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HIGH PRECISION CHANGE DETECTION OF GEOLOGICAL SURFACES

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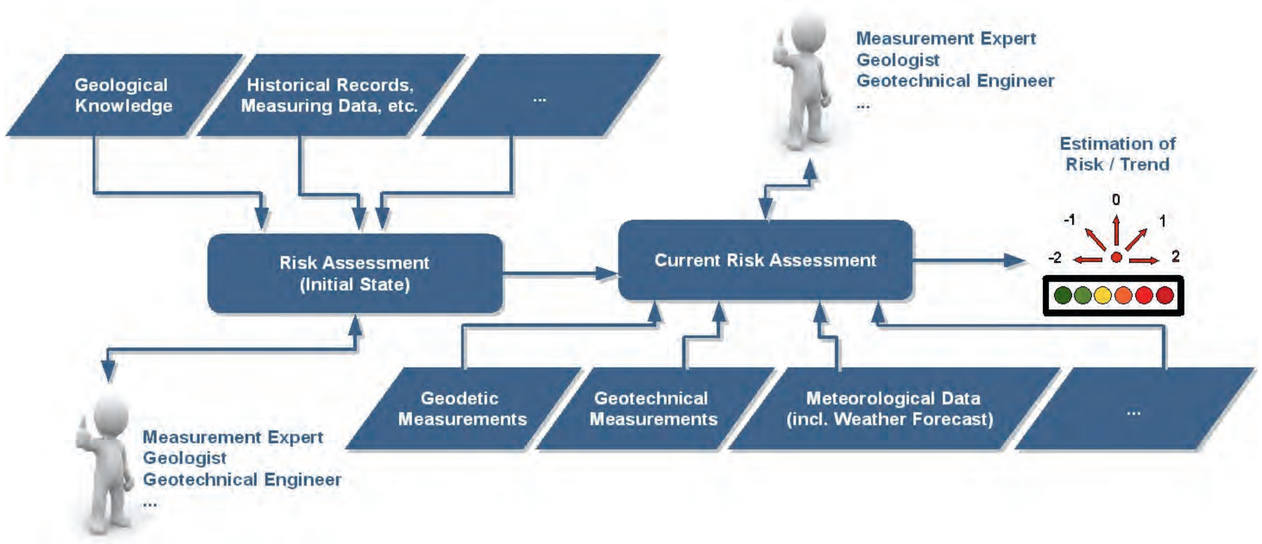
Introduction

The quantification of earth surface processes in the geosciences requires precise measurement and interpretation tools. Typical applications for precise measurement systems involve deformation monitoring for geo-risk management, detection of erosion rates, etc. Often employed for such applications are laser scanners, photogrammetric sensors and image-assisted tacheometers.

Image-assisted tacheometers offer the user (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. The camera is capable of capturing panoramic image mosaics through camera rotation if the axes of the measurement system are driven by computer controlled motors. With appropriate calibration, these images are accurately geo-referenced and oriented since the horizontal and vertical angles of rotation are continuously measured and fed into the computer. The oriented images can then directly be used for direction measurements with no need for control points in object space or further photogrammetric orientation processes. In such a system, viewing angles must be addressed to chip pixels inside the optical field of view. Hence dedicated calibration methods have to be applied, an autofocus unit has to be added to the optical path, and special digital image processing procedures have to be used to detect the points of interest on the objects to be measured.

Image Assisted Total Station (IATS) & System Copncept



The measurement system is composed of two Leica Total Stations, which are taking images of the object to be monitored.

Images are used for matching and for a subsequent surface reconstruction. The result is a high-precision surface model.

Onsite image acquisition of surface changes under investigation requires positioning the IATS at two different positions for triangulation. A geodetic network will be created including points within the area of interest (non-signalized) and stable points (control points). Concrete pillars will serve as control points for IATS setup; additional control points will be fixed in the vicinity of the pillars. All points within the geodetic network will be placed in an area not effected by erosion and will be referenced with sub-millimetre accuracy in an initial survey.

Data Interpretation

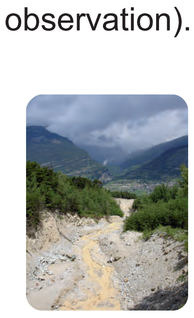
The concept of data interpretation is based on the "calculation" of risk factors for critical cause variables and on the elaboration of an interpretation for the deformation. Examples for cause variables can be precipitation, permafrost, critical slope angle, etc.

The challenging problem in developing such an alerting system is (1) to identify relevant factors and (2) subsequently to capture the interlinkage of these influence factors.
In our system, the process of risk assessment is divided into two steps: (1) the determination of the "Initial Risk Factor" and (2) the determination of the "Dynamic Risk Factor".

The Test Sites

ILLGRABEN:

An annual average of 3-5 debris flows have been observed in the Illgraben, generally they occur from May through October during intensive summer thunderstorms.
Bedrock erosion in the channel is at the order of 1mm per event (personal observation).



PASTERZE:

The Pasterze Glacier is the longest glacier in the Eastern Alps, but in the last decades a dramatic loss of ice was observed.

Quantification of glacier surface changes with new remote sensing techniques using photogrammetric analysis, radarinterferometry, airborne laserscanning and image assisted total stations is a primary task during the last years.

Outlook

The main goal is the developement, implementation and installation of an image-based measurement system for the task for quantification of surface processes in the Geoscience. Development and system implementation is partly completed. Currently the interpretation component is under development and some test and experiments are made in the laboratory at Vienna University of Technology. The online tests will be processed on one hand in the laboratory and on the other hand under field conditions (on-site). A first test has been done in summer 2010, from that time ongoing measurements are taken in regular time intervalls.

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