Demo Abstract, The Next Big One: Detecting Earthquakes and other Rare Events from Community-based Sensors

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1. ABSTRACT

Can cell phones be used to detect earthquakes? The Community Seismic Network (CSN) is building a dense sensor network from inexpensive and community owned sensors, such as cell phones and USB accelerometers. Detecting rare events such as earthquakes is a difficult sensing problem, and is compounded by the wide variations among sensors in a heterogeneous community network. We demonstrate an end-to-end system using Android cell phones and a cloud fusion center that allows participants to create "mock earthquakes". Upon detecting such an event, the cloud fusion center issues real-time alerts to the phones. A map-based interface to the fusion center is projected nearby, displaying the information reported by the phones.

Categories and Subject Descriptors

C.2.1 [**Computer-Communication Networks**]: Network Architecture and Design; G.3 [**Probability and Statistics**]: Experimental Design; I.2.6 [**AI**]: Learning

2. INTRODUCTION

We are building a Community Seismic Network (CSN) to: (a) provide warning about impending shaking from earthquakes, (b) guide first responders to areas with the greatest damage after an earthquake (c) obtain fine-granularity maps of subterranean structures in areas where geological events such as earthquakes or landslides occur, and (d) provide detailed analysis of deformations of internal structures of buildings after geological events.

This demo accompanies the paper "The Next Big One: Detecting Earthquakes and Other Rare Events from Community-based Sensors" [1]. Due to the unavailability of data characterizing the rare events, our approach is based on anomaly detection: sensors learn models of normal sensor data (e.g., acceleration patterns experienced by smartphones under typical manipulation). Each sensor then independently detects unusual observations (which are considered unlikely with respect to the model), and notifies a fusion center. The fusion center decides if a rare event has occurred based on the received messages. Sensors learn decision rules to control system-level false positive rates and bound the amount of required communication while simultaneously maximizing the detection performance.

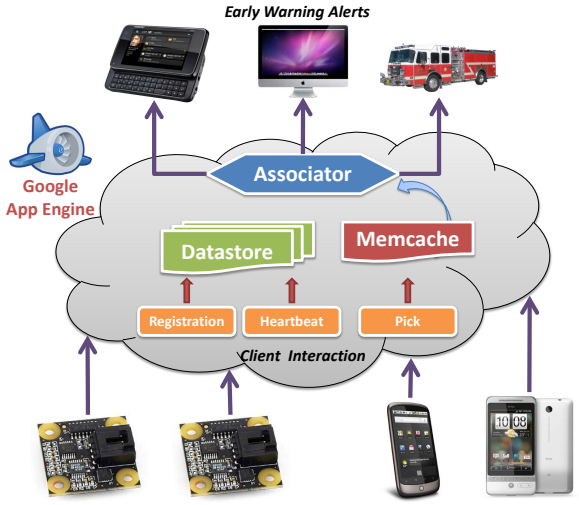

Figure 1: Overview of the CSN system.

We have developed an app for Android phones and a desktop client for USB accelerometers that volunteers can use to join the network. We chose to build our fusion center on Google's App Engine Technology for scalability, data security, and ease of maintenance. An overview of the system is shown in Fig. 1. This demonstration will showcase the Android app and App Engine Cloud Fusion Center.

3. DEMONSTRATION

In the absence of a large earthquake, we will demonstrate the end-to-end functionality of the CSN system to detect a mock earthquake and issue alerts to the phones in the network. The scenario is as follows: three Android phones running the CSN Android app will be available for participants to interact with. In the event that all three phones simultaneously report anomalies (a.k.a. *picks*), the fusion center will detect the "earthquake" and issue real-time alerts to all three phones. However, if two or fewer picks are sent, no quake is announced. Participants may experiment with producing picks by walking, shaking the phone, etc., or by placing the phones on a table and bumping the table.

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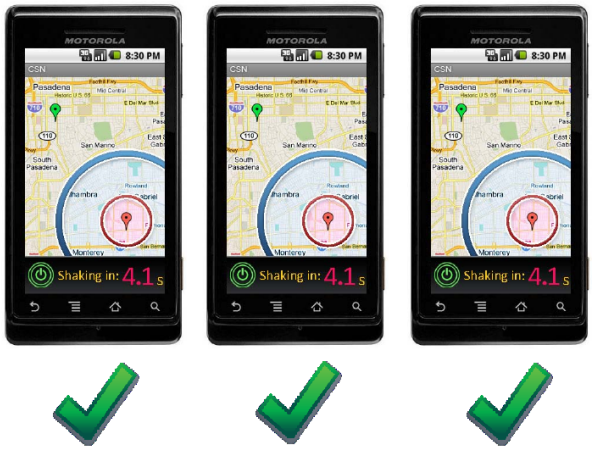

Figure 2: Earthquake alerts are sent when all three phones report picks. A notification is displayed on the app's UI.

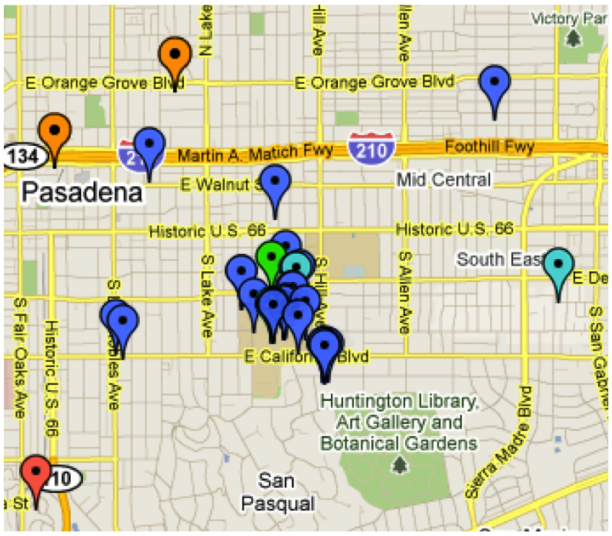

Figure 3: A map-based web interface displays the received pick information in real time.

This demonstration will involve:

- **CSN Android app** A background process continually collects data from the accelerometers onboard the phone and runs the picking algorithm to determine when to report picks. Using Android's multitasking capability, a UI displays a plot of the phone's accelerometer data and highlights when picks are sent. A second UI view shows the location of today's earthquakes worldwide on a map. A notification is displayed when an alert is received, as depicted in Fig. 2.
- **Projection of map interface** An App Engine instance of the CSN fusion center (separate from the instance that manages the actual CSN network) will receive picks from the phones in the demo. When the "earthquake" is detected, the fusion center will issue real-time early warning alerts to all phones in the demo network. These picks will be visible on a map-based web interface to the fusion center, as shown in figref-fig:sensormap. A projector will be required to display this map.

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4. REFERENCES

[1] M. Faulkner, M. Olson, R. Chandy, J. Krause, K. M. Chandy, and A. Krause. The Next Big One: Detecting Earthquakes and Other Rare Events from Community-based Sensors. In *Proceedings of the 10th ACM/IEEE International Conference on Information Processing in Sensor Networks*. ACM, 2011.