Active Project (2016 - 2017)

# High Performance Image Processing Algorithms for Current and Future Mastcam Imagers, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)


## ABSTRACT

We propose high performance image processing algorithms that will support current and future Mastcam imagers. The algorithms fuses the acquired Mastcam stereo images at different wavelengths to generate multispectral image cubes which can then be used for both anomaly detection and rough composition estimation from relatively longer distances when compared to LIBS instrument. To address the challenge in the stereo image alignment, we propose a two-step image registration approach. The first step consists of using the well-known RANSAC (Random Sample Consensus) technique for an initial image registration. The second step uses this roughly aligned image with RANSAC and the left camera image and applies a Diffeomorphic registration process. Diffeomorphic registration is formulated as a constrained optimization problem which is solved with a step-then-correct strategy. This second step allows to reduce the registration errors to subpixel levels and makes it possible to conduct reliable anomaly detection and composition estimation analyses with the constructed multispectral image cubes. Finally, in this framework, we provide a set of both conventional and state-of-the-art anomaly detection and composition estimation techniques to be applied to the generated Mastcam multispectral image cubes for guiding the Mars rover to interesting locations.


## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: Our system can be used in NASA's existing and future planetary rover missions. In particular, our algorithms can be used as an intelligent proxy to assist human operators in rover guidance. In addition, the algorithms will also provide help in the development of the next generation of Mastcam imagers. The new Mars rover that is expected to be sent to Mars in 2020 will also contain stereo Mastcam instrument that has Mastcam-Z, an advanced camera


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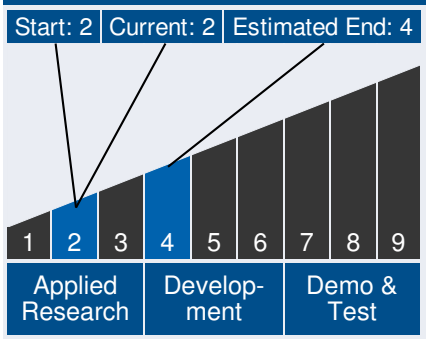
### Technology Maturity




### Management Team

**Program Executives:**

- Joseph Grant
- Laguduva Kubendran

**Program Manager:**

- Carlos Torrez

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system with panoramic and stereoscopic imaging capability with the ability to zoom [http://www.nasa.gov/press/2014/july/nasa-announces-mars-2020-rover-payload-to-explore-the-red-planet-as-never-before/#.VLkyayvF_6s]. In addition, the two-step registration approach can be used in remote sensing applications for environmental monitoring and for damage assessment after a natural disaster where precise registration is critical.

**To the commercial space industry:**

Potential Non-NASA Commercial Applications: Our technology can be useful in the biometrics field for face detection and recognition using stereo and/or multimodal stereo images. It can be also used by military for surveillance and reconnaissance that utilize multiple cameras with different views to the same scene. Another important field that our technology can have an impact is the biomedical field. In some biomedical applications, sequential imaging techniques are commonly used to detect changes in the spatial distribution of various molecules and biological materials. As an example, multispectral imaging is used to detect hemoglobin, melanin; narrowband imaging is used for cancer detection; multispectral fluorescence imaging is used to indicate molecular targeting in flexible endoscopy. All these techniques need to acquire multiple images of a sample at different wavelengths and/or polarization states in order to construct a complete spectrum for each pixel. However, the acquisition of a stack of multispectral images may take several hundred milliseconds or longer, depending on the exposure time of the camera, the number of wavelengths required and the switching time of the filter. Even though this time difference is small, the camera and the tissue may change position due to the patient's breathing. This then creates a problem since the multispectral image stack must be precisely aligned in order to extract information. Our technology might be helpful to address this challenge.

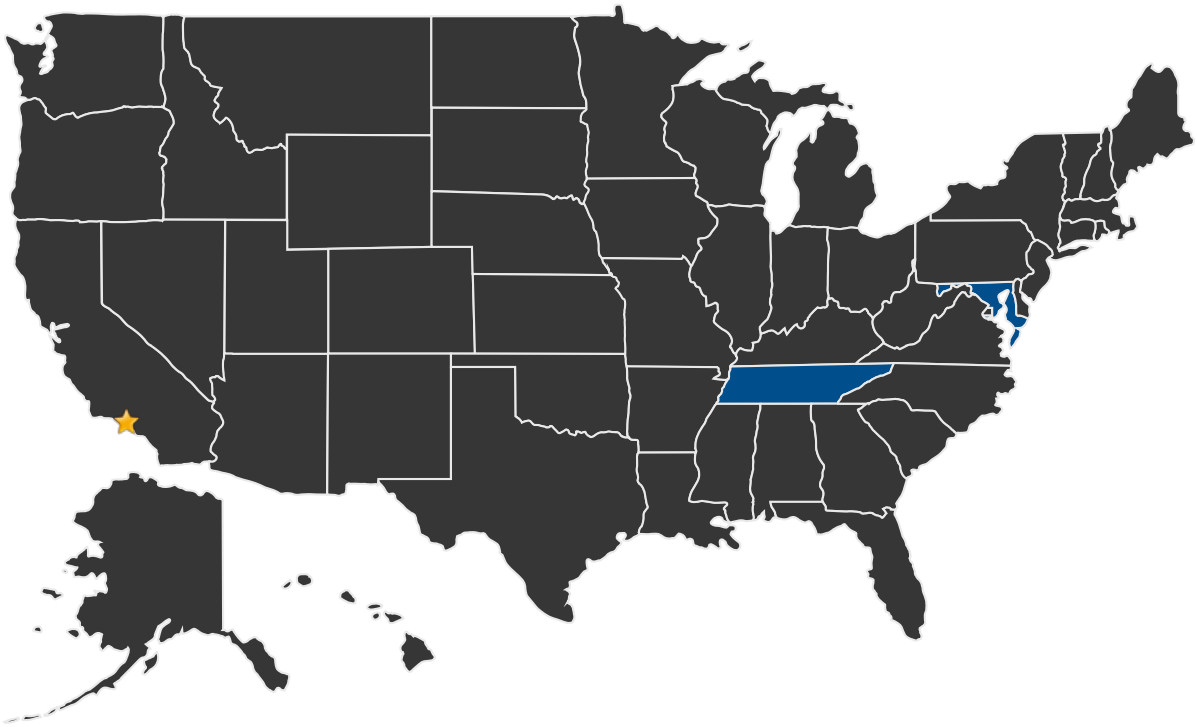
## Management Team *(cont.)*

**Principal Investigator:**
- Chiman Kwan

## Technology Areas

**Primary Technology Area:**
Modeling, Simulation, Information Technology and Processing (TA 11)
- Information Processing (TA 11.4)
  - Science, Engineering, and Mission Data Lifecycle (TA 11.4.1)

## U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

**Lead Center:**
Jet Propulsion Laboratory

**Other Organizations Performing Work:**

- Applied Research, LLC (Rockville, MD)
- University of Tennessee (Knoxville, TN)

## PROJECT LIBRARY

### Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23014)

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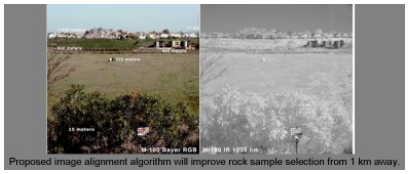
## IMAGE GALLERY




*High Performance Image Processing Algorithms for Current and Future Mastcam Imagers, Phase I*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

High Performance Image Processing Algorithms for Current and Future Mastcam Imagers, Phase I

### Potential Applications

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