# IoT Based Earthquake Prediction System

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# Problem Statement:

Earthquakes and their causes:

Short-term processes and friction Earthquake fault motion can be viewed as frictional sliding on a fault plane. The friction changes as a function of slip (relative displacement of the two sides of the fault plane), velocity, and history of contact. Thus, frictional stress controls seismic motion. An earthquake can occur only if friction decreases rapidly with slip, a process referred to as slip weakening. If friction increases with slip, or does not drop rapidly enough, slip motion either stops or occurs gradually [1].

Long-term processes: The forces generated in Earth's crust are typically described in terms of the shear stress and the shear strain. The shear stress is the force per unit area applied tangent to a plane. The shear strain is a dimensionless quantity that describes the distortion of a body in response to a shear stress. When the stress at a point in the crust exceeds a critical value, called the local strength, a sudden failure occurs. The plane along which failure occurs is called the fault plane and the point where failure initiates is called the focus. Typically, there is a sudden displacement of the crust at the fault plane following the failure, and elastic waves are radiated. This is an earthquake. For most earthquakes, the displacement occurs at an existing geological fault, that is, a plane that is already weak [1].

Ideal situation:

Predicting earthquakes is an important issue in the study of geography. Accurate prediction of earthquakes can help people to take effective measures to minimize the loss of personal and economic damage, such as large casualties, destruction of buildings and broken of traffic, occurred within a few seconds.

Reality:

There are several ways Geologist use to predict earthquakes. The results so far have been successful in telling where an earthquake has more probability to occur but when it will happen is still under research. Demonstrably successful predictions of large earthquakes have not occurred and the few claims of success are controversial. For example, the most famous claim of a successful prediction is that alleged for the 1975 Haicheng earthquake. The M 7.3 1975 Haicheng earthquake is the most widely cited "success" of earthquake prediction [2]. The ostensible story is that study of seismic activity in the region led the Chinese authorities to issue a medium-term prediction in June 1974, and the political authorities therefore ordered various measures taken, including enforced evacuation of homes, construction of "simple outdoor structures", and showing of movies out-of-doors. The quake, striking at 19:36, was powerful enough to destroy or badly damage about half of the homes. However, the "effective preventative measures taken" were said to have kept the death toll under 300 in an area with population of about 1.6 million, where otherwise tens of thousands of fatalities might have been expected [3]. Extensive searches have reported many possible earthquake precursors, but, so far, such precursors have not been reliably identified across significant spatial and temporal scales. While part of the scientific community hold that, taking into account non-seismic precursors and given enough resources to study them extensively, prediction might be possible, most scientists are pessimistic and some maintain that earthquake prediction is inherently impossible [4].

Consequences:

The damage caused by earthquakes is from ground shaking, ground rupture, landslides, tsunamis, and liquefaction. Earthquake damage from fires is the most important secondary effect. Ground shaking is the most familiar effect of earthquakes. It is a result of the passage of seismic waves through the ground, and ranges from quite gentle in small earthquakes to incredibly violent in large earthquakes. Ground rupture is another important effect of earthquakes which occurs when the earthquake movement along a fault actually breaks the Earth's surface. While active ground rupture is comparatively rare, there have been cases of it in California. Landslides are caused by earthquakes both by direct rupture and by sustained shaking of unstable slopes. They can easily destroy buildings in their path, or block roads and railroad lines, or take hilltop homes with them as they tumble. Tsunamis are a series of water waves caused when the seafloor moves vertically in an earthquake and which can travel vast distances in a short period of time [5].

Proposal:

This project seeks to resolve the issue by designing an IoT based earthquake prediction system that uses various sensors to analyse, collect and hence predict the magnitude of an earthquake.

## Software and hardware requirements:

- Software requirements:

    C programming

    Python

    Arduino IDE

    Proteus

- Hardware requirements:

    Arduino nodeMCU

    Piezo vibration sensor (sensitivity of these sensors are 0,5-50 mVs2/m in the frequency range 0,1 Hz to 200 kHz)

    accelerometer (±1g up to ±250g)

# Addition and Updates:

Since the model collects and analyses the data needed to predict earthquakes, it can be enhanced by adding algorithms to predict whether a particular area is prone to earthquakes and whether a certain pattern is observed. This data is critical because it can help disaster management in the event of an earthquake in the future. The model can also be updated to detect the smallest ground motions, which can be classified as faint, very low-magnitude earthquakes, which can be used to prepare for future high-magnitude earthquakes.

# Advantages, application and challenges:

Earthquake prediction system provides us with critical amount of time between the prediction of the earthquake. This time can be used to reduce the impact of an earthquake by many sectors of society. Individuals can use the alert time to drop, cover, and hold on, reducing injuries and fatalities, or if alert time allows, evacuate hazardous buildings. Train derailments can be reduced, chemical splits limited, patients in hospitals protected, fire ignitions prevented; workers in hazardous environments protected from fall/pinch hazards, reducing head injuries and/or death. Bifurcation and the extreme dependence of the behaviour of nonlinear geological system upon initial and continuously variable current conditions explain the inevitable unreliability of predicting the most mature earthquake sources.

# Conclusion:

This earthquake prediction system based on the Internet of Things aims to prevent the dangerous consequences of earthquakes by predicting the intensity of the earthquake, thereby giving us enough time to react. From an economical point of view, the model may also be beneficial because it prevents losses of property and goods. The land can be evacuated before the earthquake occurs, preventing huge loss of lives. We can also improve the model to make predictions more accurate and analyse patterns.

# References:


1. Physics Today 54, 6, 34 (2001); Doi: 10.1063/1.1387590
   View online: https://doi.org/10.1063/1.1387590
   Published by the American Institute of Physics

2. International Commission on Earthquake Forecasting for Civil Protection (ICEF) (30 May 2011). "Operational Earthquake Forecasting: State of Knowledge and Guidelines for Utilization". *Annals of Geophysics*. **54** (4): 315–391. doi:10.4401/ag-5350

   Jackson, David D. (2004). "Earthquake Prediction and Forecasting". In Sparks, R. S. J.; Hawkesworth, C. J. (eds.). *The State of the Planet: Frontiers and Challenges in Geophysics*. *Washington DC American Geophysical Union Geophysical Monograph Series*. Geophysical Monograph Series. **150**. Washington DC: American Geophysical Union. pp. 335–348.

3. Raleigh, C. B.; Bennett, G.; Craig, H.; Hanks, T.; Molnar, P.; Nur, A.; Savage, J.; Scholz, C.; Turner, R.; Wu, F. (May 1977), "Prediction of the Haicheng Earthquake", *Eos, Transactions, American Geophysical Union*, **58** (5): 236–272.

4. Kagan, Yan Y. (December 1997b), "Are earthquakes predictable?" (PDF), *Geophysical Journal International*, **131** (3): 505–525, Bibcode:1997GeoJI.131..505K, doi:10.1111/j.1365-246X.1997.tb06595.x

5. *"*Effects of Earthquakes**",** *Greg Anderson,* *https://topex.ucsd.edu/es10/es10.1997/lectures/lecture20/secs.with.pics/node10.html*