



## **The observation of Martian dune migration using very high resolution image analysis and photogrammetric data processing**

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Although the origins and processes of Martian aeolian features, especially dunes, have not been fully identified yet, it has been better understood by the orbital observation method which has led to the identification of Martian dune migration such as a case in Nili Patera (Bridges, 2012), and the numerical model employing advanced computational fluid dynamics (Jackson et al., 2015). Specifically, the recent introduction of very high-resolution image products, such as 25 cm-resolution HiRISE imagery and its precise photogrammetric processor, allows us to trace the estimated, although tiny, dune migration over the Martian surface.

In this study, we attempted to improve the accuracy of active dune migration measurements by 1) the introduction of very high resolution ortho images and stereo analysis based on the hierarchical geodetic control (Kim and Muller, 2009) for better initial point settings; 2) positioning error removal throughout polynomial image control; and 3) the improved sub-pixel co-registration algorithms using optical flow with a refinement stage conducted on a pyramidal grid processor and a blunder classifier. Consequently, this scheme not only measured Martian dune migration more precisely, but it will further achieve the extension of 3D observations combining stereo analysis and photoclinometry. The established algorithms have been tested using the HiRISE time series images over several dune fields, such as the Kaiser, Procter, and Wirtz craters, which were reported by the Mars Global Digital Dune Database (Hayward et al., 2013). The detected dune migrations were significantly larger than previously reported values and slightly correlated with the wind directions estimated by Martian Climate Database (Bingham et al., 2003). The outcomes in our study will be demonstrated with the quantified values in 2D and volumetric direction. In the future, the method will be further applied to the dune fields in the Mars Global dune database comprehensively and can be compared with the numerical simulation.

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