NASA SPACE APPS CHALLENGE

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Octa Aerospace

Educational Course Proposal
OCTA-SAT

By Octa Aerospace
To NASA SpaceApps 2021

Introduction

Over the last decades, the aerospace industry has grown considerably both in terms of investment and new players. With the emergence of the CubeSat standard, the market has facilitated the incursion of companies offering services and components for nanosatellites, companies such as SpaceX have reduced their costs per kilogram launched and developing countries have been able to launch their own nanosatellites and develop a new industry. However, at the local level, Latin America has lagged behind not only in having a consolidated industry capable of providing components and services for nanosatellites, but also at the academic level (in schools and higher education).

Latin America has the potential to become a pole of development of aerospace technologies, but this potential must be used correctly, providing the tools and opportunities at local and global level, as it provides the opportunity to train professionals and captivate new generations. However, the number of young people involved in the aerospace and aeronautical areas is low. Following the example of the United States and EU countries, the OCTA-SAT educational program opens a door to the early development of skills and the search for human talent in young people from developing countries, oriented to aerospace development in the medium term, by providing theoretical and practical knowledge, and the formation of an international community through the development of joint scientific research projects with students.

The objective of OCTA-SAT is to develop, in the first instance, the technologies and contents to support the work of involving students in the satellite aerospace area.

Format Proposal

Online class format, with hours of content per virtual platform and asynchronous activities. OCTA-SAT can provide the content, using an online platform in a MOOC course format. The program includes the implementation of outreach activities through on-line lectures and classes with collaboration of relevant actors in the aerospace industry and scientific communities worldwide.

Virtual, pre-recorded 60-minute classes are proposed, including a diagnostic evaluation at the end of each module. In order to encourage students, an interactive class format is considered (e.g. presentation of content on satellite telemetry from the Space Operations Group). The classes and activities are hosted in a Learning Management System platform.

Hardware

Octa Aerospace has worked on the conceptual design of a modular model with a similar subsystems structure to the CubeSat format, separating each subsystem into individual stacked boards interconnected through GPIO (General Purpose IO) pins.

Payload: Space for the incorporation of payload or extensions for experiments or extra sensors.

ADCS: Subsystem composed of sensors such as accelerometers, gyroscopes, magnetometers and others to determine the position and movement of the satellite, delivering information to the CDHS to use devices such as magnetorquers, Reaction wheels or RCS.
In CanSats, typically only data is collected, although there are projects that include control surfaces to slow the rate of descent or guide the device on a particular heading.

CDHS/OBC: On-board computer, which manages the processes related to ADCS, EPS power control, datalogging and sending/receiving COM commands and more. Usually the CDHS has redundancy mechanisms, including more than one central processing unit.

EPS: Subsystem composed of a battery array (usually Lithium-ion or Lithium-ferro-phosphate) and the battery charging and protection mechanisms. The battery charging process is controlled by a microcontroller which in turn controls the MPPT charging mechanism of the solar panels. Additionally, the EPS filters and regulates the power supply to the rest of the subsystems, using MOSFETs and step-up/step-down circuits.

COM: Subsystem for transmission and reception of radio packets, with an uplink and downlink in VHF, UHF, Ku, K, Ka, etc... For the CanSat, a Semtech SX1276 LoRa chip with transmission and reception in 915MHz will be used.

Curricular Mesh

- ## Module 1: Introduction to Nanosatellites

Duration: 120 Minutes (17 blocks of 60 minutes)

Description: On this module students will learn basic concepts about nanosatellites and their subsystems while comparing actual satellites to CanSats and their equivalent subsystems.
Along with learning about nanosatellites, students will have the opportunity to know more about electronics and how to be able to design electronic circuits and use open source tools to create PCB boards.

Bloques	Contenido
1	Introduction to nanosatellites and subsystems
1	Introduction to CanSats (with kit)
2	Electronics basics
1	Microcontrollers
4	Circuit design with KiCad
2	Battery Fundamentals
1	Waves (Applied to radio frequency)
2	Telecommunications: Antennas and satellite communications
1	Fundamentals of additive manufacturing (3D Printing)
2	Use of CAD software

- ## Module 2: Programming

Duration: 510 Minutes (17 blocks of 30 minutes)
Description: Students are introduced to the logic thinking of engineering through programming, with Python 3, as it is the most widely used programming language worldwide. Python is a multi-utility language, from cybersecurity to hardware control.

Bloques	Contenido
2	Fundamentals
1	Variables
1	Arrays
1	Conditional
1	Loops
1	Functions

1	Capstone Project
2	Debug
2	File Management
2	Data Graph
2	GitHub

- ## Module 3: Telemetry and Mission Control Software

Duration: 540 Minutes (9 blocks of 60 minutes)
Description: Explanation of how the information received by the CanSat modules is transmitted up to a database, with the use of LoRa modules. <- Mention Open MCT.

Bloques	Contenido
1	LoRa and Python 3 for sending and receiving radio packets
3	Introduction to mission control work and functions
3	Javascript and NASA Open MCT
2	Telemetry integration to NASA Open MCT

- ## Module 4.1: Geospatial Information and Mapping

Duration: 240 Minutes (8 blocks of 30 minutes)
Description: Introduction to geolocation, its different systems, explanation of how it works and its application in CanSats. How to use maps as the main guiding tool to locate yourself together with other complementary tools, and how to use the information received from the CanSat to locate it and prepare a safe rescue plan for it.

Bloques	Contenido
2	Introductory Concepts of Orbital Mechanics
1	Coordinate Systems
2	Aerial photogrammetry and satellite imagery: A view of climate change
2	Fundamentals of cartography
1	Orientation with compass and GPS systems

- ## Módulo 4.2: Go for Launch

Duration: 600 Minutes (20 blocks of 30 minutes)

Description: To conclude the School Educational Program, students will work on developing a mission and design an experiment for the PAYLOAD section. They will perform launch simulations and will be included in a national community with the goal of a regional competition.

Bloques	Contenido
4	Research material search:
2	Writing scientific reports and reports.
2	Project organization: Teamwork and leadership
4	Aerodynamics: Design of parachutes and control surfaces
4	Amateur rocketry and stratospheric balloons
2	Launch protocols and safety measures
2	Payload integration