Detection of seismic signals under low SNR condition using an artificial neural network: Toward the development of low cost seismic network

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We have developed a community based low cost seismic network in Yokohama, Japan, called Citizen Seismic Network (CSN), to monitor local scale strong motion which is closely linked to community’ s life. Each sensor unit composed of 12 bit MEMS accelerometer and Raspberry Pi. Since the units are supposed to be installed under high-noise condition such as inside of house where spiky noise made by human activities often misinterpreted as seismic signal, it is difficult to discriminate the seismic signals from other noises. In such condition, applying conventional detection method using amplitude ratio (e.g. STA/LTA) is problematic. To overcome the issue, we employed an artificial neural network (ANN) that utilizes pattern recognition to retrieve seismic signals. To make the ANN work, we trained it using numerical data set produced by seismic records obtained from conventional seismometer adding CSN sensor noise. As the network input, vector modulus of three components of accelerogram are used.

Firstly we explore the optimum number of input units and training data. Secondly, using the trained ANN, we tried to identify the numerical seismic signals which are not used in the training process. As a result, 95% of the P-wave is successfully detected. The comparison with the performance of STA/LTA using real data observed by our sensor indicates that our method reduce the false detection significantly.

Detection is further improved with multiple stages training: noise data detected as “seismic signal” is included in the next training process as “noise”. The ANN trained with multiple stages stably detects P-wave for Japan Meteorological Agency seismic intensity scale above 3. It indicates that our method can make low cost MEMS sensor not only as reasonable strong motion detector but also as P-wave detector for the intensity above 3. It means our sensor network can be used as a complementary of the conventional seismic network for earthquake early warning.

