NASA SBIR 2009 Phase I Solicitation

O4.03 Lunar Surface Navigation

Lead Center: GRC

Participating Center(s): GSFC, JPL, JSC

In order to provide location awareness, precision position fixing, best heading and traverse path planning for planetary EVA, manned rovers and lunar surface mobility units NASA has established requirements for onboard navigation capabilities for surface-mobile elements of lunar missions. Proposals are specifically sought which address the following needs:

- Asset localization within a work area. Specifically, real-time relative location of vehicles and EVA crewmembers for safety and task efficiency.
- EVA crew localization for emergency walk back to a safe haven (lander, habitat, fixed reference point, etc.)
- Fixed asset localization with respect to global coordinates.
- Traverse-path planning systems and navigation-specific displays are also of interest.
- Novel navigation techniques that utilize repurposed flight vehicle sensors (INS, AHRS, low light imager, star trackers, etc.)

This topic will develop systems, technologies and analysis in support of the required capabilities of lunar surface mobility elements. Contemplated navigation systems could employ celestial references, passive or active optical information such as optical flow or range to local terrain features, inertial sensor information or other location-specific sensed data or combinations thereof. However, radiometric measurements are considered to be concomitant to the lunar communications network and the lunar network will likely be used to communicate state information between lunar mission elements. As such, the main emphasis of this topic is on systems that exploit radiometric measurements such as range, Doppler or Angle of Arrival. Radiometric measurements can be considered between lunar mission elements such as surface mobility units, elements of a lunar surface architecture (such as surface landers or habitation units or other surface mobility units) or elements of the lunar communications and navigation infrastructure such as surface communications towers or lunar communication/navigation orbiters. Note that the constellation of moon-orbiting communication/navigation satellites will support both polar outpost missions as well as short term sortie missions that can occur anywhere on the lunar surface. This constellation will likely consist of no more than six satellites and may be only be one or two satellites. Earth-based nodes are not excluded from consideration, nor are two-way radiometric measurements, nor are non-NASA-standard modulation schemes.

Emphasis of the development is on navigation accuracy, position estimate update rate (minimized correlation time), minimum Size Weight and Power (SWaP), systems that operate effectively with minimal communications/navigation infrastructure (such as towers or orbiters) or with complete autonomy, with minimal crew involvement or completely automatically. Unified concepts and systems that provide a range of hardware capabilities (possibly trading accuracy with SWaP) and/or support dual-use (e.g., navigation and communication) are of interest.

Mature system concepts and technologies including system demonstration with TRL 6 components and internalized (by NASA) standards are required at the end of a Phase 2. Candidates for technology infusion include developmental EVA space suits and prototype crew and robotic rovers. An example rover system is the Lunar Electric Rover (LER). The LER (http://www.nasa.gov/exploration/home/LER.html) is a sport utility sized, 12-wheeled, pressurized vehicle capable of supporting 14-day missions with two astronauts. Recent tests have included 140km treks across rugged terrain in Arizona. Future testing will extend the distance. Examples of a developmental EVA space suit include the Mark iii spacesuit and the REI suit (c.f. http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080012574_2008010837.pdf). Demonstration opportunities occur several times a year at lunar analog exercises such as the Desert Research and Technology Studies (D-RATS, c.f. http://en.wikipedia.org/wiki/Desert_Research_and_Technology_Studies) and the Haughton Field test (c.f. http://ti.arc.nasa.gov/projects/haughton_field/).