IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

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AN ADAPTABLE INTEGRATED VISION SYSTEM FOR LUNAR EXPLORATION

Abstract

As the international community prepares to return to the Moon with robots and humans, there is a need for new cutting-edge vision systems that are adaptable for the many varied lunar science targets, variable and challenging lighting conditions – from permanently shadowed to near constantly illuminated – and a range of robotic platforms, from micro-rovers to pressurized human rovers. Our team is developing a series of adaptable vision systems based around the core concept of an Integrated Vision System (IVS), a prototype stand-off instrument designed to be mounted on a rover mast and appropriate for both scientific characterization of the lunar surface and rover guidance, navigation, and control (GNC). The IVS concept combines a multispectral imager (MSI) with a Light Detection and Ranging (LIDAR) system for active spectral sensing and ranging. This combination allows for imaging in both illuminated and shadowed regions, while creating 3-D images that can be used for navigation, targeting features of interest, characterizing regolith and outcrops, and long-term planning.

Several versions of IVS are currently in various stages of development. The baseline IVS consists of a multispectral imager targeting a wide spectral range (400 – 1700 nm) and a LIDAR system incorporating multiple lasers (wavelengths). The multispectral imager uses a Silicon based image sensor to cover the VIS-NIR spectral range (from 400-1000nm) and an InGaAs based image sensor to cover SWIR spectral range (from 950-1700nm). In an augmented version, our patented MIPI switching mechanism allows for further expansion by adding multiple image sensors to camera ports. This capability makes the path toward expanding the spectral range to 300-2500nm feasible.

The IVS concept LIDAR system proposes using one pulsed diode laser alongside multiple continuous wave diode lasers. A pulsed diode laser is used to generate the range information and 3-D cloud data. The Continuous Wave (CW) diode lasers will be used to generate spectral images in shadowed regions. The current wavelengths of CW lasers selected based on the requirement from the science team are 980 nm, 1250 nm and 1535 nm. The wavelengths for the MSI and LIDAR systems were specifically selected based on heritage from multispectral imagers in orbit and also modified to allow the camera to rapidly differentiate between different types of lunar materials.

In addition to the core IVS concept, smaller adaptable vision systems that utilize only the MSI sensors are being developed for use on micro-rover platforms. One such version is a compact multispectral imager with active illumination source (AI-MSI), which can be interfaced to a lunar micro-rover.The advantage of the proposed AI-MSI instrument is its ability to do scientific investigation on the lunar surface in both lighting conditions while also providing a small form factor for ¡30 kg class micro-rovers.