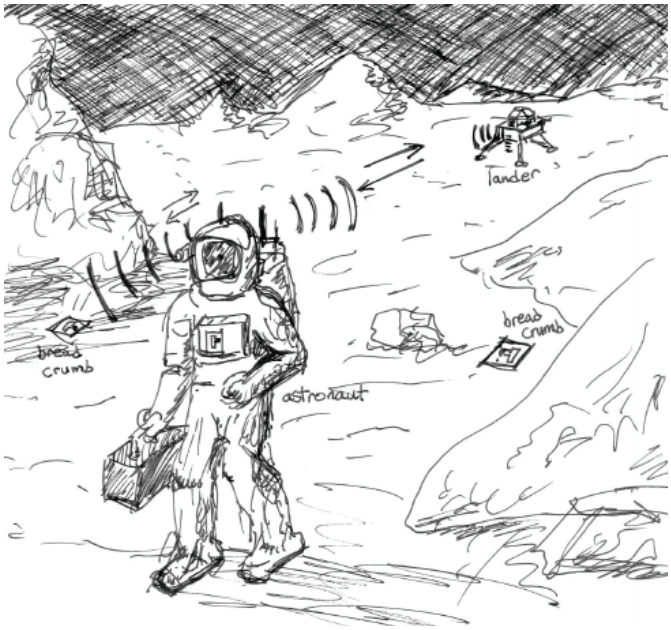
NASA093-007 TITLE: Lunar Bread Crumbs

TECHNOLOGY AREAS: Space Communications, Radiolocation, Antennas, RF engineering

OBJECTIVE: Design a radiolocation system for astronauts on moonwalk based on the "bread crumb" concept.



DESCRIPTION: Next decade, the US plans to return to the moon and perform new science missions and moon walk explorations. One of the lessons learned in previous Apollo missions was the difficulty in performing rover and astronaut excursions in the rugged, bright-white terrain of the moon; it is extremely easy for astronauts to lose their way in this featureless environment filled with valleys, hills, and craters. Earth location systems such as GPS are not available on the moon and too costly to build. However, NASA is extremely interested in testing a new "bread crumb" technique for tracking astronauts that travel through regions around their lunar lander. Much like Hansel and Gretel's bread crumbs, an astronaut on excursion would drop very small, disposable RF identification tags that operate on the principle of backscatter modulation. The astronaut's suit would contain a low-powered reader that could measure reflected tag data and coherent signal strength (amplitude and strength) in proximity of these tags as well as a signal sent from the lunar lander, using this information to navigate the lunar terrain.

The company is expected to design the antenna, RF, and communication systems for the lander-to-astronaut link and the astronaut-RF tag link, as well as the location algorithm. Several electrical conditions must be imposed on the system:

- All RF tag antennas are presumed to be connected to ideal, passive RF integrated circuits that require -20 dBm of RF power to turn-on. These antennas may be treated as 0 dBi average-gain isotropic antennas in the analysis and cannot have more than 3% bandwidth.
- You must design, build, and measure a prototype omnidirectional transmit antenna for the lunar lander. Whatever range-measured characteristics this antenna exhibits (gain and bandwidth), these are the parameters that must be used in the link design for the group's project. You may assume that the astronaut-suit-mounted antenna has identical gain and bandwidth parameters as your lander antenna.
- FCC rules do not apply on the moon, so there are no regulatory limits on power and operating frequency. However, keep radiation safety and power source limitations under consideration. The frequency of operation must lie between 1-3 GHz.

- You must have a data link with at least 100 kbps continual data support from astronaut to lander (higher rates will make your project more competitive). It must work in non-line-of-sight conditions of up to 2 kilometers, which means that you will have to formulate a reasonable propagation model for the lunar surface.

The system technical description must include (a) the RF components and modulation for the RF tag reader and astronaut-to-lander link, (b) an estimate of accuracy for the system, and (c) operational details of the location algorithm along with any deployment rules or practices that the moon-walker must follow.

PHASE I: Deliverables include (a) a browse-able, web-based technical report summarizing a design for the bread-crumb system, (b) measured prototype of an electrically small antenna for use in the tag. Link budget and location performance statistics in your technical report must be based on this measured prototype antenna. Competitive rankings will consider 1) cost, 2) predicted accuracy and performance, and 3) thoroughness and believability in your analysis in roughly equal proportions.

REFERENCES:

1. T. Pratt, C. Bostian, T. Allnutt, *Satellite Communications*, 2nd edition, Wiley, 2002.

TPOC: Greg Durgin
Phone: 404-894-2951
Fax: 404-894-5395
Email: durgin @ gatech.edu