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

Author: Dr. Gordon Osinski
Institute for Earth and Space Exploration, Western University, Canada

Dr. Jayshri Sabarinathan
University of Western Ontario (UWO), Canada
Dr. Aref Bakhtazad
Western University, Canada
Dr. Livio Tornabene
University of Western Ontario (UWO), Canada
Dr. Eric Pilles
University of Western Ontario (UWO), Canada
Mr. Chris Bell
MDA, Canada
Mr. James Burley
University of Western Ontario (UWO), Canada
Mr. Stuart Eagleson
MDA, Canada
Mr. Tim Elgin
MDA, Canada
Mr. Fred Fahim
MDA, Canada
Mr. Louis Gagnon
MDA, Canada
Mr. Brad Jones
MDA, Canada
Mr. Michael Khor
MDA, Canada
Mr. Nicholas Mitchell
University of Western Ontario (UWO), Canada
Mr. Sean Zhu
MDA, Canada

ADAPTABLE VISION SYSTEMS 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 environments (e.g., from permanently shadowed to near constantly illuminated) science targets, and robotic platforms – from micro-rovers to pressurized human rovers. Our team is developing a series of vision systems based around the core Integrated Vision System (IVS), a prototype stand-off instrument designed to be mounted on a rover mast for exploration of the lunar surface. 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. We are designing several versions of IVS. The baseline IVS consists of a MSI 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 and an InGaAs based image sensor in the 900 – 1700 nm spectral range. In an augmented version, our patented MIPI switching mechanism allows for further expansion by adding multiple image sensors (InGaAs or Silicon) to a single imaging input port. This capability makes the path toward expanding the spectral range from 300-2500nm or beyond feasible. The LIDAR system requires range information only at one wavelength for the generation of 3-D models. Thus, the IVS concept proposes using Continuous Wave diode lasers at the non-ranging wavelengths to help reduce the LIDAR size, mass and power consumption. The current wavelengths of CW lasers selected 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 (e.g., Clementine and Kaguya) and modified to allow the camera to rapidly differentiate between different types of lunar materials. In addition to the core IVS concept, we are considering alternative options for adaptable vision systems more suitable for micro-rovers. One such instrument is a compact multispectral imager with active illumination source (AI-MSI) instrument. The AI-MSI will adapt the housing and interface design of our current field tested MSI prototype in the VIS-NIR integrated with a smaller compact LED light source. 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.