Automatic Event Detection on Noisy MicroSeismograms

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Summary

Accurate automatic seismic event identification is an important problem for passive microseismic monitoring. The event arrival time is fundamental in the case of automatic localization of microseismic origins. In this paper, a new approach carrying out precise seismic event determination, based on high-order statistics (HOS), is introduced. Short term kurtosis to long term kurtosis ratio (S/L-Kurt) is a simple, accurate and fast method. The principle idea is to identify the transition from Gaussianity to non-Gaussianity which coincides with the onset of the microseismic event, despite the presence of noise. The reliability and robustness of the proposed algorithm is tested on synthetic and real field data. Even on noisy microseismograms, S/L-Kurt demonstrates an excellent performance with regard to both accuracy and noise robustness. The simplicity of the proposed method makes it an attractive candidate for large seismic data assessment.

Figure 1: *A field microseismogram (top panel) and normalized distribution densities (bottom panel). Before the seismic event, the noise acts as an almost Gaussian distribution; as soon as the P-wave onset, the distribution turns to be non-Gaussian. (The correspondence is indicated by the color of the rectangle.)*

S/L-Kurt

Inspired by STA/LTA method, we propose to utilize the ratio of short term kurtosis (STK) and long term kurtosis (LTK) to determine the change point in Gaussianity of the seismograms.

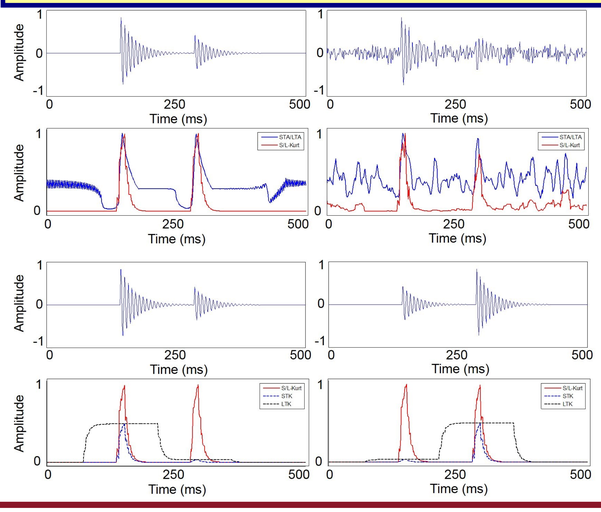

Figure 2: *S/L-Kurt method is more robust. The proposed method can recognize both seismic events, but the other two statistical attributes can only get the stronger one.*

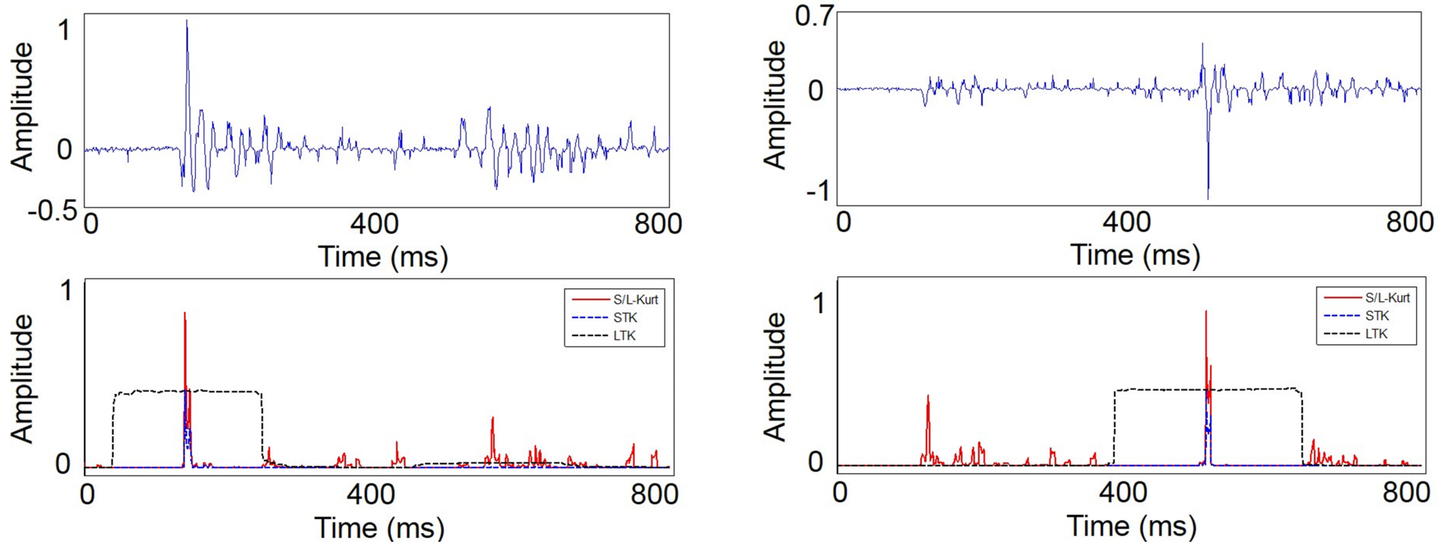

Figure 3: *Field microseismic data application results. Regardles of whether the P-wave or S-wave is stronger, S/L-Kurt can detect their arrivals.*

Signal-Noise Ratio is critical for arrival detection. Almost most automatic event identification methods work well on noise free data, but the field data could be really noisy. In addition, the arrival pickings in the same gather should show a hyperbolic pattern.

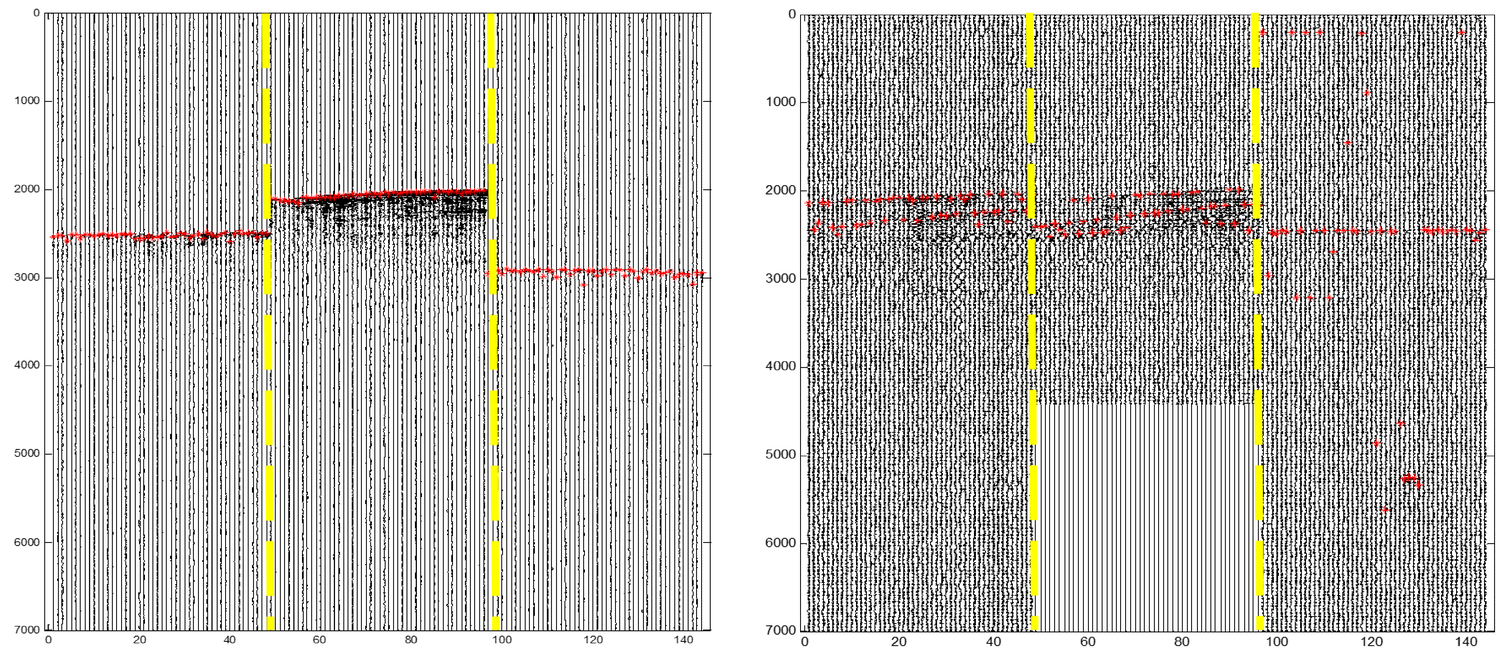

Figure 4: *Arrival picking results in both high and low SNR situations. The picking points show good correspondence with others as a move-out curve, even the SNR is low.*

Conclusions

We have developed a seismic event identification algorithm based on HOS. The proposed so called S/L-Kurt method has proved to be a reliable and accurate seismic event determination method through both synthetic and field data examples. It is noise robust and recognizes not only *P*-wave arrivals but also *S*-wave arrivals.

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