Chapter 13
An IoT-Based Earthquake Warning System for Smart Cities

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ABSTRACT

Earthquakes are the most common natural disasters that occur in India. An earthquake warning system minimizes damage and saves countless lives. A seismic wave analysis helps develop an early warning system. The bigger the earthquake, the stronger the shaking. Hence, magnitude determination is critical to developing an earthquake early warning system. The chapter deals with detecting earthquake magnitude by identifying the individual magnitude of earthquakes. An early warning system can be effectively implemented by the proposed method, along with high-end processors and the IoT (internet of things), which has the ability to collect and transfer data over networks with no manual intrusion. The proposed early earthquake warning (EEW) system can be used to support the development of smart cities so earthquake-prone zones are made less susceptible to disaster.

INTRODUCTION

Natural disasters are sudden events caused by environmental factors that threaten lives, property and the ecosystem. Every year, they kill and maim people and damage property. Earthquakes and floods strike anywhere on earth, often without warning. In India, earthquakes are commonly occurring natural disasters. They are among the most deadly natural hazards and frequently cause surface faulting, tremors, liquefaction, landslides, aftershocks and/or tsunamis. Nearly59% of India's landmass is subject to moderate and severe earthquakes that strike without warning. Earthquakes in India are caused by the movement of the tectonic plates. A tectonic plate is a massive, irregularly shaped slab of solid rock (WHO – Technical Hazard Sheet, 2018)http://www.who.int/hac/techguidance/ems/earthquakes/en/.

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The internal structure of the Earth has three major layers:

- Crust
- Mantle
- Core

The outer layer of the Earth is called the crust/lithosphere, which is very thin when compared to the other layers, and is broken into several large pieces called plates. The mantle consists of the upper mantle and the lower mantle. The plates of the Earth move because of the movement of the mantle. The center of the Earth is its core, which is nearly twice as dense as the mantle. The pattern of earthquake occurrences reveals that earthquake activity has occurred in a number of different earthquake belts (Stein &Wysession, 2003).

Earthquakes are happenings experienced during sudden movements of the Earth's crust. The upper part of the mantle, called the asthenosphere, is composed of liquid rock and lies under the Earth's crust. The plates of the Earth's crust which "float" on top of the asthenosphere layer are forced to shift as the outpouring molten material below moves. A huge amount of energy is released in the form of waves as these plates shift and interacts with each other. Though earthquakes can take place anywhere on the planet with little or no warning, a large number of severe earthquakes occur near plate boundaries, as the plates converge (collide), diverge (move away from another), or shear (grind past one another).Earthquakes can also be triggered by means of moving rock and magma within volcanoes. During the collision, divergence and shearing of plates, large sections of the crust can fracture and move back and forth to disperse the energy released. This "shaking" is felt as a sensation during an earthquake (Mooney, 2002).

Figure 1 shows the earthquake belt, which is a narrow zone on the earth's surface around which a majority of earthquakes take place.

Figure 2 shows the nine major plates: North American, Pacific, Eurasian, African, Indo-Australian, Australian, Indian, South American, and Antarctic. The Pacific Plate is the largest at 39,768,522 square miles. The Whole of India lies on the Indian Plate, whose relative motion is at a velocity of 5cms per year in the north-northeast direction (Srivastava, 2015).

Figure 1. Major Seismic Belts of the Earth
(Source: Geology Universe)