Design and Development of Earthquake/Seismic Activity Detection(prediction) System using NavIC Signals

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• **What is Earthquake?**

An earthquake is the result of a sudden release of stored energy in the earth’s crust that creates seismic waves.

• **Seismology** is the study of the generation, propagation and recording of seismic waves in the Earth (and other celestial bodies) and of the sources that produce them.

<table>
<thead>
<tr>
<th>Class</th>
<th>Magnitude</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great</td>
<td>8 and more</td>
<td>Total destruction</td>
</tr>
<tr>
<td>Major</td>
<td>7-7.9</td>
<td>Serious damage</td>
</tr>
<tr>
<td>Strong</td>
<td>6-6.9</td>
<td>Damage in populated area</td>
</tr>
<tr>
<td>Moderate</td>
<td>5-5.9</td>
<td>Slight damage</td>
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Tectonic plates getting stuck and putting a strain on the ground
Seismic Waves

Body Waves

- P-wave
- S-wave

Surface Waves

- Rayleigh wave
- Love wave

Dilations

Compressions

Wavelength

Amplitude
Ionosphere

- Ionosphere is defined as the layer of the earth’s atmosphere that is ionized by solar and cosmic radiation.
- It is formed when energetic electromagnetic and particle radiation from the sun and space ionize air molecules in the upper atmosphere.

Mapping Ionosphere Using NavIC Signals
Physics Behind Pre and Post Co-Seismic Ionospheric Disturbances

Diagram:
- **F layer**: Indicates the ionospheric plasma layer.
- **350 Km**: Distance from the Earth's surface to the F layer.
- **Atmospheric waves**: Depicted as waves propagating through the atmosphere.
- **Dynamic coupling at the earth/atmosphere interface**: Suggests interaction at the boundary between the Earth and the atmosphere.
- **Earthquake**: Indication of seismic activity.
The reason for the frequent earthquakes in Indian subcontinent is due to Indian plate driving into Asia at a rate of approximately 47mm/year.
Ongoing Research

- Magnitude wise TEC variation study.
- Epicenter-Station geodetic distance based seismic activity observation study.
- Space based distance and spread of Ionospheric disturbances.
- Usage of solar and magnetic activity related information. (for filtering data)
- Indian stations availability near identified seismic zone.
Objective: To build seismic activity detection (prediction) system using NavIC Signals

Concept (Methodology):
First time **NavIC ionospheric data has been used to detect** Earthquake that occurred in Myanmar 135 km (84 miles) north-west of Mandalay on April 13, 2016 with a maximum intensity of VI (Strong) at 8:25 pm LT (13:55 UTC)
Summary

• A new Concept/Methodology for Seismic Activity Monitoring in Indian region has been designed and developed using the regional NavIC System signals as input in near real time.

• Further refinement and validation of the developed concept is in progress.