Automatic Seismic Wave Detection with Deep Learning - Application to temporary observation data at Hachijojima Island -

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There are 111 active volcanoes in Japan, of which 50 volcanoes have been selected as "volcanoes that require enhanced monitoring and observation systems for volcanic disaster prevention." Geophysical studies using natural earthquakes, such as imaging the crustal structure beneath a volcano, are important for evaluating the eruption risk of a volcano. However, the current seismicity around Hachijojima Island where studying area is low. Therefore, thepurpose of our research is to detect small earthquakes that had not been picked before by seismic wave automatic detection using a deep learning technology.

Machine learning technology, especially deep learning, automatically extracts many features from earthquake data with labels indicating Pwave,Swave, noize. In previous studies using machine learning, because of hardware problems thatthe computational speed was slow, and because of simple network structure, sufficient results could not be achieved.

However, recently due to the development of computational technology such as Graphic Processing Units (GPU), successful results has been obtained.

In this study, we used the Generalized Phase Detection framework (GPD) consisting of a Convolutional Neural Network (CNN) model (Ross et al., 2018). GPD has been trained using earthquakes labeled by analysts at the Southern California Seismic Network (SCSN).

First, we have applied GPD to the continuous seismic waveform data observed by the F-net seismometer at Hachijojima Island, and then GPD was applied to the waveform data obtained by our temporary earthquake observation in Hachijojima Island.

As a result, in both data, we were able to detect more earthquakes than the number of earthquakes currently published by the Japan Meteorological Agency. However, since GPD is a network using CNN and recognizes the waveform as an image, it is picked based on the learned features regardless of the relationship of the P-S time series. Thus, the P-wave-only earthquake and S-wave-only earthquakes were detected.

In the future, we will examine the validity of the detected earthquakes and apply a time series data analysis using the Recurrent Neural Network.

Keywords: Deep Learning, Convolutional Neural Network, Hachijojima Island, Automatic Seismic Wave Detection

