Laser-based Localization of Robot Swarms for Lunar Infrastructure Construction Using Control Towers

NASA’s Artemis program aims to restart crewed missions to the moon. This program may lead to semi-permanent human settlements on the lunar surface. Before the arrival of humans, robots can prepare the infrastructure for a long-term base on the moon. They can also take over the dirty, dull, and dangerous tasks, reducing the personnel necessary to support science missions on the moon. Using multiple rovers in a swarm increases the efficiency of operations such as infrastructure construction and support. However, in the early stages of lunar base development, the infrastructure for the navigation and communication of such robots is limited, with difficulties in supporting large swarms of rovers.

We propose a design for control towers to support a swarm of infrastructure construction robots. These towers will provide communications, navigation, and power beaming using lasers. The advantage of using lasers is that the same hardware can handle communications links, precise positioning, and wireless power transfer instead of using different dedicated systems.

For lunar rover communication and positioning, we examine the possibility of using laser communications using a “smart skin.” Previously, we have proposed utilizing a “smart skin” containing solar panels for laser communication with and between small satellites. Current commercially available solar panels for space vehicles can detect violet and blue lasers, even in daylight, making them viable options for sensors in laser communications. Using existing solar cells as sensors can reduce costs compared to installing receivers in each rover for radio navigation and communications.

We attempt to apply communications using lasers and solar panels to find the precise positions of individual rovers in a swarm on the moon. Laser communications and positioning will allow more effective rover cooperativity and situational awareness. Our proposed method also aims to reduce the cost of installing sensors and infrastructure for communication and positioning.