Internship in ESA's Advanced Concepts Team

on

Wireless Power Transmission Network for Lunar Exploration

Topic description

Concepts for lunar surface bases and scientific/exploration infrastructure will require an effective power distribution system to connect a power generation system to different mobile and stationary power users, which could be up to 100 kilometres apart. Therefore, setting up conventional cable-based transmission lines between them to distribute power would be impractical.

A wireless power transmission network (WPTN) may be an enabling technology in facilitating this requirement. Wireless power transmission is a concept dating back to Nicola Tesla and was first demonstrated in in laboratory settings in the microwave frequency range in the 1960s [1] and studied extensively in the frame of solar powered satellites (SPS) to beam energy from orbits to the Earth surface [2]. Based on advances in both laser generation technology, beam control and PV efficiencies, the use of lasers has become increasingly attractive, especially for applications such as in space, where the security trade-offs are different than on Earth [3]. In either case, the focus has been on point-to-point transmissions of energy. There has been very little consideration on wireless grid networks, starting from one-to-many in parallel and serial setups, to many-to-many locations involving hubs and relays.

The focus of this study will be to apply laser power transmission to lunar infrastructure concepts. The task will be to provide system-level trade-offs of a WPTN that can deliver energy to a set of lunar bases spread over a 150 square kilometre region. Different architectures for the transmission line infrastructure can be proposed, such as using a SPS to beam energy directly to all locations, a single lunar plant that transfers the energy closer to the ground, or using multiple lunar plants in a network transferring energy between one another.

The candidate's tasks:

- Set up a parametric model of a lunar surface power transmission infrastructure involving fixed and mobile elements, based on state-of-the art wireless power transmission technologies for generation, transmission, reception and relay systems)
- Make a high-level trade-off based on a parametric analysis considering one to three lunar surface reference power transmission concepts, optimising them for transmission efficiency, reliability and eventually cost (mass).

The ideal candidate:

Required:

- Understanding of power transmission systems.
- Understanding of optics.

Desired:

- Understanding of wireless power transmission technologies.

References:

[1] Brown, W. "An experimental microwave-powered helicopter", Journal of Microwave Power, Volume 1, Issue 1, 1966
[2] Brown, W. "Beamed microwave power transmission and its application to space", IEEE Transactions on microwave theory and techniques, Vol. 40, No. 6, 1992
[3] Summerer, L. Purcell, O. "Concepts for wireless energy transmission via laser", ICSOS, 2009