A Community Seismic Network for Early Warning

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Summary

A system that provides early warning of intensive shaking from earthquakes will save lives, reduce property damage, and help secure the power grid. The current seismic network in Southern California is too sparse to provide early warning. This project is developing a distributed system using MEMS sensors attached to volunteers’ computers in homes and schools, as well as in cell phones and laptops. The vast community seismic network will quickly report data about ground motion near epicenters and thus provide early warning of shaking and invaluable information about areas that most need help immediately after a quake.

We expect such systems to be used in Southern California and in areas of the world that don’t have seismic networks today.

Benefits

- Dense network yields accurate results
- Inexpensive sensors facilitates widespread deployment
- System enables the community to help in handling crises

Challenges

- Need efficient, fault-tolerant algorithms to compensate for noisy data and make rapid decisions
- System architecture needs to be robust against infrastructure failures, flooding of messages and security breaches
- Need to cope with mobile sensors such as cell phones and laptops
- Cannot allow too many false positives but must warn of severe shaking.

Deployment & Operation

- Users can purchase inexpensive Phidgets brand three-axis USB accelerometers and install client software
- During an earthquake, primary waves (P-waves) have a significant lead time over damaging secondary waves (S-waves). Once a P-wave is detected, the client immediately triggers a “pick” event and sends data to the server
- At the server-side, fault-tolerant algorithms pinpoint the source of an earthquake and send early warning alerts

Responses to Warnings

- Activation of safeguards in critical operations
- Stabilize electrical grid configuration
- Suspend read/write operations to prevent data corruption
- Stop elevators and open doors
- Stop trains

Future Directions

- Work with water and power utilities to deploy sensors in substations and accept early warning of intensive shaking
- Work with school systems in Southern California to help science teachers deploy sensors and teach students about geology, information processing, and sensor networks.
- Make the client and server-side software “bullet-proof” so that they can be deployed easily and reliably.
- Experiment with different models for analysis and warning, and determine how to best reduce false positives.

The current seismic network is too sparse for earthquake early warning

Example output from the server after receiving data from four different sensors

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