AUTOMATED PROCESSING OF CaSSIS ANAGLYPHS. A. M. Fennema[1], S. Sutton[1], R. S. Heyd[1] and J. Perry[1], [1]Lunar and Planetary Laboratory, University of Arizona, 1541 E. University Blvd, Tucson, AZ 85721-063, audrie@lpl.arizona.edu.

Introduction: The Colour and Stereo Surface Imaging System (CaSSIS) onboard the ExoMars Trace Gas Orbiter (TGO) is a pushframe camera capable of acquiring images in up to 4 colors, at scales down to 4.5 m/px. A full description of the instrument can be found in [1]. Due to its rotation mechanism, CaSSIS is capable of acquiring both images of a stereo pair in one overflight. The convergence angle for stereo pairs is 22.4°. The near-simultaneous nature of CaSSIS stereo pairs results in minimized photometric differences between images, thus producing excellent 3D anaglyph as well as digital terrain models. An anaglyph, which can be viewed in 3D with red-blue glasses, is assembled by placing one image of the stereo pair in the red channel and one image in the blue and green channels. Anaglyphs can aid in the qualitative analysis of complex surfaces with a minimized amount of computational and personnel resources. They also make exceptional products for public outreach. Currently, grayscale anaglyphs are being produced from PAN filter images through automated processing.

Anaglyph Processing: Because we do not want to correct for topographical effects as in orthoimages, the MOLA DTM shape model is not used. Instead, the mean radius over the intersection of the images is extracted from the MOLA DTM. The images are then mapped onto a spherical surface of this radius

Stereographic projection is used for our anaglyphs. Since the parallax for CaSSIS stereo pairs lies in the along-track direction, the projection is rotated in such a way that the horizontal edges of the non-projected images become the vertical edges in the anaglyph.

Uncertainty in spacecraft and camera pointing can cause mis-registration between the two images. There are two key challenges to completely automating anaglyph processing without manual intervention. The first challenge is achieving vertical alignment between surface features in the images. It is crucial that there is no vertical misalignment of surface features between images. This type of misalignment makes the anaglyph uncomfortable for the viewer to look at. The second challenge is maintaining optimum horizontal separation, which creates the 3D effect. Separation in the horizontal direction is inherent and required for 3-D viewing, but it is important for the comfort of the viewer that it is not too large.

The ISIS3 *coreg* application is used to co-register the two images. Each stereo pair and the terrain they cover are unique. Automated registration is unlikely to create perfect anaglyphs for every stereo pair without occasional manual intervention. The goal is to find an optimal set of *coreg* parameters that are successful in creating useful, if not perfect, anaglyphs for the greatest number of stereo pairs.

Once the registration process is complete the two images are stacked into an RGB image with the left-eye image going into the red channel and the right-eye image going into the green and blue channels. Any image area not present in all channels is nulled out and subsequently all null pixels around the outside of the anaglyph are trimmed off. A linear stretch is applied and a standard png product is produced.

Future Work: Improvements to the automated registration process are continuing. The current processing script, written in python, will be adapted for processing controlled by the Nextflow [2] workflow management system, described here [3]. Development of an automated process to produce color anaglyphs is planned for stereo pairs where two or more colors are acquired.

References: [1] Thomas, N. et al. (2017) Space Sci. Rev., 212, 1897. [2] Di Tommaso P. et al. (2017) *Nature Biotechnology, 35:4,* 316–319. [3] Heyd R. S. et al. (2019) *4th Planetary Data Workshop.*

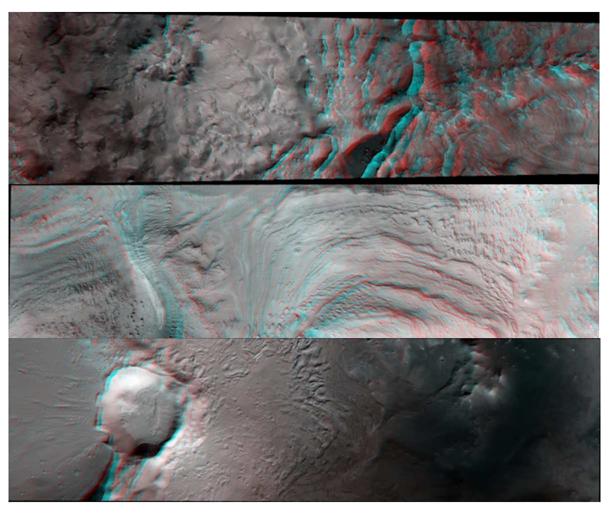

Figure 1: Examples of pan-pan anaglyphs. CaSSIS images MY34_005005_331, MY34_005025_355 and MY34_005389_147.