Improved 3D Mars Control Net from a Combined Adjustment of VIKING images and Mars Orbiter Laser Altimeter data

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INTRODUCTION. The current global spatial control net of Mars provides the geodetic basis for an orthoimage map composed of image data sets obtained from VIKING missions from 1976 to 1980. This map is not consistent with data returned from the Mars Observer Laser Altimeter (MOLA) onboard the spacecraft Mars Global Surveyor (MGS).
In order to adjust the VIKING orthoimage map to MOLA, a new photogrammetric analysis of the global control net including MOLA data has been initiated. Altogether, coordinates of more than 3700 Martian surface points and outer orientation parameters of more than 1140 images are to be determined in the adjustment process. The methods applied are presented in this report.

METHODS. Input data for the photogrammetric process are manually measured image coordinates in VIKING images from RAND Corp. and USGS (United States Geological Survey) and corresponding MOLA heights. Furthermore, full ground control information from one well-known point, the Mars Pathfinder landing site (MPF), is available. Thus, providing necessary tie to the planet's surface.
To be able to use the accurate laser altimeter elevation information, a Digital Terrain Model (DTM) was created from so-called planetary radii obtained by MOLA. Interpolated radii were then extracted for each control point and introduced as additional conditions for the coordinates of each global control point into a combined bundle block adjustment using image coordinates and the navigation data of the camera as observations.
The control point coordinates in the areocentric object coordinate system, referenced to the MDIM2 coordinate system, and the camera position coordinates and orientation angles, as determined in the 1999 global adjustment at the DLR, are used as initial values for the unknowns. Necessary coordinate transformations for MPF, object points, and camera positions between IAU94 and the MDIM2 coordinate system are done using VICAR (Video Image Communication and Retrieval) software, developed at the DLR.
The adjustment is expected to yield a significant improvement in the accuracy of the object point coordinates as well as for the outer orientation parameters. The computation of the bundle block adjustment is carried out using the software CLIC, developed at the Technical University of Munich (TUM), department of photogrammetry.

CONCLUSION. Including accurate MOLA data in a combined bundle block adjustment of the Mars Control Net, using VIKING image coordinates and spacecraft navigation information, we hope to gain significantly improved object point coordinates and outer orientation parameters for VIKING images.
Based on these outer orientation parameters, together with the MOLA areoid heights digital elevation model, it is further intended to create an improved digital orthoimage map of 64 pix/deg resolution to serve as a unique and consistent image database in an up-to-date reference frame for planning future missions to Mars.