DigitSeis: Opportunities for Digitization of Analog Seismograms Through Educators and Citizen Science

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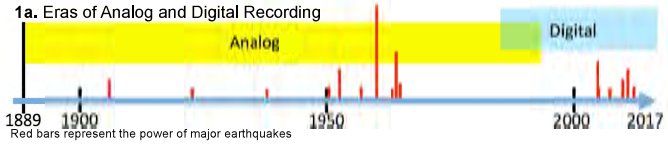
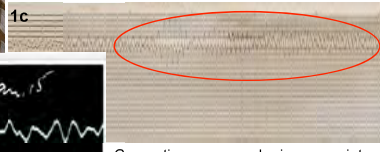
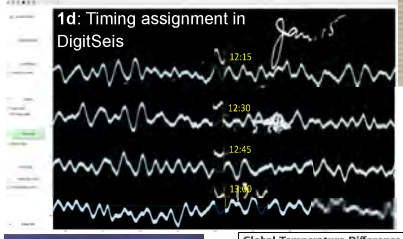
Introduction

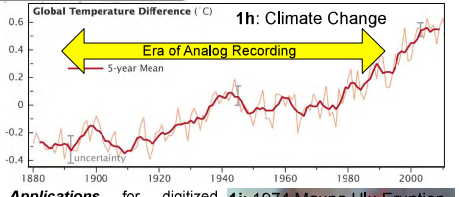


A large amount of seismic data was recorded during the analog era (**1a**) and is still stored around the world in the form of paper records (**1b**,**1c**). However as a result of their format, these records are often inaccessible to modern analyses. To address this issue, there have been several softwares developed to convert scanned images of paper seismograms into digital traces. DigitSeis[1], a software developed by the Harvard Seismology Group, is the only one of these that takes into account the timemarks and generates digital time series.

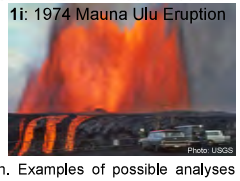




Converting scanned images into digital time-series via DigitSeis is partially automated but **still requires human inputs** for complications such as crossed traces (**1c**) and assigning reference times (**1d**).



Applications for digitized analog seismograms are widespread and far-reaching. The greatest merit of analog records are the long time span they cover, allowing for quantitative analysis of long timescale or rare phenomenon. Examples of possible analyses include yields and behavior of nuclear tests (**1e**), behavior of past volcanic eruptions (**1i**), storm strength from wave-generated seismic noise (**1f**,**1g**), and generally long-timescale problems not typically associated with seismology such as climate change (**1h**).



Deployment

Kyoto Tsukuba Kaisei High School

Miyazaki Prefectural Nobeoka High School

DigitSeis is currently being used in Japanese high schools (**Table 1**), as research experience where students provide the human oversight needed for digitizing seismograms. **This is the first time DigitSeis has been deployed on this scale,** and this was made possible by the work of the School Innovation Forum in seeking participation of schools. In total, almost 180 students across 14 high schools are participating. The program was categorized in most schools as an extracurricular activity, though it was given either as extra independent study or as part of the regular curriculum in a few cases.

Solicitation of Participation

School interest and participation was solicited by the School Innovation Forum. This was accomplished largely through reaching out to high schools via email, their website, and network of educators.

Development of Student Interest

Participating schools were provided with materials about seismology and earthquakes. Special focus was put upon the way that the analog seismograms which students digitized could be used in the future to solve big problems in science (e.g., finding new earthquakes, environmental monitoring, etc.).

Training

Students were given video-walkthroughs and an example analysis (that has been previously digitized) to learn to use the DigitSeis software. Once this example image has been successfully digitized, students are asked to progress to other previously undigitized images.

Table 1

School Name	*Activity Type*	*Students*
Ritsumeikan Keisho Junior & Senior High School*	Curricular & Extracurricular	19
Miyagi Prefectural Tagajo High School	Independent Study	5
Tokyo Metropolitan Hibiya High School	Independent Study	15
Yokohama Science Frontier High School	Extracurricular	12
Yashiro Senior High School	Extracurricular	4
Naganoken Suwa Seiryo High School	Extracurricular	11
Kyoto Prefectural Momoyama Senior High School	Extracurricular	14
Kyoto Tsukuba Kaisei High School*	Independent Study	13
Nara Women's University Secondary School	Extracurricular	2
Wakayama Prefectural Tanabe High School	Extracurricular	3
Tottori Prefectural Yonago Higashi High School	Extracurricular	2
Tokushima Prefectural Wakimachi Senior High School	Extracurricular	9
Miyazaki Prefectural Nobeoka High School	Curricular	59
Kumamoto Prefectural Daini High School	Extracurricular	7

* Indicates a private school

Technical Challenges

During this first deployment of DigitSeis, we encountered several technical problems which any similar project should likely take into account. Chief among these were:

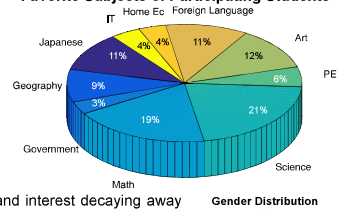
Compatibility - Software had to be made compatible with many different systems from the newest machines to 32-bit Windows machines with 2GB RAM.

Network Access - Many Japanese schools have strict internet access policies making it difficult for schools to download and upload materials for the project.

Results

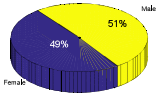
Participant Statistics

Favorite Subjects of Participating Students

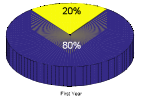


Students were given a survey to complete at the beginning of the program asking them their favorite subjects, and then their skill and interest level in the different components of STEM. In general, **participating students favor Math and Science as subjects**, though this may be due to the extracurricular nature of the program. Within STEM, students generally report skill at around 50 and interest decaying away from 100 on a 0-100 scale. **Male participants report both higher skill and interest than their female counterparts** whose responses were generally more grouped around 50. The survey will be re-administered at the end of the program. **Participating students are 80% first year students,** and the rest are second years (of three year high schools), making this is a great opportunity to introduce the sciences.

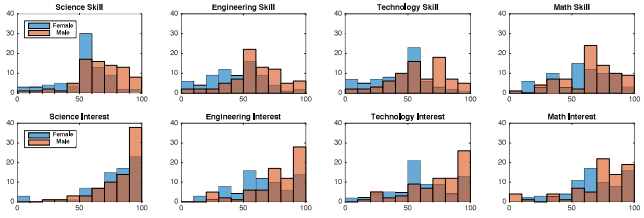
Gender Distribution

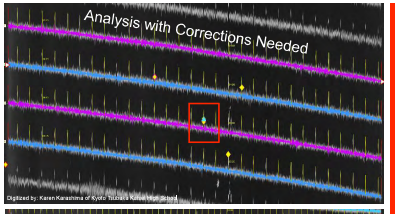


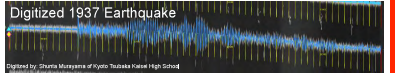
Year Distribution

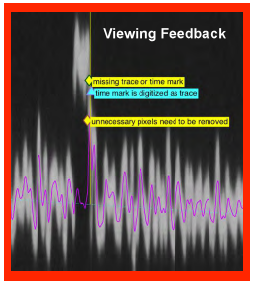


Self Reported Skill and Interest in STEM Subjects (0-100 Scale)









Digitization Results

Of the first round of digitized analyses received, many did require corrections, and as a result, a feedback component of the program has been developed. This allows analysts/graders to add comments to the actual point on the analysis where the issues are, allowing the student to go straight to the issue and correct the problem. Although first analyses typically require some corrections, most are of a usable quality. Especially exciting is an earthquake from 1937 that was recently newly digitized by a student who has moved beyond the first training analysis.

References and Acknowledgements

1) Bogiatzis, P., and M. Ishii (2016), DigitSeis: A New Digitization Software for Analog Seismograms. *Seismological Research Letters*, 87(3), 726-736.

DigitSeis Main Page: http://www.seismology.harvard.edu/research/DigitSeis.html

DigitSeis Citizen Science (English): http://www.seismology.harvard.edu/research/DigitSeisJapan/index_en.html

DigitSeis Citizen Science (Japanese): http://www.seismology.harvard.edu/research/DigitSeisJapan/index.html

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