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Vision-Based Geo-Monitoring – A New Approach for an Automated System

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The necessity for monitoring geo-risk areas such as rock slides is growing due to the increasing probability of such events caused by environmental change. Life with threat becomes to a calculable risk by geodetic deformation monitoring. An in-depth monitoring concept with modern measurement technologies allows the estimation of the hazard potential and the prediction of life-threatening situations. The movements can be monitored by sensors, placed in the unstable slope area. In most cases, it is necessary to enter the regions at risk in order to place the sensors and maintain them. Using long-range monitoring systems (e.g. terrestrial laser scanners, total stations, ground based synthetic aperture radar) allows avoiding this risk.

To close the gap between the existing low-resolution, medium-accuracy sensors and conventional (co-operative target-based) surveying methods, image-assisted total stations (IATS) are a suggestive solution. IATS offer the user (e.g. metrology expert) an image capturing system (CCD/CMOS camera) in addition to 3D point measurements. The images of the telescope's visual field are projected onto the camera's chip. With appropriate calibration, these images are accurately geo-referenced and oriented since the horizontal and vertical angles of rotation are continuously recorded. The oriented images can directly be used for direction measurements with no need for object control points or further photogrammetric orientation processes. IATS are able to provide high density deformation fields with high accuracy (down to mm range), in all three coordinate directions. Tests have shown that with suitable image processing measurements a precision of 0.05 pixel $\pm$ 0.04·σ is possible (which corresponds to 0.03 mgon $\pm$ 0.04·σ). These results have to be seen under the consideration that such measurements are image-based only. For measuring in 3D object space the precision of pointing has to be taken into account.

IATS can be used in two different ways: (1) combining two measurement systems and measuring object points by spatial intersection, or (2) using one measurement system and combining image-based techniques with the integrated distance measurement unit. Beside the system configuration, the detection of features inside the captured images can be done on the basis of different approaches, e.g. template-, edge-, and/or point-based methods.

Our system is able to select a suitable algorithm based on different object characteristics, such as object geometry, texture, behaviour, etc. The long-term objective is the research, development and installation of a fully-automated measurement system, including a data analysis and interpretation component.

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