Geophysical Research Abstracts
Vol. 19, EGU2017-12792, 2017
EGU General Assembly 2017

MACS-Himalaya: A photogrammetric aerial oblique camera system designed for highly accurate 3D-reconstruction and monitoring in steep terrain and under extreme illumination conditions

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The DLR Institute of Optical Sensor Systems has developed the MACS-Himalaya, a custom built Modular Aerial Camera System specifically designed for the extreme geometric (steep slopes) and radiometric (high contrast) conditions of high mountain areas. It has an overall field of view of 116° across-track consisting of a nadir and two oblique looking RGB camera heads and a fourth nadir looking near-infrared camera. This design provides the capability to fly along narrow valleys and simultaneously cover ground and steep valley flank topography with similar ground resolution.
To compensate for extreme contrasts between fresh snow and dark shadows in high altitudes a High Dynamic Range (HDR) mode was implemented, which typically takes a sequence of 3 images with graded integration times, each covering 12 bit radiometric depth, resulting in a total dynamic range of 15-16 bit. This enables dense image matching and interpretation for sunlit snow and glaciers as well as for dark shaded rock faces in the same scene.
Small and lightweight industrial grade camera heads are used and operated at a rate of 3.3 frames per second with 3-step HDR, which is sufficient to achieve a longitudinal overlap of approximately 90% per exposure time at 1,000 m above ground at a velocity of 180 km/h. Direct georeferencing and multitemporal monitoring without the need of ground control points is possible due to the use of a high end GPS/INS system, a stable calibrated inner geometry of the camera heads and a fully photogrammetric workflow at DLR.
In 2014 a survey was performed on the Nepalese side of the Himalayas. The remote sensing system was carried in a wingpod by a Stemme S10 motor glider. Amongst other targets, the Seti Valley, Kali-Gandaki Valley and the Mt. Everest/Khumbu Region were imaged at altitudes up to 9,200 m. Products such as dense point clouds, DSMs and true orthomosaics with a ground pixel resolution of up to 15 cm were produced in regions and outcrops normally inaccessible to aerial imagery. These data are used in the fields of natural hazards, geomorphology and glaciology (see Thompson et al., CR4.3).
In the presentation the camera system is introduced and examples and applications from the Nepal campaign are given.