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Event-triggered Geophone Platform for Co-Detection of Seismic Events

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Capturing seismic signals at scale is a very powerful method for the assessment of structural aspects in the earth surface. Apart from being able to quantify structure and stability precursors imminent to failure events can be assessed but in many cases the cost for applying this technology is prohibitive: Since it requires large amounts of power to operate seismic sensors continuously and also very large amounts of data need to be propagated and processed. Therefore the utilization of seismic sensors is only viable in the context of larger monitoring infrastructure or in temporary campaign mode.

The concept of co-detection, introduced by Failletaz etal. (2016) capitalizes on sensors that are not sampled continuously to allow classical spectral analysis but rather only capture and process data when something interesting, i.e. an “event” is happening. Further, this concept builds on placing many sensors in a region of interest leveraging the aggregate of all event detections rather than a single or few continuously operating seismic sensor systems. In this work we present a battery-powered event-triggered wireless geophone sensing platform that is capable of detecting and characterizing seismic events based on a preselectable signal threshold level. This platform is built based on a commercial standard geophone (ION SM-6 OB 15Hz). An ultra low-power threshold detection circuit can be configured via a wireless sensor network. While idle this platform consumes sub-mA quiescent current and therefore is capable of autonomous operation over years from a single battery. Upon detection of an event the digitizer is initialized, the signal is captured for a pre-defined period, analysed using on-board machine-learning classification and the results are transmitted via a low-latency wireless sensor network (Sutton, 2017) to a central database.

We demonstrate this platform based on a case study in steep bedrock mountain permafrost located at the prominent rockfall of the Matterhorn Hörnligrat site at 3500 m a.s.l.. Ten event-triggered geophones are installed since August 2018 demonstrating the feasibility of this novel technological and methodological approach for the quantitative assessment of natural hazard processed in an extreme environmental setting.