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USE OF CROSS-CORRELATION METHOD TO DETECT AFTERSHOCKS OF MOURMOURY EARTHQUAKE

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Detection of seismic events is the first step in most seismological studies. There are different methods for earthquake detection for example manual detection, sta/lta and cross-correlation (matched-filter) detection. Each one one of these methods have some advantages and disadvantages. Manual detection and sta/lta methods are useful for detecting any unknown source that could occur anywhere in case that amplitude of arrival signals is higher than the level of ambient noise in stations. These methods have some restrictions in detection of very small events near stations or the medium sized events far from the seismic stations where the arrival amplitude is less than the amplitude of ambient noise. In these cases, the cross-correlation technique could be successfully employed to detect signals that are buried in the noise (Schaff and Waldhauser, 2010).

Siesmic signals recorded in a station, are the result of convolotion of instrumental response, the attenuation, the green function and also the source term. Signals of two separate events with close hypocenter recorded in the same station have exactly the same instrumental response and approximately similar attenuation and green functions. Therefore the differeces observed in the signals could only be attributed to the source term (Zhang & Wen, 2015). It is also known that the source term for events that are close to each other in time and space are similar (Bobrov et al., 2012). This gives us a method to detect the events in a signal based on the similarity with previously observed events. To use this method, it is needed to select some well recorded events in the area and use them as templates to correlate with the data from the same station and detect high-similarity sections of the data and consider them as new events.

In this study, the data from a dense temporary network consisting of 14 seismic stations installed to monitor the aftershocks of Magnitude 6 ML earthquake 2014-08-18 T02:32:06 near Mormori, Ilam is used to investigate the advantages of using cross-correlation technique to detect aftershocks of this event. The software Eqcorrscan (a python package writen by Calum J. Chamberlain), which implments the cross-correlation detection method was used to detect the aftershocks.

A catalog of events previously located manually and taking advantage of sta/lta method for the detections of events was used as reference and for the selection of templates. The templates were extracted on the P-phase on vertical component and S-phases on horizental components. The pre-processing step is very important in this method. The spikes in the data were removed and also in case of gaps they were filled with zeros. The continuous data was filtered between 0.5-24 HZ. The selected templates were correlated with the data of the same stations and in cases were the ratio of similarity in sum of shifted cross-correlation of traces were above a threshold, they were considered as an event. Figure 1 shows a sample of shifted and sum of cross-correlations with the templates. In this figure, the red line shows the threshold for detections. In the detections the 3 s interaval between detection was set to pervent loop detections.

The results of this study shows that nearly 3 times as many as the events detected in the reference catalog were detected employing the cross correlation method for detecting the aftershocks. Table 1 shows a sample of number of detections for 7 days of aftershocks compared to the reference catalog. Figure 2 shows samples of detected events on different stations.

Table 1. Compare detected aftershocks of 7 days for 2014 Ilam, Iran earthquake.

No.	Date	Manual detection	Cross-correlationdection	More time detection
1	2014-08-24	57	132	2.31
2	2014-10-10	3	7	2.33
3	2014-10-11	4	12	3
4	2014-10-14	3	13	4.33
5	2014-10-16	16	69	4.31
6	2014-10-21	9	51	5.66
7	2014-10-25	7	10	1.42
	Total detections	99	294	2.97

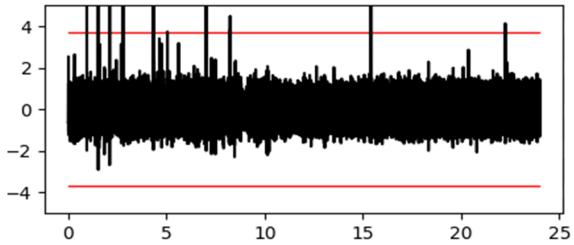

Figure 1. Shifted and sum of cross-correlations with the templates.

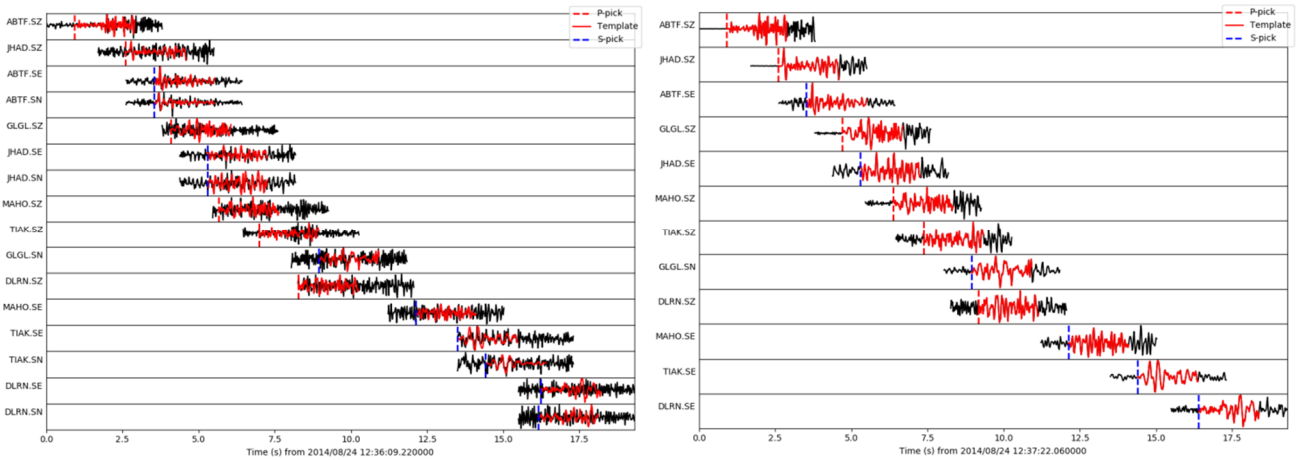

Figure 2. Samples of event detection using cross correlation method.

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