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The PanCam instrument on the 2018 Exomars rover: Science Implementation Strategy and Integrated Surface Operations Concept

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Geologic context as a combination of orbital imaging and surface vision, including range, resolution, stereo, and multispectral imaging, is commonly regarded as basic requirement for remote robotic geology and forms the first tier of any multi-instrument strategy for investigating and eventually understanding the geology of a region from a robotic platform. Missions with objectives beyond a pure geologic survey, e.g. exobiology objectives, require goal-oriented operational procedures, where the iterative process of scientific observation, hypothesis, testing, and synthesis, performed via a sol-by-sol data exchange with a remote robot, is supported by a powerful vision system. Beyond allowing a thorough geological mapping of the surface (soil, rocks and outcrops) in 3D, using wide angle stereo imagery, such a system needs to be able to provide detailed visual information on targets of interest in high resolution, thereby enabling the selection of science targets and samples for further analysis with a specialized in-situ instrument suite.

Surface vision for ESA's upcoming ExoMars rover will come from a dedicated Panoramic Camera System (PanCam). As integral part of the Pasteur payload package, the PanCam is designed to support the search for evidence of biological processes by obtaining wide angle multispectral stereoscopic panoramic images and high resolution RGB images from the mast of the rover [1]. The camera system will consist of two identical wide-angle cameras (WACs), which are arranged on a common pan-tilt mechanism, with a fixed stereo base length of 50 cm. The WACs are being complemented by a High Resolution Camera (HRC), mounted between the WACs, which allows a magnification of selected targets by a factor of $\sim$8 with respect to the wide-angle optics.

The high-resolution images together with the multispectral and stereo capabilities of the camera will be of unprecedented quality for the identification of water-related surface features (such as sedimentary rocks) and form one key to a successful implementation of ESA's multi-level strategy for the ExoMars Reference Surface Mission. A dedicated PanCam Science Implementation Strategy is under development, which connects the PanCam science objectives and needs of the ExoMars Surface Mission with the required investigations, planned measurement approach and sequence, and connected mission requirements.

First step of this strategy is obtaining geological context to enable the decision where to send the rover. PanCam (in combination with Wisdom) will be used to obtain ground truth by a thorough geomorphologic mapping of the ExoMars rover's surroundings in near and far range in the form of (1) RGB or monochromatic full (i.e. 360°) or partial stereo panoramas for morphologic and textural information and stereo ranging, (2) mosaics or single images with partly or full multispectral coverage to assess the mineralogy of surface materials as well as their weathering state and possible past or present alteration processes and (3) small-scale high-resolution information on targets/features of interest, and distant or inaccessible sites. This general survey phase will lead to the identification of surface features like outcrops, ridges and troughs and the characterization of different rock and surface units based on their morphology, distribution, and spectral and physical properties. Evidence of water-bearing minerals, water-altered rocks or even water-lain sediments seen in the large-scale wide angle images will then allow for preselecting those targets/features considered relevant for detailed analysis and definition of their geologic context. Detailed characterization and, subsequently, selection of those preselected targets/features for further analysis will then be enabled by color high-resolution imagery, followed by the next tier of contact instruments to enable a decision on whether or not to acquire samples for further analysis. During the following drill/analysis phase, PanCam's High Resolution Camera will characterize the sample in the sample tray and

observe the sample discharge into the Core Sample Transfer Mechanism.
Key parts of this science strategy have been tested under laboratory conditions in two geology blind tests [2] and during two field test campaigns in Svalbard, using simulated mission conditions, an ExoMars representative Payload (ExoMars and MSL instrument breadboards), and Mars analog settings [3, 4]. The experiences gained are being translated into operational sequences, and, together with the science implementation strategy, form a first version of a PanCam Surface Operations plan.

References:
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