IAF SPACE SYSTEMS SYMPOSIUM (D1)
Technologies that Enable Space Systems (2)

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RECENT IN-FLIGHT RESULTS WITH THE MICROHAPS NEAR-SPACE PLATFORM FOR SPACE TECHNOLOGY TESTING

Abstract

During the last six years the Space Systems Laboratory of the University of Pisa has been developing a small, low cost, quick-access platform (μHAPS) for scientific experiments and technology demonstration in the stratosphere. The team at UniPi designed, manufactured, tested, and flew successfully more than 25 stratospheric missions of increasing complexity, using COTS sounding balloons as the lifting device. This was made possible by the increased availability of high performance, low power microcontrollers and sensors, so that the limited mass lifting capability of traditional sounding balloons is now much less relevant in determing the operational capabilities of such vehicles.

The μHAPS platform features an altitude regulation system that allows the platform to dwell above 25 km for several days, thanks to a control system based on deep reinforcement learning. Power is provided by flexible solar cells, providing for the needs of the payload and for supplying a reaction wheel attitude stabilization and pointing system. Full-duplex telemetry and telecommand is implemented using a LoRa spread-spectrum transceiver.

With a cost orders of magnitude smaller than space platforms, μHAPS is a sort of Cubesat of the stratosphere, well suited to act as a test bench for microsatellite technologies. With 2 to 3 kg of payload, a large variety of experiments can be conducted in near-space conditions: at 30 km air pressure is around 20 mbar, temperature is -60 C, insolation is almost exactly Air-Mass-Zero, most of ionizing radiation is unshielded, and the field of view towards the surface of the Earth is hundreds of km in all directions. While not full representative of the LEO environment, the higher stratosphere is nevertheless an excellent environment for testing of space technologies, allowing for significant TRL increase with extremely low cost, quick and repeatable access.

Among others, technology missions flown so far by our team include the analysis of the EM background noise at 868 MHz and 2.4 GHz (for IoT applications of the ISM bands); detection of AIS signals form ships in the Mediterranean; analysis of nocturnal light pollution in urban areas; and I/V curve characterization of innovative solar cells. We report on the lessons learned and outline the next design features and the expected performance of the μHAPS system as a test bench for microsatellite technology.