The International Workshop on Instrumentation for Planetary Missions

Oct 10-12, 2012, Greenbelt, Maryland

PROPOSED STANDARDS FOR DESCRIBING SPACE IMAGING SYSTEMS USED FOR PLANETARY MAPPING

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The Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC)

Introduction

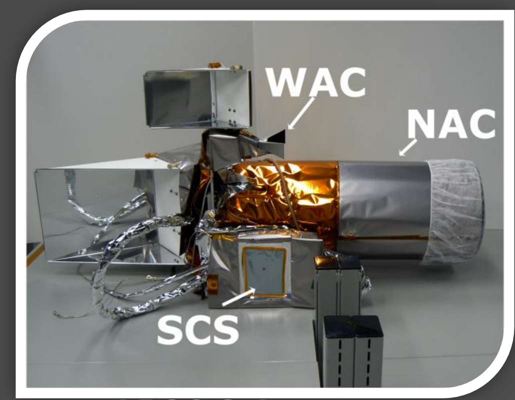
Converting space image data into meaningful datasets is a cartographic process involving the georeferencing of data into a defined planetary co-ordinate system, albeit with details that vary from one imaging system to the other. Such processing requires the development of a geometric "sensor model" or "camera model" and related set of software tools that are compatible for downstream analyses and planetary cartographic production. The lack of adequate and consistent information about space imaging systems presents a major bottleneck to both the development of the needed analysis tools and consequently to subsequent cartographic production, with measureable cost consequences to NASA and the planetary research community it supports.

In this poster, we present a multiphase approach that would aim at establishing standards by NASA for all future space imaging systems. These standards involve documenting design stage technical specifications, geometric properties, clearly defined calibration procedures to be conducted pre-launch and in-flight, and comprehensive reporting of the outcome of the camera calibration.

Rationale

There are numerous space imaging systems that have been launched strictly for planetary scientific studies and cartographic mapping purposes. The design of such systems is affected by various factors, such as:

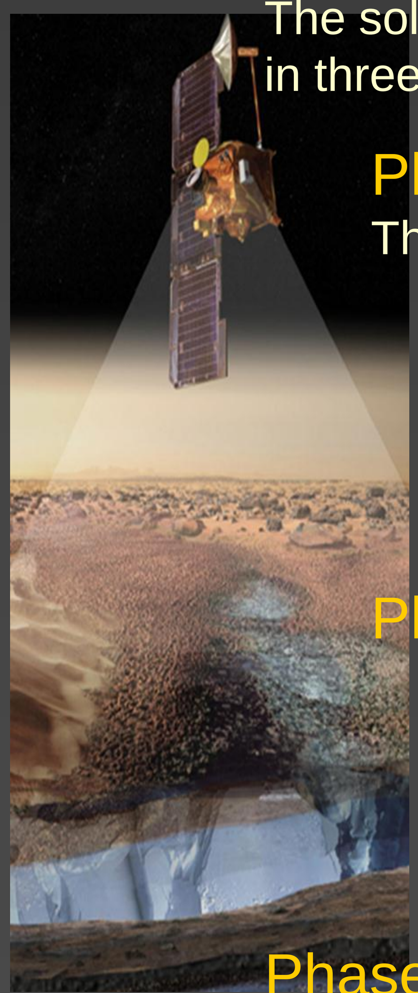
- *The current state of the art in flight-qualified technologies for detectors, optics, structures, and data processing*
- *Detailed geometric descriptions characterizing the instrument;*
- *Target planet, phenomena, and flight category;*
- *Hardware considerations, electronic circuitry, power supply, downlink and data transfer;*
- *Stability, thermal resistance, and quality of optical positioning;*
- *Cost and financial constraints; and*
- *Payload constraints.*



LROC Subsystems

Thus, for example, cameras used in the US lunar and planetary program have ranged from framing cameras with wide-angle refractive optics using photographic film (Apollo Metric camera) to a pushbroom scanner with complex, multi-surface refractive optics and a total of 14 solid-state detector arrays (MRO HiRISE). Detailed information about the many space imaging systems is crucial for planetary science because it is the first link in the chain from raw observations to scientifically useful high level products (see abstract by Archinal et al., this conference); thus there is a need for establishment and enforcement of standards of the description of these systems. Such standards would facilitate development of complete camera models required for image analysis, developments of processing tools, software compatibility, and planetary cartographic production. Lack of these standards is costly and some-times prohibitive to derive meaningful information from the acquired image data.

Proposed work



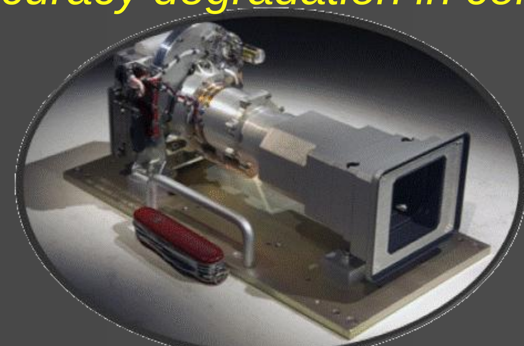
The solution is to establish standards for describing and documenting all design stage and pre-launch geometric aspects of future space imaging systems. This solution can be realized in three phases described as follows:

Phase 1: Making the Case: In this phase, a convincing argument would be presented in the form of a study that would make the case for standards through cost/benefit analysis. The goal here is to facilitate the willingness to adopt and adhere to the standards. The study would present specific quantitative measures to demonstrate:

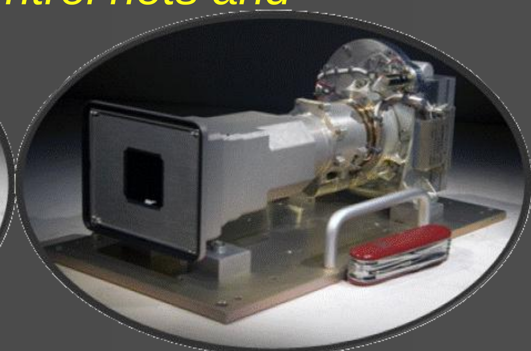
1. *That lack of standards does impose a substantial and unnecessary cost overhead in developing the camera models and adjunct analysis tools and soft-ware development. Conversely, the study would demonstrate that proposed standards would bring about measurable savings on developing the camera model and related software tools.*
2. *That lack of a standard form for camera calibration reports increases the uncertainty of both, the magnitude of errors and source of accuracy degradation in control nets and cartographic products.*

Phase 2: Initial Standards Development: Phase 2 is the core development of the standards, including but not limited to:

1. *A set of standards for design stage technical specifications, geometric, radiometric, and spectral properties.*
2. *Clearly defined description of procedures for pre-launch and in-flight calibration; and*
3. *Comprehensive reporting language of the outcome of the pre-launch and in-flight calibration as defined in the calibration procedures in #2.*

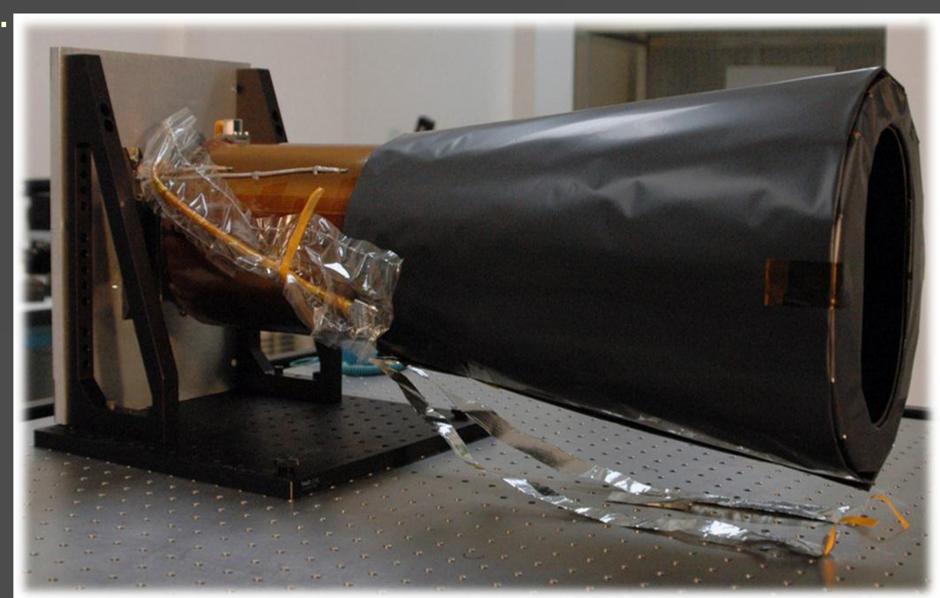


Mastcam 34 mm fixed focal length camera head



Mastcam 100 mm fixed focal length camera head.

Phase 3: Implementing the Standards: Following the study in Phase 1 and the standards in Phase 2, the out-come would be transmitted to NASA to formally adopt the standards and publish them to the public. The goal is that these standards would be listed as a requirement in any new Announcement of Opportunity (AO). In addition, NASA would stipulate that the calibration report would be submitted for review and approval prior to launch. The USGS Astrogeology Science Center could serve as the technical reviewer of the design-stage and pre-launch documentation. Finally, the development of new and more complicated sensors may require periodic standards addendums or amendments.



The Mars Reconnaissance Orbiter (MRO) Context Camera (CTX)

Conclusion

Feed back on the needs for such standards, the phasal approach presented, and the desired cost savings outcome are very much solicited for this effort. We are particularly interested in working closely with the developers of past, present, and notional camera systems to maximize the simplicity and consistency of calibration reports while ensuring that the documentation standards capture the details of even the most complex instruments.

The Mars Reconnaissance Orbiter (MRO)