mission and see the retrieved data from the launch. Other CanSat teams, both present and future, are and will be able to access the site to view reports, documents and lectures. The website is programmed from the ground up using HTML, CSS and JavaScript with JetBrains' professional WebStorm editor. The site can be accessed via *https://teamatlas.no/*. The team's aforementioned social media platforms are also easily accessible through this website. Additionally, a CanSat themed game is being developed by members of the team, this can be accessed through *https://teamatlas.space/*.

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