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An Aerodynamically Controlled Cross-track Tethered CubeSat System for Remote Sensing Applications

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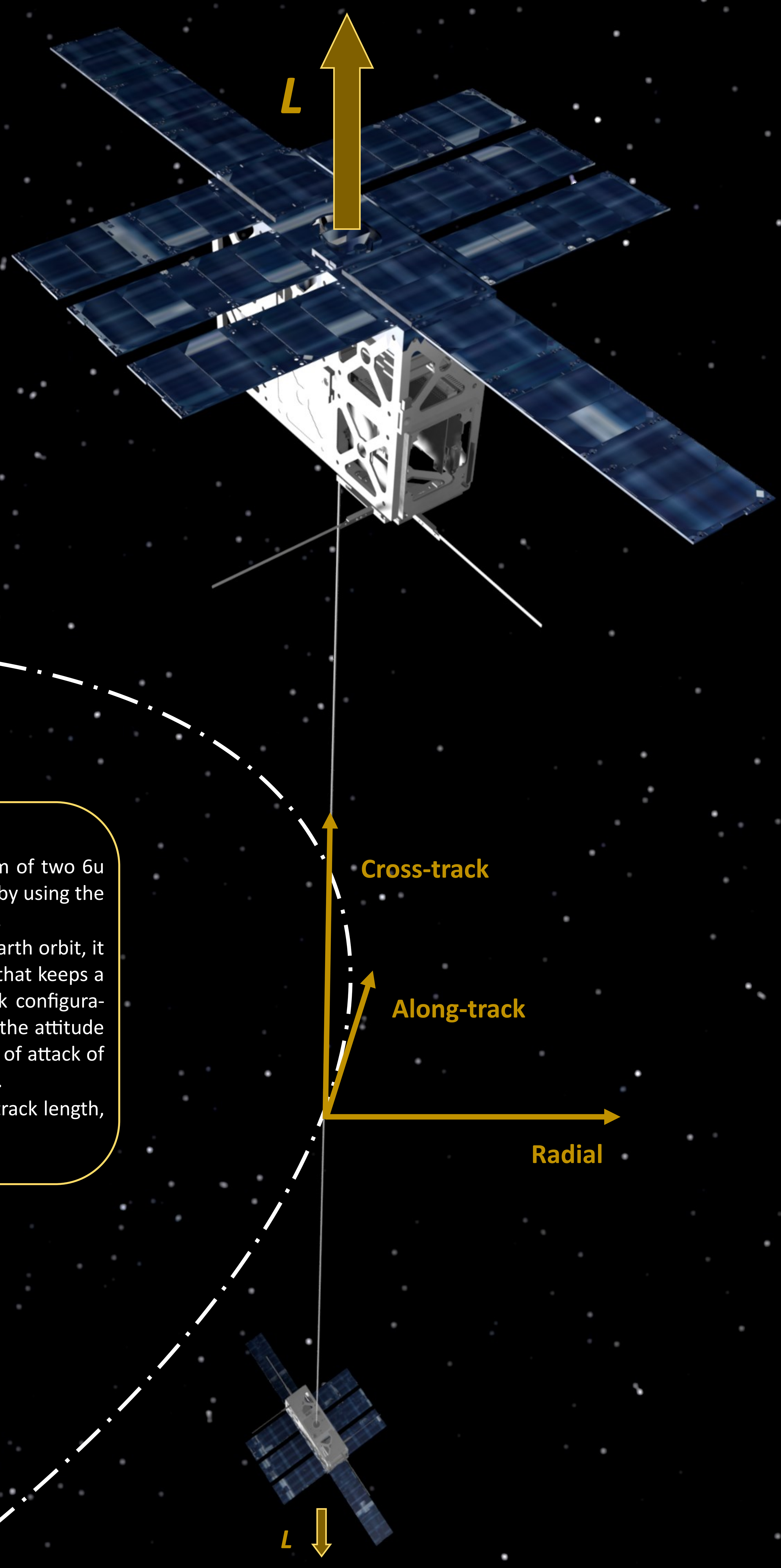
ABSTRACT

In this study, a distributed space system consisting of two 6u CubeSats connected by a tether is considered. This architecture is dimensioned for remote sensing applications. By sampling a signal from different orbital positions and combining the collected data, it is possible to equate the performance of a large monolithic antenna. The solution proposed here is to use a tether in order to mechanically connect the satellites in a cross-track flight-configuration by exploiting the rarefied atmosphere of low Earth orbit to generate a force that stabilizes and controls the system. By controlling the attitude of the satellites, the tether is constantly kept in tension and aligned in the cross-track direction. A system with this architecture maximizes mission performance by maintaining always a maximum cross-track extension and thus a constant measurement resolution.



Space Tether

Formation flying tethers are cables that mechanically connect two or more satellites. These are generally used in radial configuration (i.e., perpendicular to the Earth's surface), so as to exploit the stabilizing effect of Earth's gravity gradient. Former studies showed that it is possible to use environmental effects to stabilize these systems in a cross-track configuration [1,2] .

By exploiting these techniques it is possible to maintain constant tension in the tether, so as to control the relative positioning of the satellites at the ends without using propellant.

Aerodynamic Stabilization

The proposed architecture consists of a system of two 6u CubeSats connected by a tether and stabilized by using the patent-protected aerodynamic stabilization [4].

By exploiting the rarefied atmosphere of low Earth orbit, it is possible to generate an aerodynamic lift (L) that keeps a constant tension in the tether in a cross-track configuration. This force can be controlled by acting on the attitude of the two satellites, so as to control the angle of attack of the solar array with respect to the atmosphere.

This architecture guarantees a constant cross-track length, maximizing its remote sensing performance.

Radar Sounding Application

By placing different sensors along the tether it is possible to sample a signal along the cross-track direction; by exploiting the movement of the system along the orbit, it is possible to sample the signal in the along-track direction. Thanks to Synthetic Aperture processing techniques, it is possible to combine these samples to achieve the performance of a monolithic antenna of very large dimension. This enables to have high resolution while using longer wavelengths that can penetrate the underground (Radar Sounding) [3].

This type of configuration could provide accurate information on glacier thickness, soil moisture, and the presence of underground resources.

Bibliography

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[3] Stefano Aliberti, Marco B. Quadrelli, and Marcello Romano, "A Novel Radar Remote Sensing Orbiting System Using Tethered Satellites", in 74th International Astronautical Conference, Baku, Azerbaijan, October 2023

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