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Seismic Detection of snow Avalanches using Wavelet-Based Hidden Markov Models

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The knowledge of avalanche activity is of primary importance for risk management in alpine areas. Important decisions, such as reopening of roads or ski runs after snowfalls, are usually dependent on evaluating an avalanche risk and the probability of their occurrence. The knowledge of avalanche activity can help us to understand better the avalanche phenomenon itself and help in the validation of the deterministic models for avalanche hazard estimation.

Normally, the evaluation of avalanche activities at avalanche areas are based on visual inspections by humans. However, snow avalanches activity is usually accompanied by harsh weather conditions, which makes these types of observations often impossible.

It is known that snow avalanches produce seismic signals which can be measured by appropriately designed and deployed networks. The seismic sensors due to their characteristics are suited for the detection of the avalanche events, as well as their physical characterization. The analysis of the ground seismic signal can therefore enable us to detect avalanches at the time of their occurrence. However, for a detection to be successful, seismogenic sources must be differentiated to avoid false alarms. To resolve this problem, in this work, we applied a pattern recognition system using wavelet transforms for the feature extraction from the seismic signals followed by the hidden Markov models for the identification of the seismogenic source as an avalanche.

The combination of discrete wavelet transforms and hidden Markov models was introduced and discussed for the first time by Crouse et al. (1998). The approach used in

this work is derived from a system developed for the classification of seismic signals of volcanic origins (Alasonati et al., 2006) with the following approach: A discrete wavelet transformation (DWT) carries out the task of features extraction; DWT coefficients are then classified over a set of a priori trained hidden Markov trees. The tree-structure of Markov models reflects the natural structure of the DWT in a time-frequency plane, which is the visualization that at best can show the characteristics of DWT vectors.

The analysed data comes from the data set that contains seismic signals recorded from different avalanches in Spanish Pyrenees, Switzerland and Norway. Hereby, we show first results of the application of the system on detection of avalanches seismic signals.

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