Arduino Earthquake Detection System

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January 25, 2016

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Rationale

Every year thousands of earthquakes over 5.0 magnitude occur around the world (United States Department of the Interior, 2015). For a lot of these earthquakes the victims have no warning and are not prepared for the destruction that is an earthquake however, in most of these situations even a couple seconds of warning could have saved lives. That's where an early warning detection system would be very helpful. Most people sadly do not have access to an early warning system or do not have the money to build their own. This is why the Arduino Earthquake Detection System would be useful. People would be able to afford a cheap accurate earthquake detection system that could have the possibility of saving lives. This research would also be important scientifically because science is all about exploring the why, where, what, when, why, and how of the unknown and this research could provide more light on the subject of earthquakes and other geological disturbances.

Goals, Expected Outcomes, and Description of Hypothesis

The goals for this project are to research enough about earthquakes to determine the best way to build and use a seismometer. Then the next step is to use that research to build a cheap and as accurate as possible early warning earthquake detection system using common household items and an Arduino Uno. The research question for this project is, is it possible to build an early warning earthquake detection system using cheap/common household electronics and materials? The hypothesis for this project is if the following plan listed below is used, then it is possible.

The suspected outcome of this project is that an early warning earthquake detection system will be successfully created but it will probably not be as accurate or efficient as a professional earthquake detection system. A professional seismometer can measure from 500 to 0.00118 Hz (Wikipedia, 2015). The seismometer in this project would not be able to realistically be this accurate. It is possible however to create a seismometer that could pick up vibrations from geological events happening inside of the Earth. It is also totally possible to create a system using common/cheap electronics and other materials (Arduino, 2015). By using this research and other sources, it is entirely possible to save and help a lot of people's lives. (like mentioned in the rationale).

Materials and Methods

Materials

The materials that are needed for this project are as follows: an Arduino Uno (already have) to use as the micro controller, a computer to use as the Arduino's internet connection and to program on, the cables and wires (already have) required for the Arduino and for the external wiring, resistors and other small electronic components (already have) for the external wiring, breadboard (already have) for the external wiring, LED light bulbs (already have) to be used as warning lights, scrap wood and other building materials (already have) to be used to create the homemade seismometer, weights (already have) to use on the homemade seismometer, and an optional Apple mobile device (already have) to be alerted on. The estimated budget on this project is about $0.00.

Procedures

1. Research and design a seismometer prototype by researching what kind of waves are measured before an earthquake strikes and then seeing how to build a seismometer that could pick up these waves.
2. Build the the seismometer prototype and test to see if it works in a simulated earthquake.
3. Draw Arduino wiring diagrams to interface with the Arduino Uno.
4. Wire the Arduino, seismometer, and other electrical components to interact in the way that was planned in the diagrams
5. Pseudo code the Arduino Earthquake program and plan out the specific earthquake hit variables.
6. Program the Arduino Uno to work with the seismometer and other elements.
7. Prepare the Blynk app on the iPhone to receive the notifications and other signals from the Arduino Uno.
8. Test the Earthquake Prediction System in a simulated earthquake.

Risk and Safety

Although this is not a specifically hazardous experiment, there are still a couple of risks that should be mentioned:

1. Although there is no high voltages being used in this project, it is always a good idea to use caution when using electronics to avoid destruction to property or yourself.

2. Whenever building something one must always use extreme caution not to harm her/himself or others while using and/or operating building tools and/or machinery.

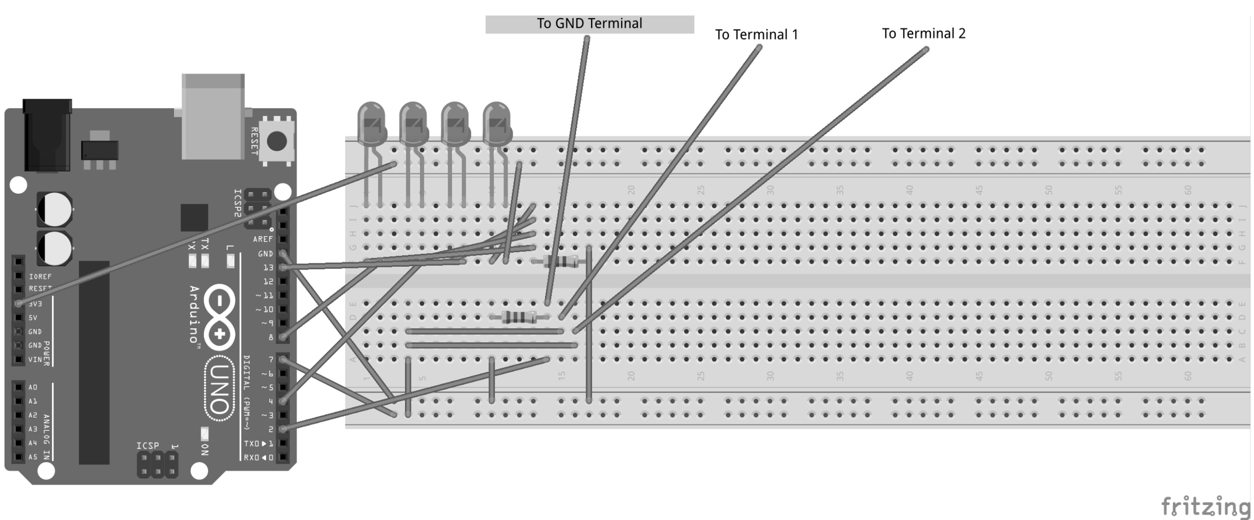
3. The frequencies being used by the Arduino Uno and other electronic devices in this project shouldn't interfere with anything, however it always recommended to be careful around certain frequencies.

Data Analysis

The data that will be collected throughout this project is whether or not the Arduino Earthquake Detection System will be able to predict an earthquake. This will be done through a test at the end of procedures through a simulated earthquake. If the Arduino Earthquake Detection System is able to predict that earthquake then this project will be counted as a success.

Data and Observations

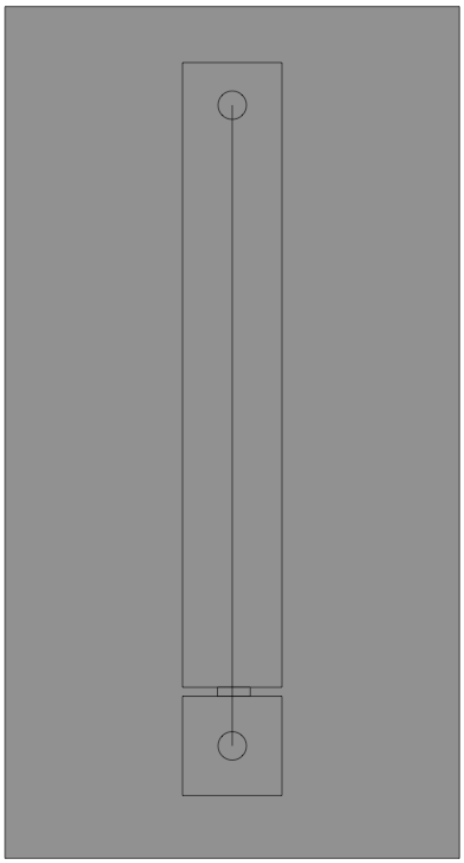
Arduino Wiring Diagram:

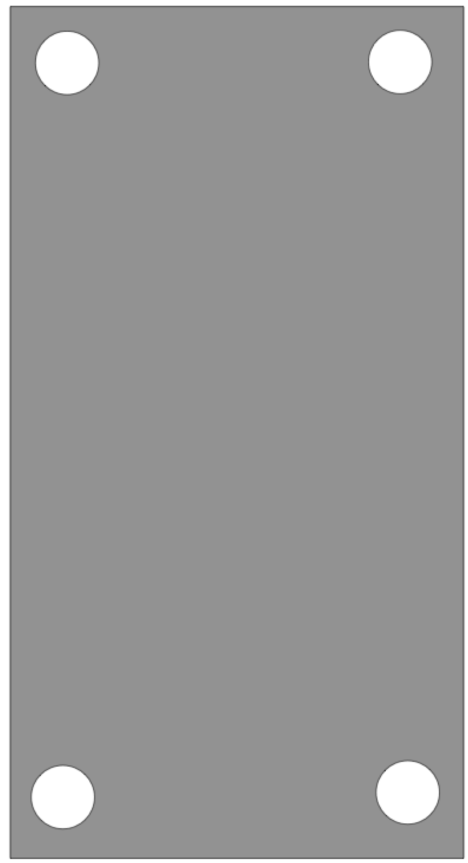


Schematic Views of Seismometer:

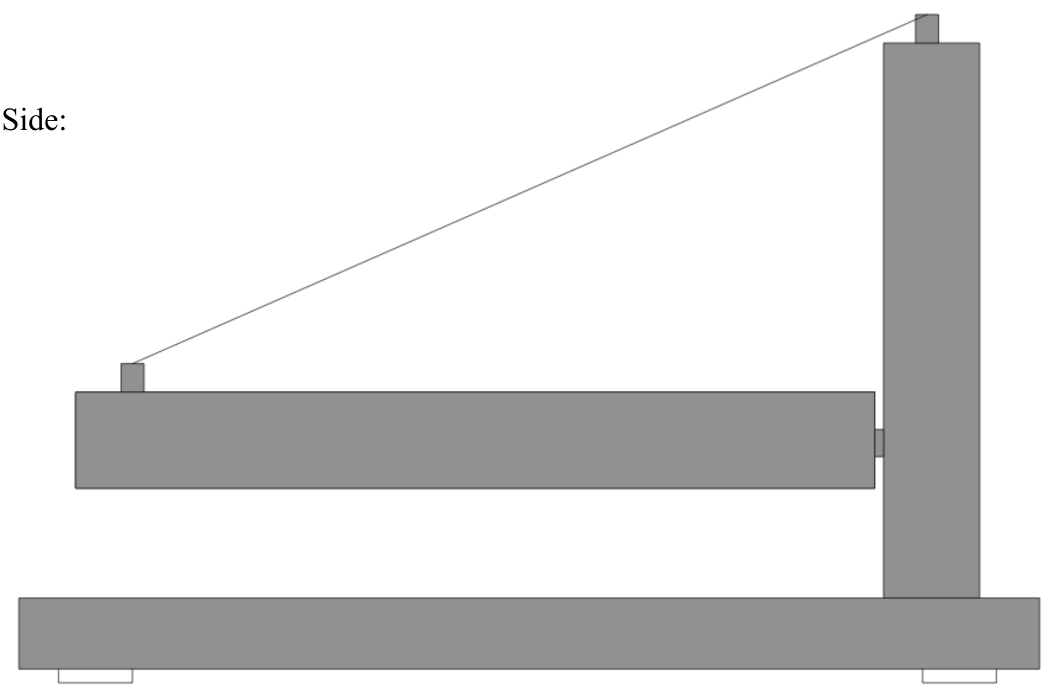
Top:

Bottom:

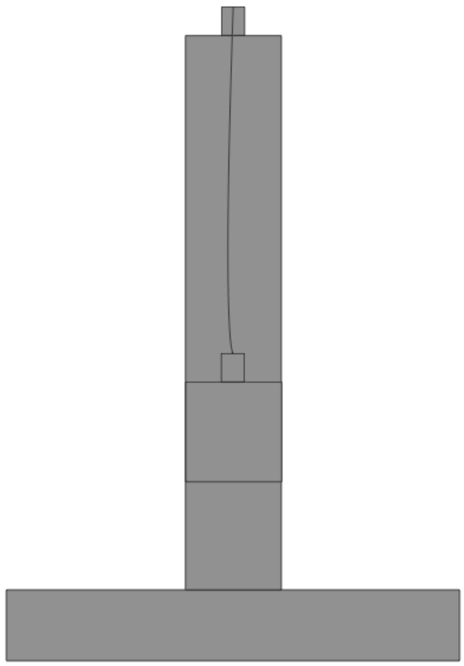




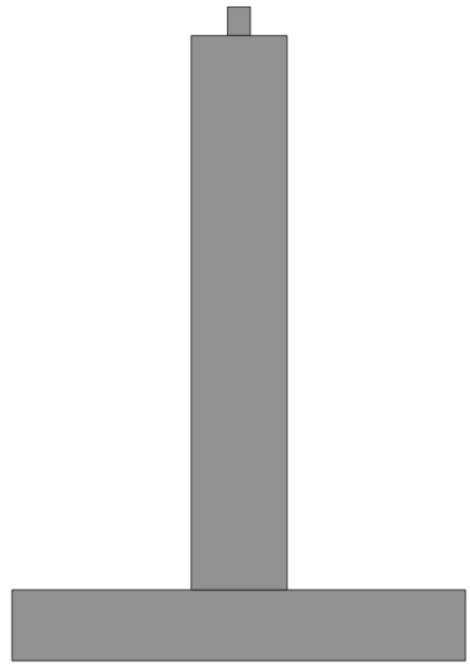
Side:



Front:

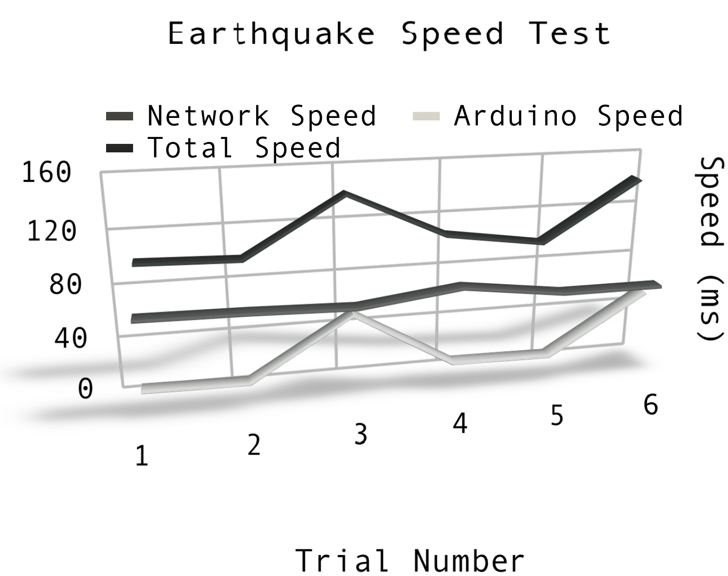


Back:



Earthquake Simulation:

Trial Number	Network Speed (ms)	Arduino Speed (ms)	Total Speed (ms)
1	82	23	105
2	81	22	103
3	79	66	145
4	88	24	112
5	79	23	102
6	79	67	146



Claim

Through following the above procedures, an Arduino Earthquake Detection System was able to be constructed and it was successful in predicting a simulated earthquake.

Evidence and Analysis

The evidence from this experiment fully supports the claim above. Through following the procedures above a functional seismometer was able to be constructed in an orderly, efficient, and reliable way. Then after building the seismometer and interfacing it with the Arduino the seismometer became fully functional in theory. After the simulated earthquake that theory was then confirmed and the seismometer became fully functional. Although the experiment was conducted in such a way where most errors were eliminated a few errors and slight problems did occur. One of the problems is that the speed of how fast the notification gets to the mobile device is very dependent on the network speed of wherever the detector is. The detector has been built in a way to make this as less of a problem as possible, but it still sometimes becomes an issue. Another tiny problem with the experiment is it had to go through many phases before the detector was able to become functional. This is an issue because some of the procedures may not have been altogether recorded and/or standardized creating less accurate data. However, throughout most of the experiment it was mostly accurate and the data is reliable.

Reading and Reflection

The initial question for this experiment was, is it possible to build an early warning earthquake detection system using cheap/common household electronics and materials? Throughout the experiment this question has been answered. An earthquake detection system built with cheap/common household electronics and materials was able to be constructed, however ideas on earthquake detection and the ability to do so have changed. It is much harder to predict an earthquake than one might think. The way that this earthquake detector works (and most others around the world) is it measures the p-waves and turns it into a signal that can be read by a computer. Then using that signal it sends an alert out to the public. This model of earthquake detection is commonly used in Japan. In Japan, the detectors send a signal to a computer. This computer then sends the signal to the broadcasting tower and the broadcasting tower sends out an alert to the general public. Another type of way that the Arduino Earthquake Detection System predicts earthquakes is by detecting the foreshock of an earthquake. The foreshock of an earthquake is a smaller seismic disturbance right before the main (largest) seismic disturbance. “Foreshock activity has been detected for about 40% of all moderate to large earthquakes, and about 70% for events of M>7.0. They occur from a matter of minutes to days or even longer before the main shock, for example the 2002 Sumatra earthquake is regarded as a foreshock of the 2004 Indian Ocean earthquake with a delay of more than two years between the two events. Some great earthquakes (M>8.0) show no foreshock activity at all, such as the M8.6 1950 India - China earthquake” (Wikipedia, 2016). From the above quote we can see that foreshocks are not the best way to predict earthquakes, however sometimes they can predict large earthquakes very well.

The Arduino Uno was picked for this project for many reasons but the main one was it’s ease of use for it’s capability. The Arduino is a microcontroller that uses the ATmega328P microprocessor. Through the use of this microprocessor and other onboard equipment it is able to process inputs and outputs to perform specific programmable tasks. “Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community" (Arduino, 2016). This quote really explains why the Arduino Uno was picked for this specific experiment and why it has been used for so many others like it.

Many parts of this experiment were hard and challenging, but with scientific ingenuity combined with research and knowledge, those challenges were overcome. "Opportunity is missed by most people because it is dressed in overalls and looks like work" (Edison, 2016).

Conclusion

Throughout this project, by combining the use of an Arduino Uno and a homemade seismometer, the Arduino Earthquake Detection System was able to be constructed and built. This research and much more like it can hopefully lead to a more effective way of predicting earthquakes, and the more research that's done, the more lives that can be saved.

Resources

Arduino - ArduinoBoardUno. (2016). Retrieved January 26, 2016, from https://www.arduino.cc/en/Main/ArduinoBoardUno

Blynk. (2016). Retrieved January 27, 2016, from http://docs.blynk.cc/

Earthquake Early Warning (Japan). (2016, January 10). Retrieved January 25, 2016, from https://en.wikipedia.org/wiki/Earthquake_Early_Warning_(Japan)

Earthquake Facts and Statistics. (2015, January 13). Retrieved November 12, 2015, from http://earthquake.usgs.gov/earthquakes/eqarchives/year/eqstats.php

Foreshock. (2015, October 25). Retrieved November 12, 2015, from https://en.wikipedia.org/wiki/Foreshock

P-Wave. (2015, November 4). Retrieved November 12, 2015, from https://en.wikipedia.org/wiki/P-wave

Repeating Earthquakes. (2014, July 23). Retrieved January 26, 2016, from http://earthquake.usgs.gov/research/parkfield/eq_predict.php

Seismic Scale. (2015, April 16). Retrieved November 12, 2015, from https://en.wikipedia.org/wiki/Seismic_scale

Seismometer. (2015, November 8). Retrieved November 12, 2015, from https://en.wikipedia.org/wiki/Seismometer#Modern_designs

Thomas A. Edison quote. (2016). Retrieved January 26, 2016, from http://www.brainyquote.com/quotes/quotes/t/thomasaed104931.html

WHAT IS ARDUINO? (2015). Retrieved November 12, 2015, from https://www.arduino.cc/

Top:

Bottom:

Front:

Back:

Side:

Wiring Diagram: