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Machine Learning For Waveform Spectral Analysis On Signal Seismic With Broadband Vertical Component

Marzuki Sinambela[123], Janner Simarmata[4], Eva Darnila[5], Naikson Fandier Saragih[6], Parulian Siagian[7], Putri Ramadhani[3], Kerista Tarigan[1], Sunardi[8]

[1] Department of Physics FMIPA, Universitas Sumatera Utara, Medan 20155, Indonesia
[2] Indonesia Meteorology, Climatology and Geophysics Agency, Medan, Indonesia
[3] Department of Informatics Engineering, STMIK Budi Darma, Medan, Indonesia
[4] Department of Electrical Engineering, State University of Medan, William Iskandar, Indonesia
[5] Department of Informatics Engineering, Malikussaleh University, Lhoksumawe, Indonesia
[6] Department of Informatics Engineering, Universitas Methodist Indonesia
[7] Mechanical Engineering Nomensen HKBP University, Jl.Sutomo 4A ,Medan, Indonesia
[8] Aviation Engineering, Civil Aviation Engineering and Safety Academy, Medan, Indonesia
sinambela.m@gmail.com

Abstract

Machine learning of seismic signal waveform is core component to realize the characteristics of signal. The processing of waveform signal is broadly used for analysis of real time seismic signal. The numerous wavelet filters are developed by spectral synthesis using machine learning python to realize the signal characteristics. Our paper aims to generate and processing the row data of waveform from seismic sensor by using Continuous Wavelet Transform (CWT). CWT is clearly to identify of spectral amplitudes and frequency-energy from component of signal seismic performed by Broadband Network in Indonesia. Finally, by machine learning python allows good time resolution for identified and performed of seismic signal from broadband which deployed in Indonesia.

Keywords: Machine Learning, signal seismic, CWT

1. INTRODUCTION

Machine learning techniques attempt to leverage the concept and principle of "learning" the formulas associated with different types of data characteristics. Our method extends current techniques and incorporates concepts from machine learning. Signal of seismic was differentiated from base natural source of either earthquakes. We analyzing seismic waveforms from a broadband network of seismic station which deployed in Indonesia. The broadband network had been produced the type of the standard for exchange of earthquake data (SEED). The Standard for the Exchange of Earthquake Data (SEED) was developed and designed for digital signal research community[1]. Digital methods are not only increased data quality but also created new challenges. The seismic signal data is available with various channels HH, BH, LH, VH and UH, with sampling frequency of 100,80,20,1,0.1 and 0.01 samples per second, respectively. In this case, we try to analyze the channel of BH* with Broadband Vertical Component (BHZ). We choose the BATI Station, which a part of CTBTO's network station in Indonesia, which had been deployed, and there are 6 station which installed. We analyze BATI station to look the performance and characteristics of nuclear explosion signal on North Korea that occurred on September 03, 2017. In this paper aims to generate and processing the waveform and analyze the characteristic of waveform of signal seismic as a nuclear explosion by using machine learning python on morlet and using the power spectral density. Analyze seismic noise for broadband seismic station had been done by using power spectral density[2][3], the other researcher try to identify the performance of seismic station[4][5]. Machine learning python (MLPy) in this case to perform a morlet wavelet transform by analysis of waveform signal from broadband seismic data recorded on September 03, 2017 with Magnitude 6.3 and Depth 1.0 Km. By using machine learning python (Mlpy) on wavelet transform allows good time resolution for low frequencies of nuclear explosion characteristic.

2. DATA AND METHODS

2.1 Data

The broadband data were employed from BMKG-IA real time seismic monitoring network at the Indonesia Tsunami Early Warning System (Ina-TEWS). We use the nuclear test on September 03, 2017 from North Korea as a research area, the location of each CTBTO's broadband stations is show in figure 1 and table 1. We take the BMKG-IA broadband station seismic by using the available data on September 03, 2017. We used Python by providing routines for the handling of seismic data. It provides read/write support for the most relevant waveform data formats in use at data center and observatories, its support the standard metadata exchange format of Dataless SEED (MSEED), and it comes with clients to interact with the most important data center at BMKG Network in figure 1.

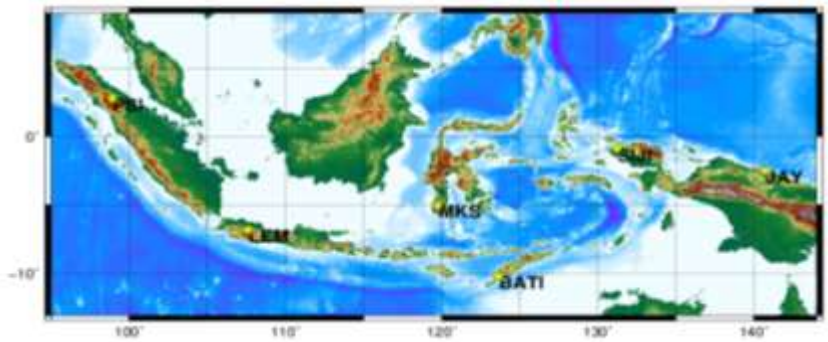

Figure 1. Distribution of CTBTO's Broadband Network Seismic in BMKG-IA

2.2 Methods

We generate the Mini SEED data to SAC (seismic analysis Component) by python for 3 Component in Figure 2, Broadband Horizontal Component (BHE), Broadband Vertical Component (BHZ) and Broadband (BHE). In this case, we only analyze the Broadband Vertical Component (BHZ). The wavelet analysis discussed in this paper employed application of the continuous wavelet transform (CWT) using the Morlet wavelet [6][7][8] and power spectral density. This appeared effective and operative at identifying features in seismic data. We used the machine learning python (MLPy) to processing the waveform of signal seismic[9][10].

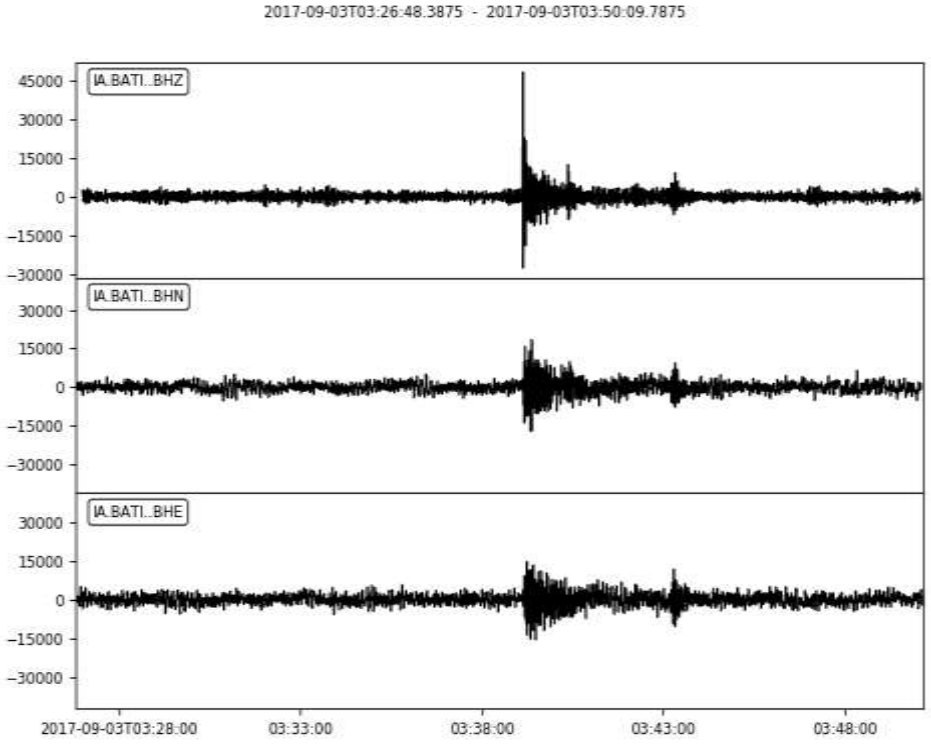

Figure 2. BATI waveform with 3 Component (BHE, BHN, BHZ)

3. RESULT AND ANALYSIS

3.1 Power Spectral Density

In this study, we analyze the CTBTO's broadband for one week. BATI Station on Figure 3 indicated good performance, the spectral waveform between New High Noise Model and New Low Noise Model. The period of time series of the waveform in by power spectral density.

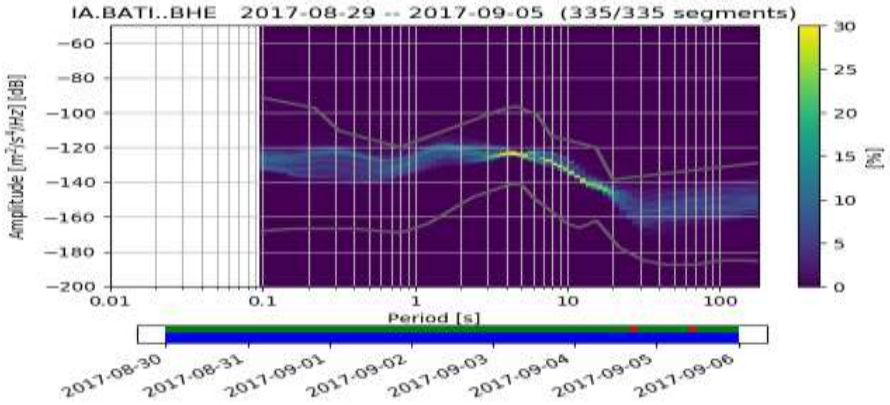

Figure 3. Power Spectral Density for CTBTO's Station on BATI Station

The power spectral density of BATI between -160 dB until -90 db. There are small gaps for each CTBTO's Station which indicated in red at period on September 05-06, 2017.

3.2 Machine Learning Python on Morlet Wavelet

In this phase, we analyze all CTBTO's broadband station to show the frequency-energy and looking the characteristic of nuclear test waveform. From six CTBTO's sensor we got BATI station clearly recorded the nuclear explosion waveform.

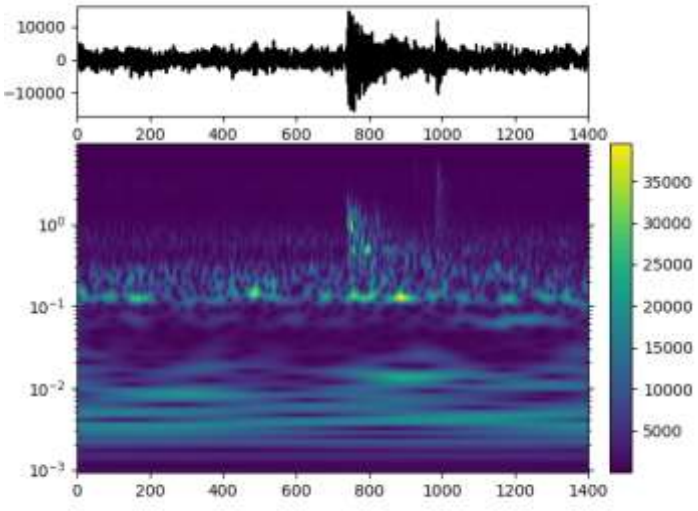

Figure 4. BATI waveform by mlpy package in python using Morlet

By using machine learning python on morlet wavelet, the waveform indicate the S-component is not clearly on BATI sensor and its clearly for P-component, the frequency 10^0 Hz in figure 4. The condition support the period of the waveform is available to analysis by continuous wavelet transform. By using machine learning python (mlpy) we got the result of the continuous wavelet transform, bluish color represented low energy and yellowish colors represent high energy.

The condition support the period of the waveform is available to analysis by continuous wavelet transform. By using machine learning python (mlpy), showed the bluish color represented low energy and yellowish colors represent high energy.

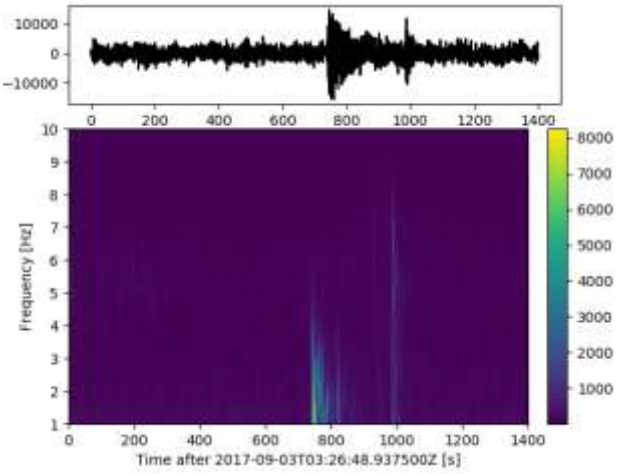

Figure 5. BATI waveform of BHZ by machine learning python on morlet

The BATI waveform of broadband vertical component (BHZ) in figure 5 was generated from mini SEED (MSEED) in Figure 4. Figure 5 showed clearly the spectrum amplitude of signal and the phase of P is clearly. The representative of the signal seismic only show the spectrum of the broadband component vertical (BHZ). It is very different with figure 4, which showing the accumulate of mini seed.

4. CONCLUSION

The signal seismic had been generated and using machine learning analysis of waveforms signal seismic obtained a useful way of observing the arraying spectral (time-frequency) components of a seismic broadband wavelet on wavelet method. CWT is possible to clearly and simultaneously of amplitudes and processing frequency-energy from signal seismic component.

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REFERENCES

[1] T. K. Ahern, R. Casey, D. Barnes, R. Benson, and T. Knight, "Seed Reference Manual," *Int. Database Syst. Philadelphia, Pa*, p. 224, 2014.
[2] Y. E. L. F. Ellah, A. E. K. Hairy, A. B. D. E. L. Al, L. E. L. M. Oudnib, J. G. Allart, and C. T. Homas, "Ambient seismic noise levels : a survey of the permanent and temporary seismographic networks in Morocco Bruit de fond sismique : interpellation des réseaux sismographiques permanents et temporaires au Maroc," no. 1998, pp. 39–54, 2014.
[3] S.-A. Ouadfeul, "On the broadband seismic data filtering using the Wavelet transform and the f-k filter," 2016.
[4] J. Park *et al.*, "Performance Review of the Global Seismographic Network for the Sumatra- Andaman Megathrust Earthquake," *Seismol. Res. Lett. May*, vol. 76, no. 3, 2005.
[5] C.-R. Lin *et al.*, "Ambient Noise and Teleseismic Signals Recorded by Ocean-Bottom Seismometers Offshore Eastern Taiwan," *Terr. Atmos. Ocean. Sci.*, vol. 21, no. 5, p. 743, 2010.
[6] U. B. dan M. Z. Marzuki Sinambela, "ANALISIS DEKOMPOSISI SPEKTRAL DATA SEISMIK DENGAN TRANSFORMASI WAVELET KONTINU," *Megasains*, vol. 53, no. 9, pp. 1689–1699, 2013.
[7] S. Sinha, P. S. Routh, P. D. Anno, and J. P. Castagna, "Spectral decomposition of seismic data with continuous-wavelet transform," vol. 70, no. 10, pp. 19–25, 2005.
[8] H. Kazemeini, C. Juhlin, K. Zinck-Jørgensen, and B. Norden, "Application of the continuous wavelet transform decomposition to channel deposits and gas detection at Ketzin Germany," in *69th European Association of Geoscientists and Engineers Conference and Exhibition 2007: Securing The Future. Incorporating SPE EUROPEC*

ISBN: 978-602-52720-0-4
Juli 2018
Hal: 748 - 752

2007, 2007.
[9] B. Rouet-Leduc, C. Hulbert, N. Lubbers, K. Barros, C. J. Humphreys, and P. A. Johnson, "Machine Learning Predicts Laboratory Earthquakes," *Geophys. Res. Lett.*, vol. 44, no. 18, pp. 9276–9282, 2017.
[10] J. W. Cooley and J. W. Tukey, "An Algorithm for the Machine Calculation of Complex Fourier Series," *Math. Comput.*, vol. 19, no. 90, p. 297, 1965.