On the Feasibility of Quantum Docking for Cubesats

Massimo Biella*, Athip Thirupathi Raj*, Jekan Thangavelautham*
jekan@arizona.edu

The recent year-over-year increase in the number of small satellites launched into space requires innovative docking solutions to enable the service providers and the end customers to benefit most from the new technologies available through on-orbit servicing, and in-space assemblies. From constructing more extensive commercial infrastructures in earth's orbit to creating scientific platforms in deep space, ensuring that the docking procedures execute flawlessly is a critical step to guarantee the success of a mission. Recent advances in non-contact docking technologies will enable different satellites to lock with each other while maintaining a safe physical distance. This mitigates the risks associated with traditional docking procedures, such as mechanical failures, while not requiring that the two vehicles have docking adapters with specially designedmale-female docking interfaces. In addition, small spacecraft that use non-contact docking mechanisms are suitable for swarm applications, surveillance, kinematic chains, and assistance to a "mothership."

This paper discusses possible concepts that would enable quantum docking technologies. The objective is to have two or more vehicles in space utilizing flux-pinning to achieve non-contact docking. The satellites will be able to identify and acknowledge each other's position and attitude using Active Lighting Cues with blinking LED lights and Visible Light Communication (VLC) and align each other to allow the quantum docking procedure to start. When the desired target separation is achieved, the two spacecraft will be kept locked with each other through flux-pinning.

Currently, quantum docking represents one of the most promising ways to dock two satellites in space. After the docking is achieved between two satellites, it will be possible to add more to create a contactless system capable of continuously evolving and adapting in shape and size as requested by the mission. This evaluation will present how to relate the strength of the magnetic pinning to the mass and relative approach speed of the two satellites to be docked.

Keywords: Quantum Docking, Small Satellite, Swarm, Flux Pinning, Non-Contact Docking

* Space and Terrestrial Robotic Exploration (SpaceTREx) Laboratory, Aerospace and Mechanical Engineering Department, University of Arizona