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"A School Seismograph System at KVIS, Thailand"

- A new construction and its seismograms -

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Abstract— A new hand-made seismograph system for school use is installed at a science high school in the eastern part of Thailand. The system consists of one vertical seismometer and two horizontal ones. The seismometers have aluminum + brass pendulums and electro-magnetic sensors. The signals are amplified by integrating amplifiers and AD converting by Arduino. A laptop-PC is employed for recording, while a 40-inch LED TV is used for real time signal display. The students and visitors can watch the real-time ground signals and recognize the mechanism of seismometers. The detecting limits of this system are less than M4.0 for local earthquakes and M6.5 for foreign ones.

Keywords—seismograph, school use, hand-made, Arduino

Thematic line— "Educational tool"

1 Introduction

Seismographs are a fundamental tool for geoscience, and yet there are only a few attempts to use a seismograph as a teaching tool at high-school level. It is hard to motivate students in Thailand to study earthquake or related disasters because Thailand rarely has earthquakes. We have been developing handmade seismographs for school use over the past two decades (eg. Okamoto, 1999).

A few years ago, we completely refreshed our system by using new strong magnets, a modern micro-controller and a sophisticated programing code (Okamoto, 2016, Okamoto and Ito, 2014). This new system is now successfully installed at the Kamnoetvidya Science Academy (KVIS). The system has been in operation to continuously monitor daily seismic activities on this campus. Many seismograms have been generated by the seismograph for teaching geoscience. The system has detected several foreign earthquakes already. These are, for examples, the recent North Korean nuclear test and the Mexico M8.1 earthquake. This poster shows details of our system and some interesting results generated.

2 Instruments

2.1 Outlines

The seismograph consists of 1) sensor 2) pendulum 3) damper, and 4) logging system. Our all hand-made system is comprised of the parts shown in Figure 1.

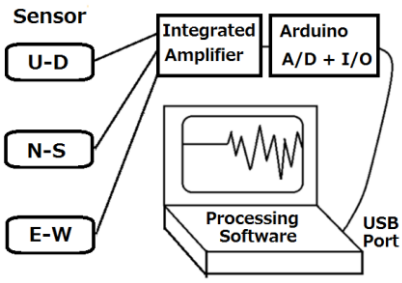

Figure 1. Block diagram

2.2 Hardware

1) Electro-magnetic sensor: copper coil and strong neodymium magnets
2) Pendulums: modified Ewing type (vertical) and Swing-gate type (horizontal)
3) Pivots: thin phosphor bronze plates (0.1 mm), crossed in vertical system
4) Aluminum plate (0.5 mm and electro-magnetic friction damping
5) Integrated amplifier + A/D converter with "Arduino Uno"

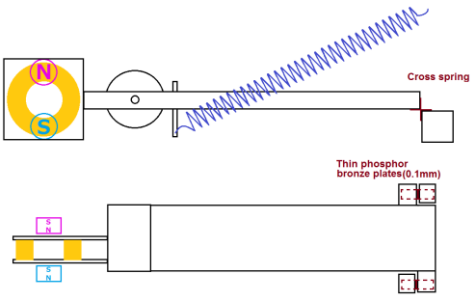

Figure 2. Pendulum (vertical / horizontal)

Figure 3. Winding coil

Figure 4. Vertical sensor

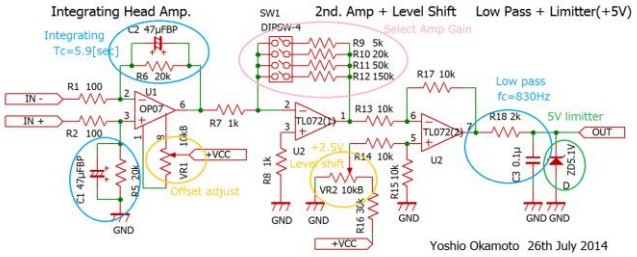

Figure 5. Integrating Amplifier

2.3 Software: Arduino IDE+Processsing

1) 24 hours real-time signal display (3ch) with time marks
2) Save data both digit data + image data

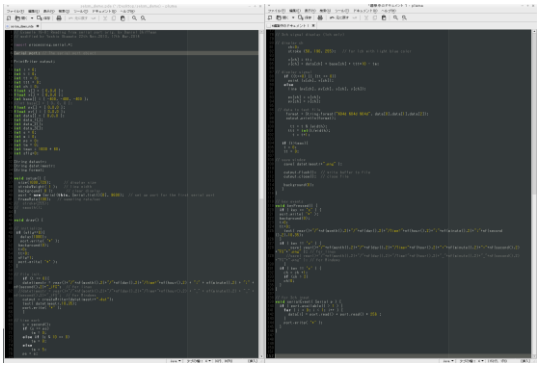

Figure 6. Controlling software
(Arduino IDE + Processing)

2.4 The key concepts of our seismographs;

1) To show the mechanism of seismographs, a transparent body cover and an aluminium pendulum with brass as a mass have been used.
2) Continuous real-time display with time-marks; 64 Hz sampling rate, 30 sec signal x 60 lines = 30 min display; one recorded file
3) A 40-inch big monitor is used for real-time signal display. Many visitors enjoy this first Thailand School Seismograph System.

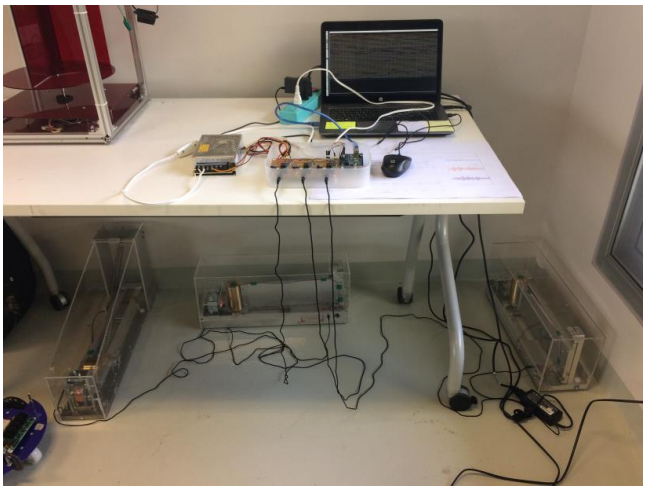

Figure 7. Whole system in the Physics ICT room
Three seismometers under the table.
(Left:Vertical, Center and Right: Horizontal)

3 Seismograms

3.1 Foreign Seismograms

The KVIS school system was installed in early September and some trial observations were made. In the trial recording period several interesting signals were recorded.

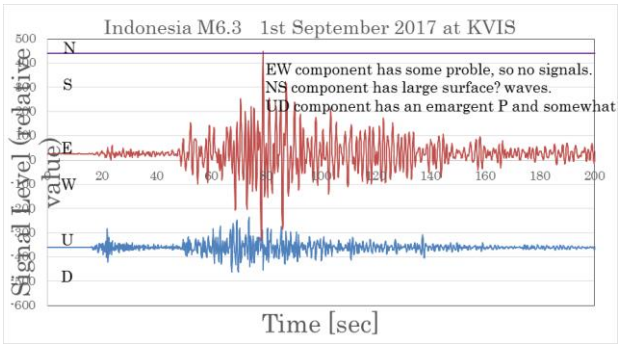

Figure 8. Indonesia M6.3
(Blue: UD, Orange: EW Black: NS, No signal)

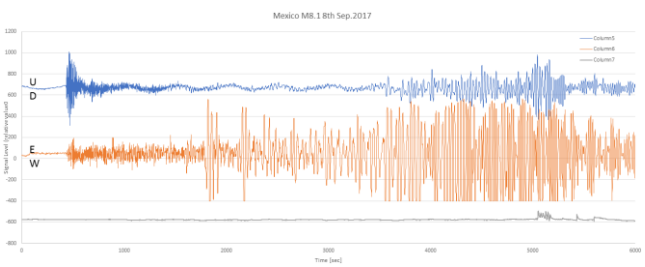

Figure 9. Mexico M8.1
(Blue: UD, Orange: EW Black: NS, No signal)

3.2 North Korean Nuclear test signal

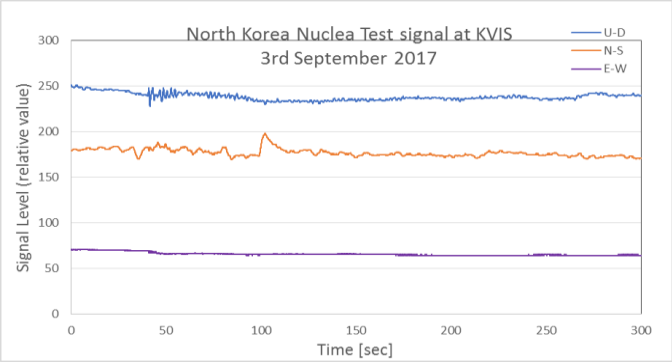

Figure 10. North Korean nuclear test signal M6.3 (Blue: UD, Orange: EW Black: NS, No signal)

4 Discussion

4.1 Evaluation of results

1) An integrated amplifier is used to show the displacement ground motion instead of the velocity output of a common electro-magnet system.
2) The seismic noise level of our campus is quite low due to a stable hard granite base, and also for being far away from coast. Therefore, only weather based long period tremors and artificial tilts are recorded as background noise.
3) The detecting limit of earthquake is less than M4.0 for local earthquakes and M6.5 for foreign earthquakes.
4) The M6.3 North Korean nuclear test signal was clearly recorded as a vertical component. The signal is unique and is characteristic of the nuclear test signal.

4.2 Further study

1) To estimate the magnitude (Richter scale) from our seismograms.
2) More seismograms are needed to perform such quantitative analysis.
3) To study how to co-operate the other school seismology program; eg. https://www.iris.edu/hq/sis

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