Geophysical Research Abstracts
Vol. 12, EGU2010-8828, 2010
EGU General Assembly 2010

Sensor Fusion of Position- and Micro-Sensors (MEMS) integrated in a Wireless Sensor Network for movement detection in landslide areas

Christian Arnhardt, Tomas Fernández-Steeger, and Rafig Azzam
Department of Engineering Geology and Hydrogeology, RWTH Aachen University, Germany

Monitoring systems in landslide areas are important elements of effective Early Warning structures. Data acquisition and retrieval allows the detection of movement processes and thus is essential to generate warnings in time. Apart from the precise measurement, the reliability of data is fundamental, because outliers can trigger false alarms and leads to the loss of acceptance of such systems. For the monitoring of mass movements and their risk it is important to know, if there is movement, how fast it is and how trustworthy is the information. The joint project "Sensorbased landslide early warning system" (SLEWS) deals with these questions, and tries to improve data quality and to reduce false alarm rates, due to the combination of sensor date (sensor fusion). The project concentrates on the development of a prototypic Alarm- and Early Warning system (EWS) for different types of landslides by using various low-cost sensors, integrated in a wireless sensor network (WSN). The network consists of numerous connection points (nodes) that transfer data directly or over other nodes (Multi-Hop) in real-time to a data collection point (gateway). From there all the data packages are transmitted to a spatial data infrastructure (SDI) for further processing, analyzing and visualizing with respect to end-user specifications. The ad-hoc characteristic of the network allows the autonomous crosslinking of the nodes according to existing connections and communication strength. Due to the independent finding of new or more stable connections (self healing) a breakdown of the whole system is avoided. The bidirectional data stream enables the receiving of data from the network but also allows the transfer of commands and pointed requests into the WSN. For the detection of surface deformations in landslide areas small low-cost Micro-Electro-Mechanical-Systems (MEMS) and positionsensors from the automobile industries, different industrial applications and from other measurement technologies were chosen. The MEMS-Sensors are acceleration-, tilt- and barometric pressure sensors. The positionsensors are draw wire and linear displacement transducers. In first laboratory tests the accuracy and resolution were investigated. The tests showed good results for all sensors. For example tilt-movements can be monitored with an accuracy of +/- 0,06° and a resolution of 0,1°. With the displacement transducer change in length of >0,1mm is possible. Apart from laboratory tests, field tests in South France and Germany were done to prove data stability and movement detection under real conditions. The results obtained were very satisfying, too. In the next step the combination of numerous sensors (sensor fusion) of the same type (redundancy) or different types (complementary) was researched. Different experiments showed that there is a high concordance between identical sensor-types. According to different sensor parameters (sensitivity, accuracy, resolution) some sensor-types can identify changes earlier. Taking this into consideration, good correlations between different kinds of sensors were achieved, too. Thus the experiments showed that combination of sensors is possible and this could improve the detection of movement and movement rate but also outliers. Based on this results various algorithms were setup that include different statistical methods (outlier tests, testing of hypotheses) and procedures from decision theories (Hurwicz-criteria). These calculation formulas will be implemented in the spatial data infrastructure (SDI) for the further data processing and validation. In comparison with today existing mainly punctually working monitoring systems, the application of wireless sensor networks in combination with low-cost, but precise micro-sensors provides an inexpensive and easy to set up monitoring system also in large areas. The correlation of same but also different sensor-types permits a good data control. Thus the sensor fusion is a promising tool to detect movement more reliable and thus contributes essential to the improvement of Early Warning Systems.