Long and continuous tradition of development of educational and research OUFTI CubeSats at University of Liège

Sebastien DE DIJCKER[1], Xavier WERNER[2], Valéry BROUN[3], Serge HABRAKEN[4], Gaëtan KERSCHEN[2], Jacques G. VERLY[1]

[1] University of Liège (ULg), Department of Electrical Engineering and Computer Science, Liège, Belgium

[2] University of Liège (ULg), Department of Aerospace and Mechanics, Liège, Belgium

[3] Haute Ecole de la Province de Liège (HEPL), Engineering Department, Electronics Service, Liège, Belgium

[4] University of Liège, Centre Spatial de Liège (CSL), Liège, Belgium

Introduction

On 17 September 2007, the Department of Electrical Engineering of the University of Liège (ULg) brought the university into the emerging discipline of design and construction of full nanosatellite systems (space & ground). This initiative - with a primary goal of education - came just 4 years after the launch of the pioneering CubeSats by Stanford University on 30 June 2003. Below, we briefly describe the sequence of developments of complete small-satellite systems at the ULg. The HEPL of Liège works closely with the ULg on several of them.

OUFTI-1

The first ULg nanosatellite was the 1-unit (1U) CubeSat called OUFTI-1. Its primary mission was to send a D-STAR repeater to orbit. D-STAR is an amateur-radio protocol that allows, on Earth, for the digital transmission of voice and data via Internet and radio links. OUFTI-1 thus aimed at extending the terrestrial D-STAR repeater network into space. Its secondary mission was to tests high-efficiency solar cells.

After a few years of independent development at the ULg, OUFTI-1 was selected to be part of the first edition of the Fly Your Satellite! (FYS) program managed by the ESA Education Office. Together with two companion satellites, OUFTI-1 was successfully launched on 25 April 2016 from “Centre Spatial Guyanais” in Kourou, French Guyana, aboard Soyuz Flight VS14. The radio beacon operated successfully for 12 days, providing strong, high-quality signals and precious telemetry data. However, the satellite then fell silent, without warning, before the AX.25 telecommand/telemetry system and the D-STAR payload could be activated.

In 8 years, about 50 students did their Master theses on some aspects of the development of the OUFTI-1 ground and space segments.

OUFTI-2

On 6 July 2016, following a debriefing at ESA concerning the first FYS launch, several senior people on the OUFTI-1 project decided to build a successor to OUFTI-1 that would benefit from the lessons learned during the development, tests, and operations in orbit of OUFTI-1. The new satellite was naturally called OUFTI-2. In contrast to the more than 8 years that it took to build the complete OUFTI-1 space and ground system, the team set up the challenge of building the new CubeSat in a little over one year. The primary payload is still a D-STAR repeater. The secondary payloads are one experiment to evaluate the performance of two different types of shields to protect electronic circuits from radiation, and one experiment by high-school students to provide attitude data using an electronic circuit performing inertial and magnetic measurements. OUFTI-1 is very different from OUFTI-2; e.g. its software was entirely redone from scratch. Figure 1 gives an exploded view of OUFTI-2, as currently envisioned.

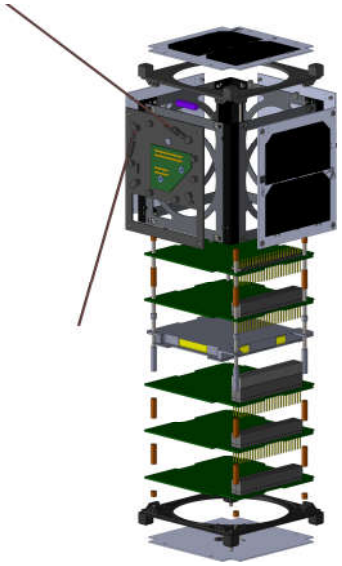

Fig. 1: Exploded view of OUFTI-2, as currently envisioned.

Constellation of small satellites

In parallel with the OUFTI-1 and OUFTI-2 projects, the ULg conceived, starting in 2015, a satellite constellation system for the observation of the Earth in the hyperspectral wavelength domain using small satellites. This project quickly attracted the attention of the Walloon government and Walloon aerospace industry. The latter has now taken the lead of the project. A market study showed that there are business opportunities for a constellation of small hyperspectral satellites.

OUFTI-Next

In the fall of 2016, the ULg assembled a panel of multi-disciplinary experts in a unique ideation session aiming at systematically and quickly identifying innovative scientific

missions for nanosatellite/CubeSats. Among the many ideas that emerged from the ideation process, the ULg selected that of an Earth-observation, 3U CubeSat and corresponding ground segment to produce images in the mid-wave infrared (MWIR) with a resolution of at least 50 m, destined to measure the hydric stress of vegetation, which would allow farmers to provide optimal irrigation to their crops. Performing useful MWIR imaging from a 3U CubeSat would be a World's first. Ultimately, a constellation of 4 satellites in each of 2 distinct orbits would be required to provide the necessary revisit rate. Figure 2 gives a view of OUFTI-Next, as currently envisioned.

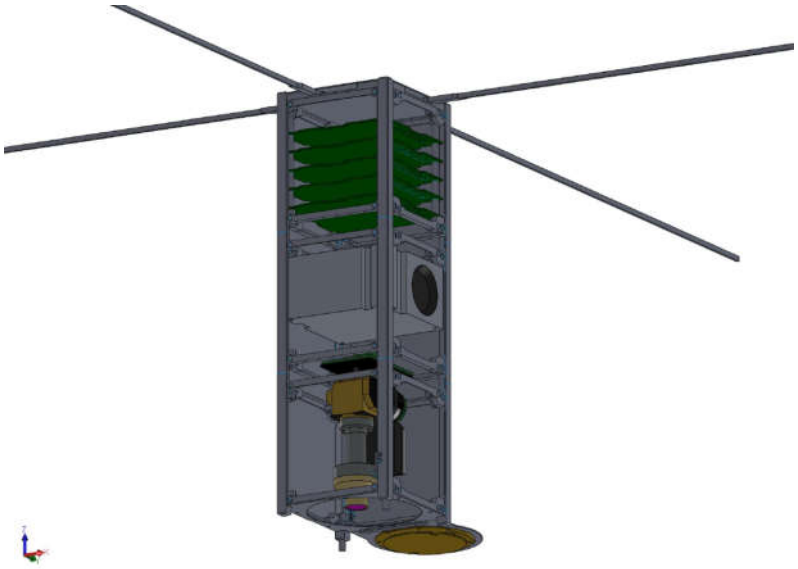

Fig. 2: View of OUFTI-Next, as currently envisioned.

Conclusion

Since the fall of 2007, the ULg has worked continuously on a sequence of projects of small satellites - mostly CubeSats - systematically interweaving the educational and research aspects of such projects.

Preference for presentation: Oral

Symposium topic(s): Technology Demonstration on CubeSats, Scientific Missions, CubeSat Constellations

Author for correspondence: Sebastien DE DIJCKER
Université de Liège
Institut Montefiore, B28
Allée de la découverte, 10
4000 Liège
+32 4 366 37 38
s.dedijcker@ulg.ac.be