Efficiently Detecting Earthquakes and Tsunami Through GSM Network

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Abstract

Humanity is always under the threat of earthquakes. Anatolian peninsula is one of the well-known area which amongst the areas endangered by earthquakes. During the history many dramatic examples have been occurred. In these earthquakes many people either died or have been injured. In addition, lots of damage in this area has been occurred. More west, in the Sea of Marmara, these earthquakes have also initiated Tsunamis which hit the coastline and caused secondary damages. In this paper GSM-based seismicalert system that could warn before an earthquake strikes. Earthquakes strike without warning. The resulting damage can be minimized and lives can be saved if people living in the earthquake-prone area are already prepared to survive the strike. This requires a warning before strong ground motion from the earthquake arrival. Such a warning system is possible because of energy wave released at the epicenter of the earthquake travels slower than light. The warning signal from the earthquake epicenter can be transmitted to different places using satellite communication network, fiber-optics network, pager service, Cell phone services or combination of these. The satellite-based network is ideal when an alert system has to cover a large country like India. For earthquake-prone states like Gujarat, a seismicalert system using the global system for mobile communication network spread throughout the state is proposed here. This system does not try to find the epicenter or fault line caused by the earthquake. It simply monitors the earth vibrations and generates alert when the level of earth vibrations crosses a threshold.

Keywords

GSM, Accelerometer, Interface Unit, Application Server, Network or sms Server

I. Introduction

The earthquake, caused by 5 to 8 meters upthrust on a 180-km wide seabed at 60 km offshore from the east coast of Tohoku, resulted in a major tsunami that brought destruction along the Pacific coastline of Japan’s northern islands. Thousands of lives were lost when entire towns were devastated. The tsunami propagated throughout the Pacific Ocean region reaching the entire Pacific coast of North and South America from Alaska to Chile. Warnings were issued and evacuations carried out in many countries bordering the Pacific. However, while the tsunami affected many of these places, the extent was minor. Chile’s Pacific coast, one of the furthest from Japan at about 17,000 km (11,000 mi) distant, was struck by waves 2 m (6.6 ft) high, compared with an estimated wave height of 38.9 meters (128 ft) at Omoe peninsula, Miyako city, Japan. The Tsunami warning issued by the Japan Meteorological Agency was the most serious on its warning scale; it rated as a “major tsunami”, being at least 3 m (9.8 ft) high. The actual height prediction varied, the greatest being for Miyagi at 6 m (20 ft) high the tsunami inundated a total area of approximately 561 km2 (217 sq mi) in Japan.

The earthquake took place at 14:46 JST around 67 km (42 mi) from the nearest point on Japan’s coastline, and initial estimates indicated the tsunami would have taken 10 to 30 minutes to reach the areas first affected, and then areas farther north and south based on the geography of the coastline. Just over an hour after the earthquake at 15:55 JST, a tsunami was observed flooding Sendai Airport, which is located near the coast of Miyagi Prefecture with waves sweeping away cars and planes and flooding various buildings as they traveled inland. The image of the tsunami sweeping cars on the street in Sendai was caught by an in-car camera. The impact of the tsunami in and around Sendai Airport was filmed by an NHK News helicopter, showing a number of vehicles on local roads trying to escape the approaching wave and being engulfed by it. A 4 m high tsunami hit Iwate Prefecture. Wakabayashi Ward in Sendai was also particularly hard hit. At least 101 designated tsunami evacuation sites were hit by the wave.

II. Generation Mechanisms

The principal generation mechanism (or cause) of a tsunami is the displacement of a substantial volume of water or perturbation of
This displacement of water is usually attributed to either earthquakes, landslides, volcanic eruptions, glacier calvings or more rarely by meteorites and nuclear tests. The waves formed in this way are then sustained by gravity. Tides do not play any part in the generation of tsunamis. Tsunamis can be generated when the sea floor abruptly deforms and vertically displaces the overlying water. Tectonic earthquakes are a particular kind of earthquake that are associated with the Earth’s crustal deformation; when these earthquakes occur beneath the sea, the water above the deformed area is displaced from its equilibrium position [21]. More specifically, a tsunami can be generated when thrust faults associated with convergent or destructive plate boundaries move abruptly, resulting in water displacement, owing to the vertical component of movement involved. Movement on normal faults will also cause displacement of the seabed, but the size of the largest of such events is normally too small to give rise to a significant tsunami.

Tsunamis have a small amplitude (wave height) offshore, and a very long wavelength (often hundreds of kilometres long, whereas normal ocean waves have a wavelength of only 30 or 40 metres),[22] which is why they generally pass unnoticed at sea, forming only a slight swell usually about 300 millimetres (12 in) above the normal sea surface. They grow in height when they reach shallower water, in a wave shoaling process described below. A tsunami can occur in any tidal state and even at low tide can still inundate coastal areas.

III. Japan’s Earthquake Warning System

Just after 2:46 p.m. on Friday, March 11, an earthquake warning buzzed on the cell phone belonging to Professor Kensuke Watanabe. He knew it was time for everyone in his class to bolt under their desks. The university building in Sendai, the biggest city hit by the quake and subsequent tsunami, began to shake violently. But Watanabe and his students, with that small warning, were able to use the sturdy desks as protection against falling objects. Shortly after, they fled the building for open ground. None in the group was hurt by Japan’s worst earthquake on record. “It was terrifying,” says Watanabe, “but the mobile warning really helped.” Japan has the most advanced earthquake early-warning system in the world. A nationwide online system launched in 2007, it detects tremors, calculates an earthquake’s epicenter and sends out brief warnings from its 1,000-plus seismographs scattered throughout the country, one of the most earthquake-prone nations on the planet.

The earthquake warning system, which has never been triggered before, automatically issued alerts via television and cell phones shortly after the first, less harmful, shock wave was detected,
providing time for many people to prepare for the more powerful shock wave that followed. It also caused many energy and industrial facilities, and transportation services to shut down automatically. A string of detection buoys in the Pacific Ocean detected the tsunami that resulted from the earthquake, sending warnings of possible catastrophe to many different nations.

Fig. 8: The Graphic Above Shows the Stages Involved with Triggered Japan’s Earthquake Warning System

Fig. 9: The Graphic Above Shows How the Deep-Ocean Assessment and Reporting of Tsunami (DART) Tsunami Buoys Work

IV. Proposed System

Earthquakes strike without warning. Every year thousands of people die because of this. The result of damage can be minimized by alerting the people about the occurrence of natural calamities i.e., like earthquakes, tsunamis etc. For this purpose, we use advanced technologies like GSM (Global System for Mobile communication technology).

Here’s a GSM-based seismic alert system that could warn before an earthquake strikes. Earthquakes strike without warning. The resulting damage can be minimized and lives can be saved if people living in the earthquake-prone area are already prepared to survive the strike. This requires a warning before strong ground motion from the earthquake arrival. Such a warning system is possible because of energy wave released at the epicenter of the earth quake travels slower than light. The warning signal from the earthquake epicenter can be transmitted to different places using satellite communication network, fiber-optics network, pager service, Cell phone services or a combination of these. The satellite-based network is ideal when an alert system has to cover a large country like India. For earthquake-prone states like Gujarat, a seismic alert system using the global system for mobile communication network spread throughout the state is proposed here. This system does not try to find the epicenter or fault line caused by the earthquake. It simply monitors the earth vibrations and generates alert signal when the level of earth vibrations crosses a threshold.

Fig. 10: Tsunami GSM Architecture

A. GSM

GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in many parts of the world. GSM uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA). GSM digitizes and compresses data, then sends it down a channel with two other streams of user data, each in its own time slot. GSM operates in the 900MHz, 1800MHz, or 1900 MHz frequency bands. GSM has been the backbone of the phenomenal success in mobile telecoms over the last decade. Now, at the dawn of the era of true broadband services, GSM continues to evolve to meet new demands. One of GSM’s great strengths is its international roaming capability, giving consumers a seamless service. This has been a vital driver in growth, with around 300 million. In the Americas, today’s 7 million subscribers are set to grow rapidly, with market potential of 500 million in population, due to the introduction of GSM 800, which allows operators using the 800 MHz band to have access to GSM technology too.

The mobile communications has become one of the driving forces of the digital revolution. Every day, millions of people are making phone calls by pressing a few buttons. Little is known about how one person’s voice reaches the other person’s phone that is thousands of miles away. Even less is known about the security measures and protection behind the system. The complexity of the cell phone is increasing as people begin sending text messages and digital pictures to their friends and family. The cell phone is slowly turning into a handheld computer. All the features and advancements in cell phone technology require a backbone to support it. The system has to provide security and the capability for growth to accommodate future enhancements. General System for Mobile Communications, GSM, is one of the many solutions out there. GSM has been dubbed the “Wireless Revolution” and
it doesn’t take much to realize why GSM provides a secure and confidential method of communication.

B. MEMS

Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. While the electronics are fabricated using integrated circuit (IC) process sequences (e.g., CMOS, Bipolar, or BICMOS processes), the micromechanical components are fabricated using compatible “micromachining” processes that selectively etch away parts of the silicon wafer or add new structural layers to form the mechanical and electromechanical devices.

MEMS promises to revolutionize nearly every product category by bringing together silicon-based microelectronics with micromachining technology, making possible the realization of complete systems-on-a-chip. MEMS is an enabling technology allowing the development of smart products, augmenting the computational ability of microelectronics with the perception and control capabilities of microsensors and microactuators and expanding the space of possible designs and applications.

Microelectronic integrated circuits can be thought of as the “brains” of a system and MEMS augments this decision-making capability with “eyes” and “arms”, to allow microsystems to sense and control the environment. Sensors gather information from the environment through measuring mechanical, thermal, biological, chemical, optical, and magnetic phenomena. The electronics then process the information derived from the sensors and through some decision making capability direct the actuators to respond by moving, positioning, regulating, pumping, and filtering, thereby controlling the environment for some desired outcome or purpose. Because MEMS devices are manufactured using batch fabrication techniques similar to those used for integrated circuits, unprecedented levels of functionality, reliability, and sophistication can be placed on a small silicon chip at a relatively low cost.

IV. Conclusion

This earthquake alert systems senses earthquake waves, transmits these discrete magnitude values to a central place via., GSM cell phone network, and uses computer-based decision making to deliver alert signals to the identified receivers placed at different towns and cities for both public and government consumption. The system is simple and could be configured with available resources in the country. Detailed simulation, feasibility study and experimentation are required to optimize the system and reduce the possibilities of false alarm.

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