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

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 payload's 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:

Identify, investigate, compare, evaluate, prototype and test different formats and solutions to manage onboard image metadata and payload telemetries (headers, footers, tiff tags, txt files, TM/TC PUS standard, other…) in conformance to the CubeSat's payload and platform requirements (QlevEr Sat mission requirements and technical constraints).

Description

As there is no database on board, data management must be designed for embedded computer systems.
QlevEr Sat deals with raw colour images (4096 x 4096 pixels) and computes them into lighter binary maps thanks to already developed AI algorithms running on an ARM processor, on payload side. But it will also need to deal with data about the images, i.e. image metadata and acquisition metadata. Other data relating to the payload devices (in addition to the mission data content itself and associated metadata) are called telemetries and follow defined formats in the NewSpace industry.

Example of problem to solve: of course, the AI inference must not be polluted by any header or footer lines, but header/footer information for each image should not be lost.

Currently our payload prototype uses the tiff format for images, while our platform partner use the PUS format for telemetries, but other formats may be considered, possibly leading to a combined solution.
Experience from previous satellites may be re-used.

The tasks involve:

- Based on project's preliminary specification, objectives and constraints, draw a sample list of typical image metadata (e.g. Frame No) and acquisition metadata (e.g. Acquisition Start Time) or other payload telemetries (e.g. Image Sensor Temperature)
- Understand the mission data flow (from image acquisition to ground result analysis) and focus on the role of the payload processor (after FPGA interface but before platform OBC interface)
- Study the PUS standard used by platform OBCs in NewSpace
- Study the tiff format metadata management and compare it to other possible image formats or metadata management mechanisms
- Prototype different ways of managing payload metadata and telemetries
- Write a test plan, test the options and document the results with pros and cons and make recommendations based on the simplest solution(s).

NB: The AI Python code is already developed.

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