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A proxy for variance in dense matching over homogeneous terrain

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Automation in photogrammetry and avionics have brought highly autonomous UAV mapping solutions on the market. These systems have great potential for geophysical research, due to their mobility and simplicity of work. Flight planning can be done on site and orientation parameters are estimated automatically.

However, one major drawback is still present: if contrast is lacking, stereoscopy fails. Consequently, topographic information cannot be obtained precisely through photogrammetry for areas with low contrast. Even though more robustness is added in the estimation through multi-view geometry, a precise product is still lacking. For the greater part, interpolation is applied over these regions, where the estimation is constrained by uniqueness, its epipolar line and smoothness. Consequently, digital surface models are generated with an estimate of the topography, without holes but also without an indication of its variance.

Every dense matching algorithm is based on a similarity measure. Our methodology uses this property to support the idea that if only noise is present, no correspondence can be detected. Therefore, the noise level is estimated in respect to the intensity signal of the topography (SNR) and this ratio serves as a quality indicator for the automatically generated product. To demonstrate this variance indicator, two different case studies were elaborated.

The first study is situated at an open sand mine near the village of Kiezegem, Belgium. Two different UAV systems flew over the site. One system had automatic intensity regulation, and resulted in low contrast over the sandy interior of the mine. That dataset was used to identify the weak estimations of the topography and was compared with the data from the other UAV flight.

In the second study a flight campaign with the X100 system was conducted along the coast near Wenduine, Belgium. The obtained images were processed through structure-from-motion software. Although the beach had a very low variance in intensity, the topography was reconstructed entirely. This indicates that to a large extent interpolation was applied. To assess this amount of interpolation processing is done with imagery which is gradually downgraded. Through linking these products with the variance indicator (SNR) this results in a quantitative relation of the interpolation influence onto the topography estimation in respect to contrast.

Our proposed method is capable of providing a clear indication of variance in reconstructions from UAV photogrammetry. This indicator has a practical advantage, as it can be implemented before the computational intensive matching phase. As such an acquired dataset can be tested in the field. If an area with too little contrast is identified, camera settings can be adjusted for a new flight, or additional measurements can be done through traditional means.