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TOWARDS AN AUTOMATED WAVEFORM CORRELATION DETECTOR SYSTEM

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ABSTRACT

For nuclear explosion seismic monitoring, major aftershock sequences can be a significant problem, because each event must be treated as a possible nuclear test. Fortunately, the high degree of waveform similarity expected within aftershock sequences offers a way to more quickly and robustly process these events than is possible using traditional methods (e.g. STA/LTA detection).

We explore how waveform correlation can be incorporated into an automated event detection system to improve both the timeliness and the quality of the resultant bulletin. With our first iteration of the Waveform Correlation Detector we processed three aftershock sequences – the 1994 Northridge earthquake, the 2005 Pakistan earthquake, and the 2008 Wenchuan earthquake. Our system compared incoming waveform data to a continuously updating library of known events. Incoming waveform data that correlated above a specified threshold with a library event was marked as a repeating event. We set strict window lengths, filter bands and correlation thresholds and used them with no regard to the distance between the station and the location of the main shock. Depending upon that distance, between 24% and 92% of the events in a sequence were recognized as repeating events.

We realized early on in the process that the arbitrary window length, filter band and correlation threshold were not always the best choices for doing waveform correlation. Therefore we have modified our code to adaptively and in real time determine appropriate parameters for window length, filter bands, and correlation thresholds. We then used this automated WCD to re-process some of the datasets where we had previously obtained poor results; we found the automated WCD improved results considerably, i.e. raising the number of events in a sequence recognized as repeating events from 24% to 47%.

Our system is designed to begin running shortly after a large mainshock, and adaptively determine parameters appropriate to the swarm as it runs. We use the March 11, 2011 Japan earthquake sequence to demonstrate the automated WCD. We will also present techniques used to improve the processing speed of our algorithm using the Java Parallel Processing Framework, allowing us to perform waveform correlation on larger and larger datasets.