Application of Tsunami early warning system as disaster mitigation in Bajul Mati - Gajahrejo, Malang

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Abstract. The position of Bajul Mati area that is close to the coast can potentially have a Tsunami, so need for a Tsunami warning system like Digital Seismograph. The digital seismograph a same as analog seismograph except that vibration detector was replaced by a D7S-A0001-1 vibration sensor and ADXL 345 sensor. The three stations at the coordination of Meteorology, Climatology, and Geophysics Agency, Indonesia on 07-18-2019 (12:20 to 13:20) in Gajahrejo Village, Gedangan Subdistrict, Malang there was no earthquake. This result is the same as results of measurements carried out using the Arduino Uno R3 based digital seismograph using the D7S-A0001-1 vibration sensor and ADXL 345 sensor. The earthquake detection system and Tsunami's warnings run according to the system design and can alert when an earthquake and Tsunami occurs.

1. Introduction

The territory of Indonesia was located on 3 active tectonic plates, namely: Indo-Australian plate, Pacific Plate, and Eurasian plate. East Java includes the Indo-Australian and Eurasian plate meeting areas [1]. The southern part of Malang in the East Java region which has a relatively high earthquake rate due to the movement of the Indo-Australian plate which collides with the relatively silent Eurasian plate [2]. Recently there were earthquakes at four points: Gedangan, Donomulyo, Sumbermanjing, and Tirtoyudo.

This earthquake measuring 5.1 on the Richter scale at around 13:09, the news was released on coverage 6.0 on Wednesday, August 8, 2018. More than 40 aftershocks occurred in the southern part of Malang area on Jawa Pos (July 20, 2018). Based on official data of energy and mineral resources, East Java province has areas that have a level of Tsunami disaster, one of which was a southern part of Malang. Bajul Mati, Gajahrejo village, Gedangan sub-district was a southern part of Malang region located on the coast which includes an area that felt an earthquake [3].

The location has the potential to cause a tsunami due to several earthquake events that occurred, so the need for a Tsunami warning system. This warning system uses Seismograph devices installed in the village, so it is expected to optimize earthquake and tsunami mitigation in the village.

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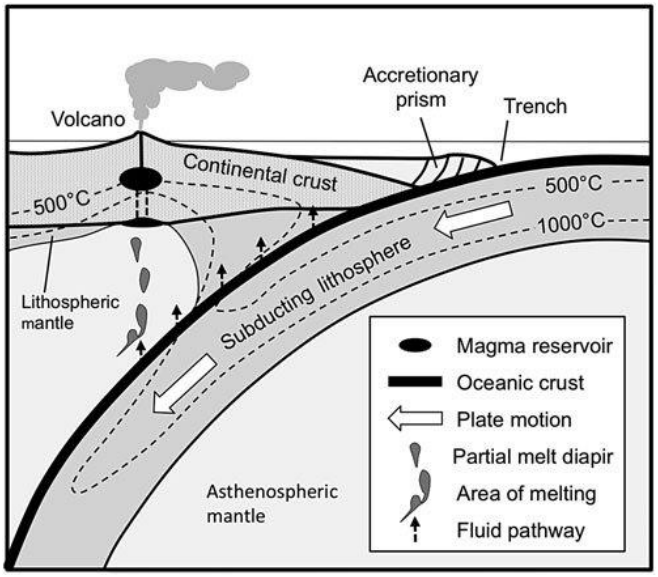

Figure 1. Subduction zone [3][4]

Based on earthquake data in the southern part of Malang, especially in Bajul Mati, Gajahrejo village, Gedangan sub-district located on the coast. The position of Bajul Mati area that was close to the coast can potentially have a Tsunami, so the need for a Tsunami warning system in the form of a Digital Seismograph device installed in the village. The main purpose of the installation was earthquake and Tsunami disaster mitigation. In general, it can be said that earthquakes were natural events that occur suddenly, so disaster mitigation is needed because it serves to reduce the risk posed by earthquakes [5].

Figure 2. Location of Gajahrejo villages: (a) map model; (b) satellite model

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2. Method

The digital seismograph is the same as analog seismograph except that the vibration detector is replaced by a D7S-A0001-1 vibration sensor and ADXL 345 sensor [6]. The accelerometer is a vibration detection sensor, which is applied to earthquake activity. The ADXL 345 sensor is a motion sensor that is very compatible with the Arduino Uno R3 microcontroller. The microcontroller is an IC contained in the complete microprocessor. This microprocessor is open source that can interact with various sensors, including ADXL 345 sensors.

The final goal of this work was to use the seismograph to properly record and plot the ground motion. After that, data was recorded on Bajul Mati - Gajahrejo, Malang must be matched with Indonesia standard measurement at the stations of form the Meteorology, Climatology, and Geophysics Agency, Indonesia.

Table 1. Stations of form the Meteorology, Climatology, and Geophysics Agency that using for matched with Indonesia standard measurement in this work at 07-18-2019 (12:20-13:20)

Station Code	Description	Specific
Komp. ITS Surabaya	ITSU,-7.304,112.968,TSA	- 100S ,TAURUS,100,,,,,1
Sta. Met. Juanda	SUJU,-7.373,112.782,TSA	- 100S ,TAURUS,100,,,,,1
Sta. Klim. Karang Ploso Malang	MAKO,-7.901,112.598,TSA	- 100S ,TAURUS,100,,,,,1

3. Result and Discussion

Arduino Uno R3 based digital seismograph uses D7S-A0001-1 vibration sensor and ADXL 345 sensor with the following display.

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Figure 3. Arduino Uno R3 based digital seismograph using D7S-A0001-1 vibration sensor and ADXL 345 sensor

Testing of Arduino Uno R3 based digital seismograph using D7S-A0001-1 vibration sensor and ADXL 345 sensors was carried out at Gajahrejo Village Office, Gedangan District, Malang on 07-18-2019 (12:20 to 13:20). Besides that, the data is compared with measurements Komp. ITS Surabaya, Sta. Met. Juanda, and Sta. Klim. Karang Ploso Malang from the coordination of Meteorology, Climatology, and Geophysics Agency, Indonesia. The data presented in Figure 4 follows.

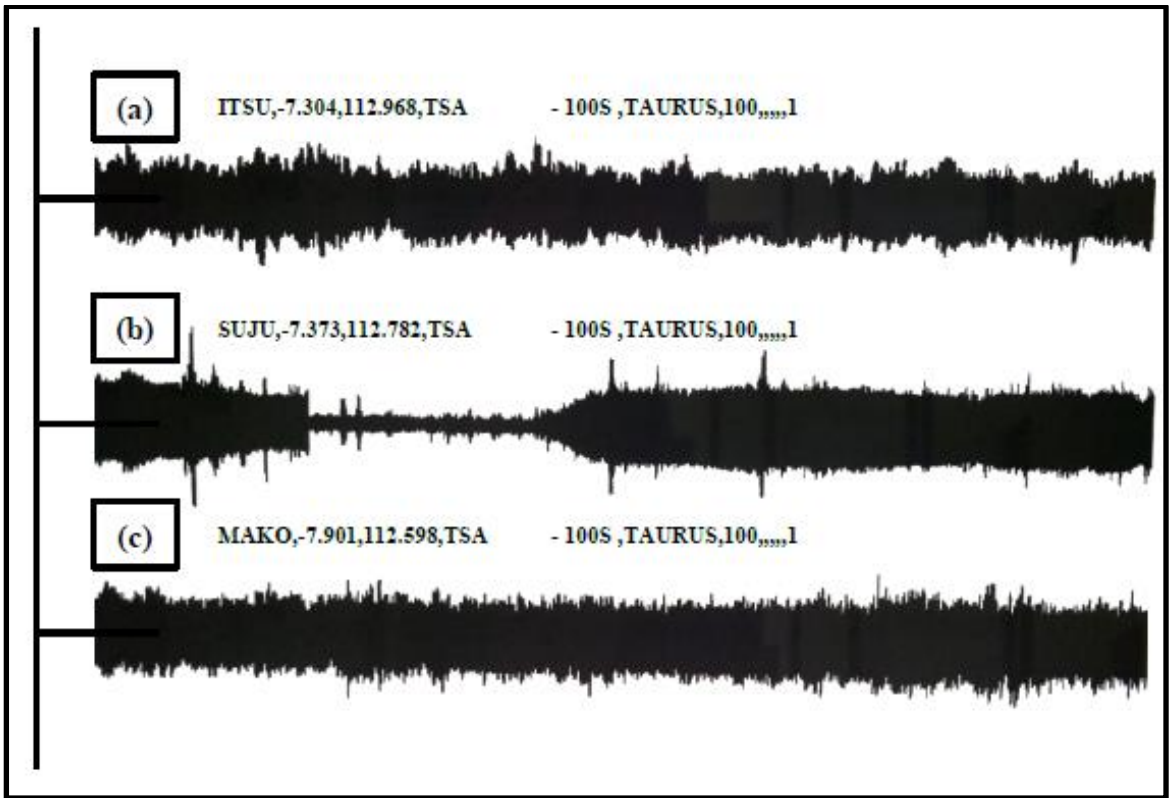

Figure 4. Measurement results of Meteorology, Climatology, and Geophysics Agency, Indonesia: (a) Komp. ITS Surabaya; (b) Sta. Met. Juanda, and (c) Sta. Clim. Karang Ploso Malang

Test results of Arduino Uno R3 based digital seismograph using D7S-A0001-1 vibration sensor and ADXL 345 sensor, i.e. sensitivity of accelerometer sensor on axis *X* is 0.297 V/g, axis *Y* is 0.2886 V/g, and *Z* axis is 0.34 V/g. All sensitivity values of each axis still enter the datasheet sensitivity range. The difference in accelerometer value obtained by ADXL 345 sensor with accelerometer value on the smartphone is 0.43% on *X* axis, 0.165% on *Y* axis, and 0.036% on *Z* axis. This difference is caused by the resultant value of the range of ADXL sensor 345. The earthquake detection system and Tsunami's warnings run according to the system design and can alert when an earthquake and Tsunami occurs.

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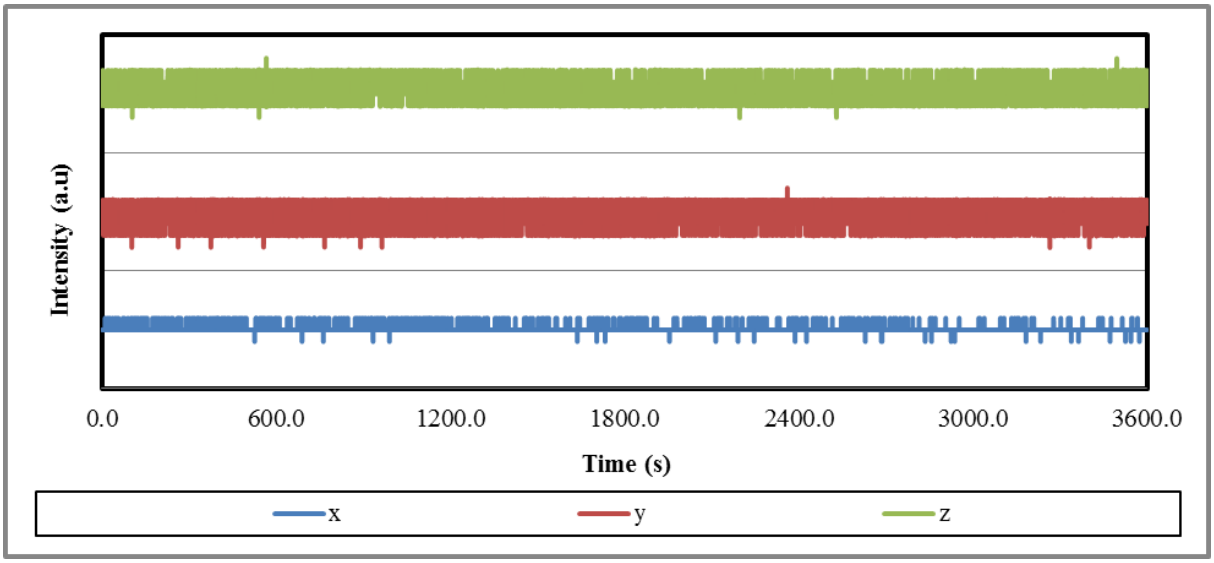

Figure 5. Measurement results of the Arduino Uno R3 based digital seismograph using D7S-A0001-1 vibration sensor and ADXL 345

Based on sources at three stations Komp. ITS Surabaya, Sta. Met. Juanda, and Sta. Klim. Karang Ploso Malang from the coordination of Meteorology, Climatology, and Geophysics Agency, Indonesia on 07-18-2019 (12:20 to 13:20) in Gajahrejo Village, Gedangan Subdistrict, Malang there was no earthquake. This result is the same as the results of measurements carried out using the Arduino Uno R3 based digital seismograph using the D7S-A0001-1 vibration sensor and ADXL 345 sensor. 3D trajectory analysis of measurement results can be shown in Figure 6 below.

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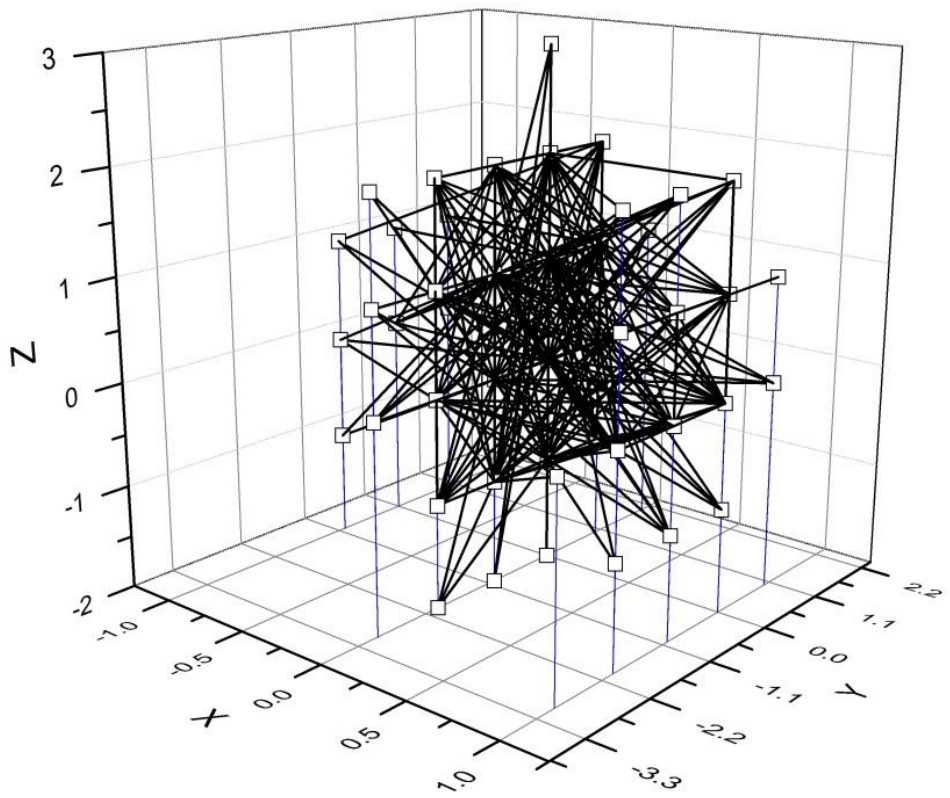

Figure 6. 3D trajectory analysis of measurement results using the Arduino Uno R3 based digital seismograph using D7S-A0001-1 vibration sensor and ADXL 345

4. Conclusion

The sensitivity of accelerometer sensor on axis *X* is 0.297 V/g, axis *Y* is 0.2886 V/g, and *Z*-axis is 0.34 V/g. All sensitivity values of each axis still enter the datasheet sensitivity range. The difference in accelerometer value obtained by ADXL 345 sensor with accelerometer value on the smartphone is 0.43% on *X*-axis, 0.165% on *Y*-axis, and 0.036% on *Z*-axis. This difference is caused by the resultant value of the range of ADXL sensor 345. The earthquake detection system and Tsunami's warnings run according to the system design and can alert when an earthquake and Tsunami occurs.

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ISBN 978-602-0951-28-7

References

[1] Zakaria Z 2007 *Bulletin of Sci. Cont*. **5** (2) 123
[2] Purbandini P, Santosa B. J, and Sunardi B 2017 *Jurnal Sains dan Seni* **6** (2) 2337
[3] Setiawan M R and Setiawan A 2015 *Jurnal Fisika Indonesia* **19** (57) 13
[4] Subagia I W, Wiratma I G L, and Sudita I K 2015 *Jurnal Pendidikan Indonesia* **4** (1) 585
[5] Nakada S 2018 Volcanic Archipelago: Volcanism as a Geoheritage Characteristic of Japan *Natural Heritage of Japan* ed Chakraborty A *at al* (Berlin: Springer International Publishing) chapter 3 pp 19-28
[6] Saraò A, Clocchiatti M, Barnaba C, and Zuliani D 2016 *Seis. Res. Lett.* **87** (1) 186

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