Abstract SF2A

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The integration of complementary remote sensing data acquired from multiple satellite platforms represents a fundamental challenge in planetary science. Firstly, it requires precise spatial alignment as a critical preprocessing step. Secondly, the fusion of these data needs to account for heterogeneous samplings and surface coverages. This registration task is particularly demanding for extraterrestrial environments due to several inherent difficulties: the scarcity of distinctive surface features that can serve as reliable landmarks, and significant variations in the spatial coverage (referred to as acquisition footprints) between different datasets. To address these challenges, we propose a novel methodology that leverages three-dimensional topographic information derived from stereo image pairs, specifically utilizing Digital Terrain Models (DTMs). Our approach employs 3D geometric principles to achieve automatic rigid registration between DTMs, enabling hands-free accurate alignment of planetary surface data, while generating a fused geometric product of the DTMS at user-defined resolution and sampling. The performance of our method is rigorously evaluated through comparative analysis against both baseline techniques and state-of-the-art registration algorithms and fusion frameworks. This evaluation is conducted using two distinct datasets: (1) a newly developed benchmark consisting of synthetic planetary DTMs specifically designed to simulate realistic extraterrestrial terrain conditions, and (2) actual Martian topographic data acquired from orbital missions. Experimental results demonstrate that our 3D geometric registration approach achieves satisfactory alignment accuracy while exhibiting significantly enhanced robustness to common remote sensing challenges. These challenges include incomplete data coverage (missing data regions) and varying degrees of overlap between different acquisitions. The practical utility of our method is further validated through its successful application to the registration of a Martian data mosaic, showcasing its effectiveness in real-world planetary data integration scenarios. Our contributions include: (1) a robust 3D geometric registration framework specifically designed for planetary DTM alignment, (2) a customizable method to fuse the geometric information of DTMs at the resolution and sampling of choice, (3) a comprehensive benchmark dataset for evaluating planetary registration algorithms, and (4) empirical validation demonstrating superior performance in handling footprint-related challenges compared to existing methods.