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# Using Photogrammetric Techniques to Map the Mars Surface

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**Abstract :** For many years, Mars surface has been a mystery for scientists. Lately with the help of geospatial data and photogrammetric procedures researchers were able to capture some insights about this planet. Two of the most imperative data sources to explore Mars are the The High Resolution Imaging Science Experiment (HiRISE) and the Mars Orbiter Laser Altimeter (MOLA). HiRISE is one of six science instruments carried by the Mars Reconnaissance Orbiter, launched August 12, 2005, and managed by NASA. The MOLA sensor is a laser altimeter carried by the Mars Global Surveyor (MGS) and launched on November 7, 1996. In this project, we used MOLA-based DEMs to orthorectify HiRISE optical images for generating a more accurate and trustful surface of Mars. The MOLA data was interpolated using the kriging interpolation technique. Corresponding tie points were digitized from both datasets. These points were employed in co-registering both datasets using GIS analysis tools. In this project, we employed three different 3D to 2D transformation models. These are the parallel projection (3D affine) transformation model; the extended parallel projection transformation model; the Direct Linear Transformation (DLT) model. A set of tie-points was digitized from both datasets. These points were split into two sets: Ground Control Points (GCPs), used to evaluate the transformation parameters using least squares adjustment techniques, and check points (ChkPs) to evaluate the computed transformation parameters. Results were evaluated using the RMSEs between the precise horizontal coordinates of the digitized check points and those estimated through the transformation models using the computed transformation parameters. For each set of GCPs, three different configurations of GCPs and check points were tested, and average RMSEs are reported. It was found that for the 2D transformation models, average RMSEs were in the range of five meters. Increasing the number of GCPs from six to ten points improve the accuracy of the results with about two and half meters. Further increasing the number of GCPs didn’t improve the results significantly. Using the 3D to 2D transformation parameters provided three to two meters accuracy. Best results were reported using the DLT transformation model. However, increasing the number of GCPS didn’t have substantial effect. The results support the use of the DLT model as it provides the required accuracy for ASPRS large scale mapping standards. However, well distributed sets of GCPs is a key to provide such accuracy. The model is simple to apply and doesn’t need substantial computations.

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