Rock Monitoring in climate change and global warming context

Degree programme: BSc in Electrical Engineering and Information Technology | Specialisation: Embedded Systems
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Global warming has increased the frequency of rockfalls in our mountains. This has an impact on the inhabitants of the regions affected, with road closures and village evacuations. The aim of the Rock Monitoring project is to develop a sensor capable of detecting three-dimensional movements, using accelerometers and a crack meter to measure rock spacing. All this while consuming very little energy and working in extreme environmental conditions.

Motivation

Climate change and global warming are responsible for periods of exceptionally high temperature at high altitudes. The consequent high stress on rock structures (mountains, cliffs) and the melting of the Permafrost cause severe rock falls (e.g., 2018 Col de la Forclaz VS). The monitoring of rock instability is of foremost importance, both for safety and research purposes, since it enables to estimate the danger of rock falls in key locations (e.g., roads, populated valleys). Existing devices cannot be used for long term continuous monitoring in extreme environments, mainly due to their size and consumption. The goal of the system developed at BFH is to cope with such limitations, being extreme low power and working at extreme temperatures. Given its complexity, it has benefitted from the contribution of different Bachelor thesis since 2015. Our contribution has been to re-design the electronics, to drastically reduce its energy consumption, to increase its reliability, and to bring it as close as possible to a final product.

Wireless Sensor Network Concept

- Power autonomy using a small solar panel and a rechargeable battery.
- Very low power consumption using LoRa radio transmission.
- Self-developed Software and Hardware.
- Designed to operate in a temperature range from -30°C to 40°C.
- Modular system for a wide range of uses (high/ medium mountains, plains).

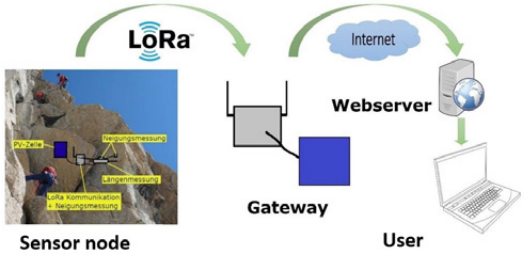
Wireless Sensor Network Composition

- Main Board: Microcontroller and LoRa Radio Module (Arduino MKR WAN 1310), External Sensor I2C Interfaces, Internal Accelerometer, Lead Acid Battery (low temperature) and Battery Management.
- Two external Sensor Boards: Accelerometer and I2C Interface.
- External Crackmeter: Standard linear potentiometer used to measure the distance between 2 points on a mountain slope.

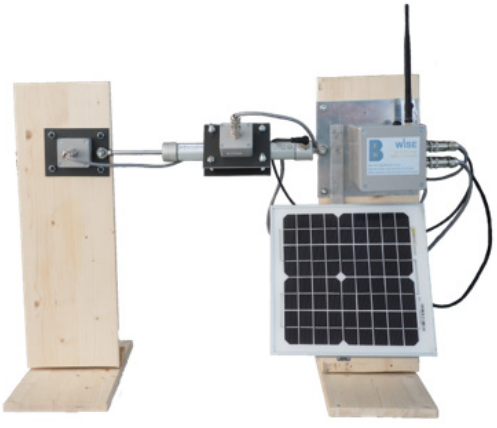
The main board can be used alone (to measure the tilt and rotation of the rock it is fixed on), or in combination with one or two accelerometers, and / or the crackmeter. It can be used without the solar panel for temporary surveillance (limited working time) or with the solar panel (unlimited working time).

Results and Outlook

A new sensor prototype has been developed. All the system's functions have been tested in the laboratory at extreme temperatures (ranging from -30°C to 40°C). Moreover, the system is capable of operating for more than 400 days without a solar panel, confirming its reliability for long term monitoring in extreme environments.



Sensor Node Prototype



Overview of the system

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