High-resolution 3D map of Mars

3D global Mars models using CTX data

Status quo

The Mars Reconnaissance Orbiter currently orbiting Mars is equipped with the instrument Context Camera (CTX), which acquires high-resolution and top quality images with a pixel resolution 5-6 meters per pixel (20 ft). Over the last 12+ years, CTX has mapped almost the whole of the surface of Mars (the coverage was 99.1% in March 2017), while also observing more than 60% of Mars more than once, either in order to check for changes related to not well understood Mars natural phenomena that happen over time or in order to generate stereo pairs to be used as an input in high-resolution 3D models.

The problem

Until today CTX imagery remains uncoregistered, meaning that each CTX image uses its own coordinate system. As a result, CTX images are not geometrically aligned both to each other as well as to the most accurate current global Mars models (generated by the MOLA instrument).

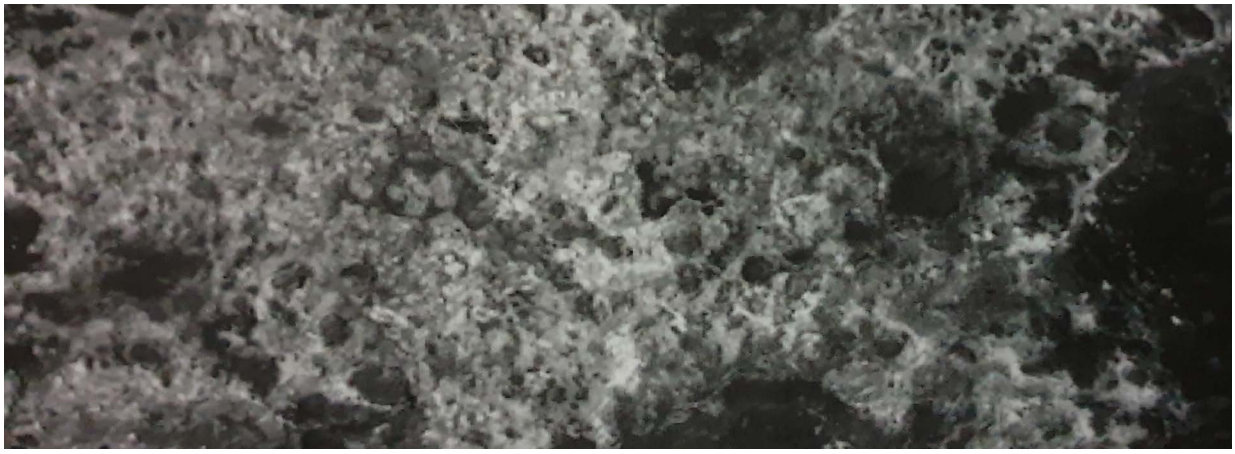
Mars scientists who want to make a local high-resolution mosaic of Mars need to spend a significant amount of time "stitching" relevant CTX images, using complex tools that require extensive human resources and expertise photogrammetric knowledge. Additionally, the misalignment of CTX to MOLA (and to HRSC, which is aligned to MOLA) inhibits the creation of 3D high-resolution mosaics that can be either rendered in a computer or 3D printed, thus generating products that are both interesting to Mars enthusiasts and useful to the scientific community.

Overview of the global CTX imagery projected on Mars using their original location metadata and their original reflectance values. Because the images are not geometrically aligned and photometrically consistent, this „mosaic" is both scientifically erroneous and aesthetically poor.

Solution

Mars Nation will build a global mosaic of unprecedented resolution (6 meters per pixel) using CTX imagery and state-of-the-art computer vision, image processing, and photogrammetry algorithms. CTX images are not going to be just geometrically consistent to each other but also aligned to MOLA and HRSC 3D models (the latter, in the 50% of Mars that they exist). The CTX global mosaic will be open source to facilitate the Mars scientific community and will act as a more accurate mapping layer on the Mars Nation marketplace. The 3D-printed models that will be produced using as input the 3D mosaic will be proprietary and sold within the Mars Nation Platform. The project will employ a data scientist for 12 months and 2 junior data scientists for 6 months resulting in the following timeline:

1. Months 1-2 - Data curation, algorithm development for geometric alignment and preliminary mosaicing.
2. Months 3-4 - Geometric alignment of all CTX images of a single quadrangle (3% of Mars).
3. Months 5-6 - Research and development of radiometric corrections. Print uncoloured 3D prints of the geometrically aligned CTX images.
4. Months 7-9 - Coloured CTX mosaic of a single Mars quadrangle. Full automation of the mosaic algorithms.
5. Months 10-12 - Global CTX mosaic. Production of coloured 3D-prints of the Mars surface.



A local mosaic using 4 CTX images as an input and both geometric and photometric calibration. Image taken from P. Sidiropoulos and J.-P. Muller, ISPRS 2016