	QlevEr Sat PROJECT
	Student "stage" subject 2021-22
	CubeSat Payload Software Logic

The Grenoble University Space Center (CSUG) (UGA - INP):

The project will be supervised by the CSUG (120 rue de la piscine, 38400 Saint Martin d'Hères).

General context:

Started in 2020, the QlevEr Sat project aims at bringing Artificial Intelligence (AI) onboard a demonstration CubeSat for Earth Observation (EO). The overall project is led by the CSUG in collaboration with the Multidisciplinary Institute in Artificial Intelligence (MIAI UGA) and Teledyne e2v. QlevEr Sat will be surveying specific regions for deforestation. A 5m resolution is necessary to observe daily changes on a given target area. As the number of satellites increases, embarking AI algorithms directly on board will drastically reduce the bandwidth required for ground data transmission: only the post-analysis results can be downlinked, rather than images themselves.

As part of the Preliminary Definition phase (Phase B) of the overall project, a QlevEr Sat demonstrator is being designed as a ground engineering model, capable of acquiring some images, running embedded AI algorithms developed by the DSE partner (Data Science Experts) and transmitting the results to the main On Board Computer assembled by the U-Space partner (the 6U platform provider).

The payload of the satellite (CSUG part) only includes an optical lens, an imager, an FPGA bridge (camera function) as well as an ARM processor running a custom Linux distribution (Ubuntu 18.04 LTS). U-Space will deal with all other navigation and telecommunication equipment.

Within this phase, the present student project addresses the embedded software system only (no optics, electronics, mechanics or thermal aspects). The AI itself is not included.

https://www.csug.fr/menu-principal/projets/qlever-sat/qlever-sat-751384.kjsp

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Objective:

Architecture, specify, develop and prototype an overall SW main program capable of dealing with all major modes, all major use cases, all major interfaces and all major anomaly cases of the satellite, starting from the payload's point of view. Specific devices may be emulated in the code.

Description

The aim is to list and organise into one overall logic all major modes, use cases, interfaces and anomaly cases that the satellite will or might come across. "Major" means that the list does not have to be exhaustive, nor perfect, but it has to be initialised in a preliminary version, starting from the payload's point of view.

Modes include the nominal mission mode (for which a preliminary specification exists), a few special modes and a survival mode.
Two use cases have already been defined (Forest and Clouds), but the defined architecture should work for N potential use cases. The image processing itself (Forest and Clouds) is already developed.
Interfaces are all software links existing between the different payload and platform modules such as: image acquisition subsystem, AI microprocessor and standard platform On Board Computer (OBC).
Major anomaly cases have to be defined. Again, this will be a non-exhaustive list, starting from the payload's point of view.
Experience from previous satellites may be re-used.

The tasks involve:

- Based on project's preliminary specification, objectives and constraints, list a maximum of modes and cases combinations
- Produce one or several diagrams and flowcharts to articulate them according to the possible chronology of events and mission scenarios
- Write the technical specification and pseudo-code of the payload "main program", sort of general task scheduler for payload devices/situations
- If possible, develop a C, C++ or Python prototype program in Linux OS to integrate and test the overall logic execution, using simulated inputs.

NB: The AI Python code is already developed.

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