A Consumer Internet-of-Things Device for On-Site and Regional Earthquake Early Warning

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Abstract

Earthquakes are a major global risk, causing the most fatalities among all natural disasters in the last 20 years with 747,000 deaths, as well as 125 million injuries or displacements and $660 billion in losses. Current earthquake early warning (EEW) systems face many challenges, such as high cost and low density of stations, high latency, and large blind zones. Dependence on public funding further limits EEW growth and sustainability.

This research pursues an alternative consumer-based approach, developing a low-cost Internet-of-Things (IoT) EEW device that can be mass deployed in homes and business facilities for on-site warning and alerting regional subscribers. This IoT device is integrated with a geophone, a single board computer, a 32-bit analog-to-digital converter, an alarm, WiFi connectivity, and custom-designed software and hardware. The device costs under $100, is about the size of a Rubik's cube, and measures ground motion at 100 samples per second. It can be managed remotely on a smartphone or computer.

The device successfully detected all earthquakes over the magnitude of M 3.0 near the Los Angeles metro area since September 2020, and produced seismic waveforms consistent with a nearby official USGS seismometer. For earthquakes above the alert threshold, the device issued an EEW alert, sounded the onboard alarm, and sent out text messages to local subscribers.

This low-cost IoT EEW device and the consumer-based approach it enables can open great opportunities for earthquake early warning, saving lives and reducing damages.