Hochschule Karlsruhe
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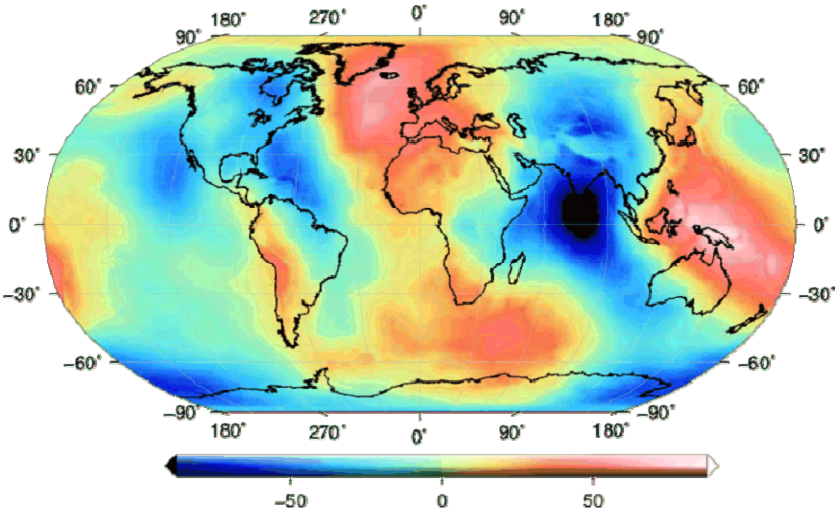
Virtual-GOCA



Observation-Simulation-Software for Geo-Monitoring-Systems

www goca.info

Institut für Angewandte Forschung

GOCA-Earth Version 1.2

Autors: Reiner Jäger, Peter Spohn

Geo-monitoring

With the worldwide use of newer and more efficient construction methods, the demand for geodetic supervision rises. In the past, buildings were constructed with the highest possible effort regarding safety and stability. Today, however, for the planning of constructions, new methods are introduced which are edging technical feasibility. These new methods require an increase of measurement accuracy and also a decrease of the epoch timespans, aiming to a continuous online geodetic monitoring of the building or construction. Otherwise, the security for man and building cannot be guaranteed.
Global climate changes, population growth and the successive expansion of general land-use area lead to a conflict between land use and prevention of natural hazards, such as slopes or thawing permafrost zones. This conflict can also be transferred to generally critical areas, like regions with volcano activities or earthquakes.
Geodetic geo-monitoring starts with the storage of original measurements and ends with their reporting, - or in case of emergency, with the alarming of responsible persons. Completely automated, it also reduces permanent costs.

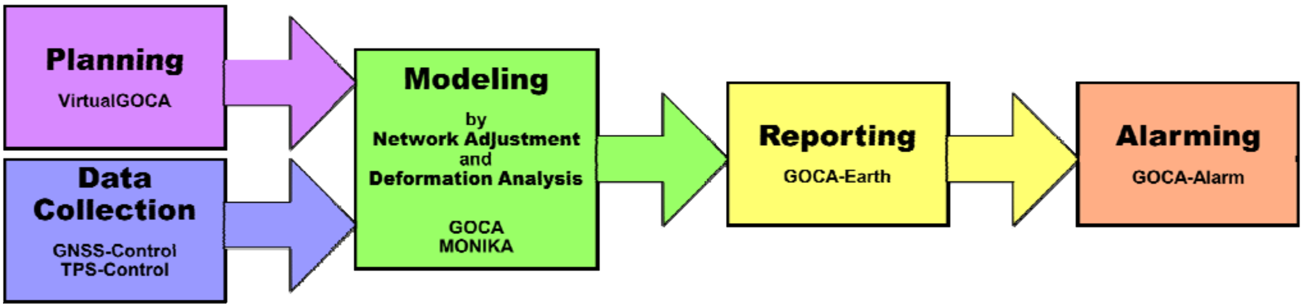


Figure 1: General scheme of an automatic geo-monitoring system

GOCA

The mobile or fixed installed multi-sensor-system GOCA 4.3 can be used as a rapid alarm system for natural disasters (landslides, volcanos) or it can be applied in the section of geotechnical facilities (mining, barrages, tunnels). The monitoring is based on geodetic network adjustment by use of GNSS (GPS/GLONASS/GALILEO) and terrestrial sensors (total stations, water level gauges, leveling instruments). The data of the sensors are send via the corresponding data-collecting and communication-software (fig. 1) within the open interface of the GKA-format to the GOCA-software. The GOCA-system can be used for online monitoring as well as for postprocessing. Through the realization of a classical deformation analysis based on a geodetic network adjustment there are no restrictions concerning the network design and the scale of the network in the GOCA system. So even GNSS base stations or total stations can be located in the object point area. After the georeferencing adjustments, robust filters (displacement estimation, kalman filter) are applied to prevent false alerts.

Virtual-GOCA

Interdisciplinary the task of geo-monitoring (environmental monitoring) is divided in four segments, data collection (sensor network, data communication), modeling (data processing, statistics, predictions), reporting (documentation, protocols, web visualization) and reaction (response due to alerts) (see fig.1). The main target of the geodetic modeling segment is the three-dimensional displacement vector **u** of the object points in a homogeneous coordinate reference system.
Currently new possibilities of modeling and prediction are created due to the ongoing automation in the geo-monitoring sector and the variation of available geodetic and

geotechnical sensors. But these sensors also set up new requirements for the modeling like scalability of the geo-sensor networks in space and time, or deep combination of different geodetic and geotechnical sensor types (“integrated deformation analysis”) and reliability of the whole system during the online monitoring. The classical geodetic network adjustment (Gauß-Markov-Model and its enhancements like deformation analysis) cannot achieve these new standards without a redesign or redevelopment in the domain of mathematical models.

The software Virtual-GOCA was created, to support these new trends and developments in an effective and cost-saving way. Virtual-GOCA replaces all kind of geodetic data collection software by virtually creating GNSS/TPS/LS sensor observations in an worldwide homogeneous reference coordinate system. And because these sensors are only simulated, there is no restriction in the number of sensors or the distances and connections between them. So Virtual-GOCA can be used on the one hand to test and verify other deformation analysis softwares and their and alert modules. On the other hand it is also possible to plan sensor networks for geo-monitoring with Virtual-GOCA and show these simulated projects to customers or on exhibitions in real time mode.
To set up a virtual geo-sensor network, landmarks are defined with the free available GoogleEarth® software and saved in a KML file. In Virtual-GOCA this KML file is imported to get the geographic coordinates of all defined landmarks/points. With the help of the geoid model EIGEN04 (fig. 4) and an additional earth surface model, Virtual-GOCA calculates automatically all ellipsoidal heights and deflections for all points. This data is needed to add real environment corrections to the horizontal and vertical angles in the total station system. As types of observations, distance measurements, angle measurements, baselines and leveling measurements can be set and used to create almost any kind of geodetic sensor network in Virtual-GOCA. This includes also the specific accuracies of the different observation types, as well as local heights of prisms and GNSS antennas.

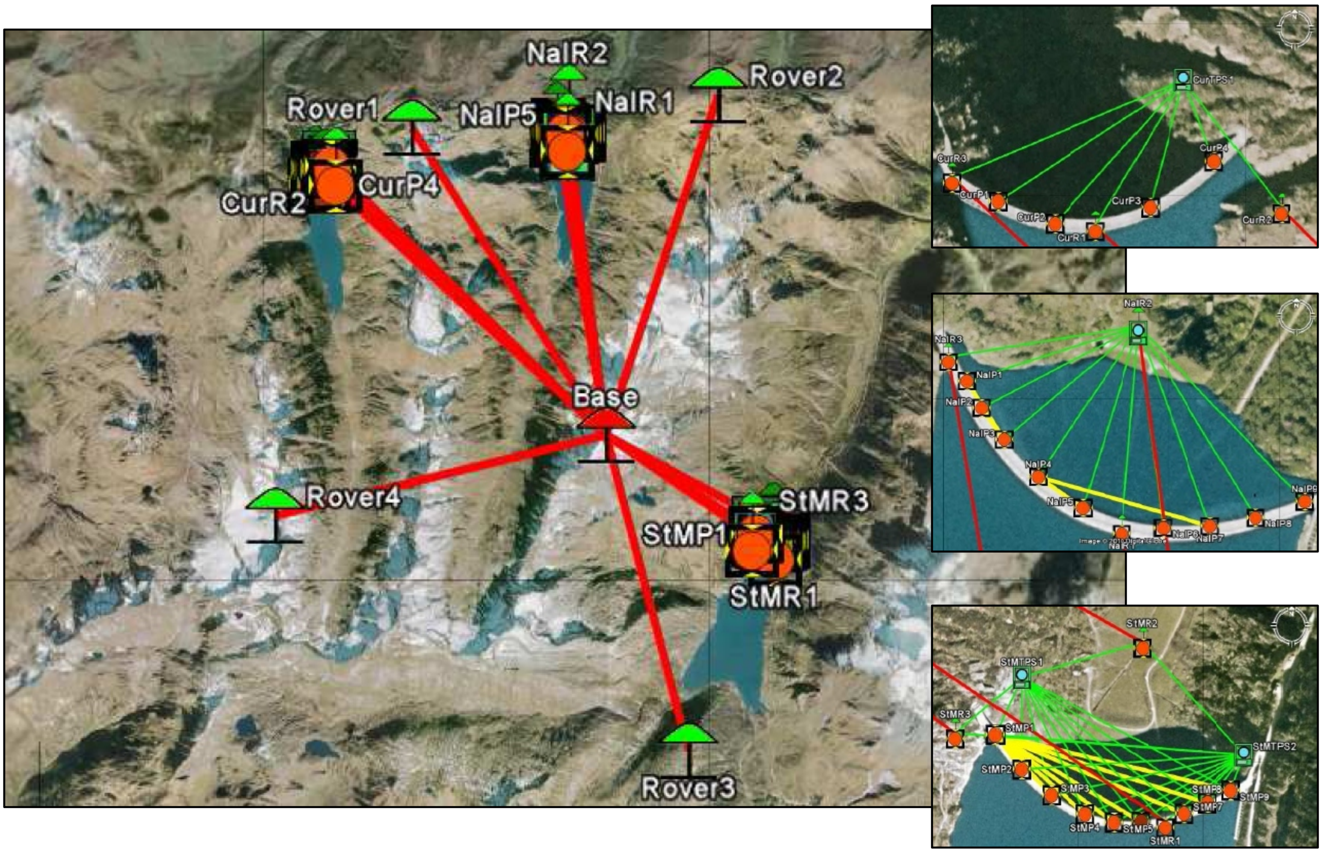


Figure 2: Example of a combined GNSS/TPS/LS sensor network configuration from Virtual-GOCA

An additional feature of Virtual-GOCA is to simulate plunders and observation errors to test the alert software. And even whole slide movements can be simulated.
The observations during the simulation can be created either in real time or for a selectable timespan. All virtual observations and measurements are stored in GKA files. First, because the GKA interface is an open and editable ASCII file interface. Second, because these GKA data can directly be imported in the GOCA deformation analysis software for further processing in the geo-monitoring segment 2 (see fig. 1).

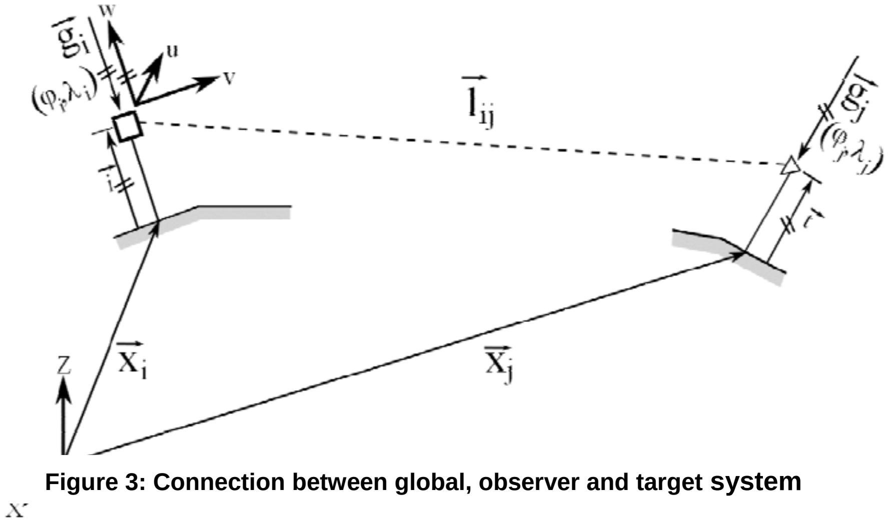


Figure 3: Connection between global, observer and target system

Virtual-GOCA was developed in VisualStudio2008 with an object orientated architecture. So it is always possible to extend the software in the future.

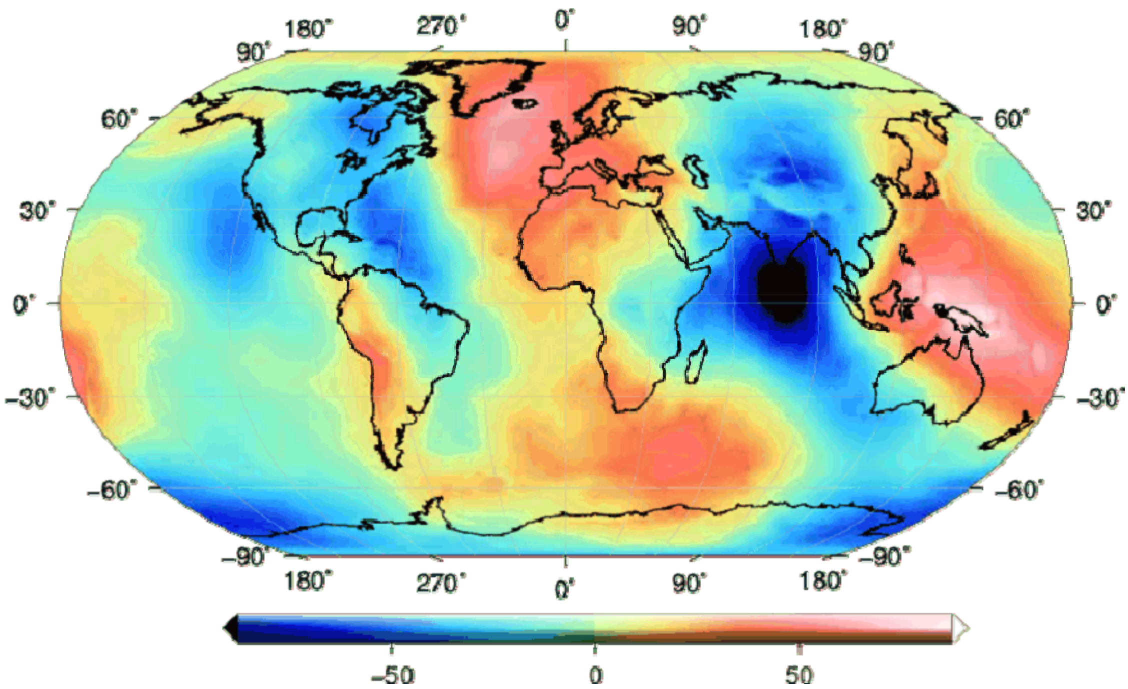


Figure 4: Worldwide geoid model (Eigen04)

Contact (Head of GOCA und MONIKA RaD Project)

Address: Prof. Dr.-Ing. R. Jäger, Hochschule Karlsruhe - Technik und Wirtschaft
Institute of Applied Research, Molkestraße 30, 76131 Karlsruhe
www.imm.hs-karlsruhe.de
E-Mail: reiner.jaeger@goca.info
Web: www.goca.info und www.monika.ag
Phone.: ++ 49 / (0) 721 / 925 – 2620 . Fax: ++ 49 / (0) 721 / 925 - 2597