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

He, Vivien (School: Palos Verdes Peninsula High School)

Earthquakes are a major global risk, causing the most fatalities among all natural disasters, as well as significant amount of injuries, displacements, and economic losses. While there has been great development in earthquake early warning (EEW) systems, there are many challenges, such as high cost and low density of seismic stations, high latency, large blind zones, and difficulty in projecting ground motion at a user's location. Dependence on public funding further limits EEW growth and sustainability. This research pursues an alternative consumer-based approach. A low-cost Internet-of-Things (IoT) EEW device was designed, built, and tested, which can be mass deployed in homes and business facilities to provide on-site warning and alert regional subscribers. This IoT device is integrated with a geophone-based seismometer, a single board computer, a 32-bit analog-to-digital converter, an alarm, WiFi connectivity, and custom-designed packaging. A software was written in Python to control the device, detect earthquakes, and issue alerts. The palm-sized device is built with under $100, measures ground motion at 100 samples per second, and can be managed remotely on a smartphone or computer. This device successfully detected all earthquakes over the magnitude of M 3.0 around Los Angeles from September 2020 to February 2021. For earthquakes above the alert threshold, the device issued EEW alerts, sounded the alarm, sent out text messages to local subscribers, and produced seismic waveforms consistent with a nearby official USGS seismometer. This low-cost IoT EEW device and the consumer-based approach it enables can create great new opportunities for earthquake early warning.

Awards Won:
Third Award of $1,000
U.S. Agency for International Development: Second Award Working in Crisis and Conflict