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Feasibility analysis and residual evaluation of automated planar segmentation results of large-scale Martian surface structures

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As increasingly larger coverage of DTMs is available for the Martian surface, not only the number of studies on individual specific Martian features increase, but the need for large-scale geomorphometric evaluation is amplified as well. The computer power and the increasingly sophisticated methods are about to allow such extensive studies. Our DTM segmentation method that has been tailored and tested recently for various geoscientific applications, now allows to process large DTMs created within the framework of ESA Mars Express HRSC project. The implementation uses computation parallelization, kd-tree approach for storage and several sophisticated techniques in seeking for seed points to improve performance. Test runs on high-capacity multi-core computers demonstrate that now processing of complete DTMs of an orbit is feasible.

The possibility to process large areas also implies that the segmentation results in high number of planar facets, typically several thousand features. Furthermore, the segmentation is often sensitive to the initial parameters (number of points to calculate local normal vectors, point-to-plane distance, angular tolerance, etc.) and also the use of splitting segments parameter has typically a stronger influence on the corresponding segmentation pattern. This complexity may complicate the evaluation of the results.

In order to recognize the general behaviour a number of test runs have been carried out. The resulting sets of planar facets were then evaluated whether the segmentation fulfilled the original purpose (e.g., in the case of the modeling of an impact crater, its typical features should be modeled. In case of unsatisfying coverage or residual values those models have been sorted out.

Model results considered to be satisfying are then analysed from the point of view of the residual values (the pointwise difference of measured height and modeled height). The distributions of the residuals are sometimes asymmetric, but the results are typically still acceptable. Asymmetric and non-continuous segmentations arise if the area is complex, composed of various landforms. This may also imply the need to process the area with various parameter sets, in order to cover features like impact craters, volcanoes, topographic scarps, debris slopes and landslides. According to our experience it is not easy to have low residuals, a good coverage of all features and high percentage of meaningful planar facets. However, this type of result can be achieved by the introduction of successive segmentation phases; the phases process a given number of points and the remaining points will be put into the next segmentation step.

The final goal of the whole segmentation is the geostatistical evaluation of the parameters planar features (size, slope, aspect, average of residual values, etc.).

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