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DESIGN AND ANALYSIS OF SURFACE COMMUNICATION SYSTEM FOR LUNAR MISSIONS

Abstract

In typical wireless telecommunication systems, the generic propagation model is characterized by the existence of multiple propagation paths between the transmitter's and the receiver's antennas. Since the propagation model depends strongly on the surrounding terrain environment, the receiver receives signals from different directions with different strengths, time delays, and polarization. Hence, it results in the deterioration of the communication quality.

Due to the terrain topology of the lunar surface, surface communication for lunar missions received a lot of attention in the past few decades. The uncertain terrain as well as the random distributed slopes on the lunar surface affect strongly the transmitted signal, even at short distances. The cause of those multi-paths is the reflection and diffraction of the signal due to the various objects that exist between the transmitter and the receiver. Moreover, for such a terrain, line-of-sight (LOS) communication is not feasible for short antenna length which considered more practical for small lunar vehicles. Consequently, this imposes a limit on how far the rover can travel. Given the short antenna constraint, the transmission distance can be improved mainly by increasing the power which is not preferable for small rovers.

Motivated by the above, this work proposes a surface communication system using a simple and low power transceiver. The study considers non- line-of-sight (NLOS) communications as well as different practical propagation models. It provides the link budget for various communication configuration for lunar missions such as communications between astronauts and between the rover and lander. Also, extensive analysis is conducted to evaluate the system for different frequency bands, power, and random distributed terrain.