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An Artificial Neural Network Model Based Study of Seismic Wave

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***Abstract*—**A study based on ANN structure gives us the information to predict the size of the future in realizing a past event. ANN, IMD (Indian meteorological department) data and remote sensing were used to enable a number of parameters for calculating the size that may occur in the future. A threshold selected specifically above the high-frequency harvest reached the area during the selected seismic activity. In the field of human and local biodiversity it remains to obtain the right parameter compared to the frequency of impact. But during the study the assumption is that predicting seismic activity is a difficult process, not because of the parameters involved here, which can be analyzed and funded in research activity.

***Keywords*—**ANN, Bayesian class, earthquakes, IMD.

I. Introduction

EVENTS of earthquakes in the Sikkim region are largely related with the tectonic activity along well known faults in the Himalayas, namely, Main Boundary Thrust (MBT), Main Central Thrust (MCT) [1].

- In the seismic zoning map of India made by Bureau of Indian Standards, the entire area of Sikkim lies in Zone IV [1].
- Several statistical methods are there to predict earthquake beforehand so that loss of lives and property can be minimized but among them ANN is much better predictor because it can capture non-linear relationships.
- ANN follows a computational paradigm that is inspired by the structure and functionality of the human brain. ANN also performs computation in terms of patterns rather than data [2].
- A number of models based on ANNs can predict earthquakes, and the model used here is a Bayesian class with an algorithm of back propagation.

Objective

- To analyze earthquake IMD data using some statistical method.
- To assess the effectiveness of ANN in prediction of earthquake.
- To use remote sensing based parameter slope and aspect ratio for earthquake study.

II. Materials and Method

- ANN technique
- IMD Data used
- ASTER GDEM data for slope and aspect

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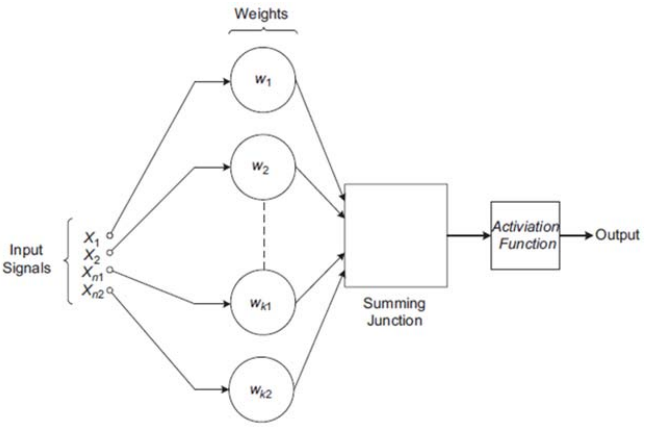

Fig. 1 Basic model of ANN [2]

ANN Modeling

ANN is an attempt to simulate the multiple layers of simple processing elements through neurons with specialized hardware or sophisticated software. The most basic element of the human brain is a specific type of neuron, which provides one with the abilities to remember, think and apply previous experiences to every action [2]. This means for ANN, building an artificial neural network just like of the human brain and working on the given data and making further predictions based on that data [2].

Layered Network

The input layer behaves with a number of properties, with the last layer, between the hidden layer existing, being equal to the number of classes as the output. Each neuron is associated with the next layer. If this is true then it is called field forward neural network. Back propagation techniques are used in neural network to reduce error to achieve the required target value [2], [3], [12], [13].

Architecture

- Number of layers: 3
- Number of neuron on the layers: Input: 5 (Lat, Long, bath value, slope, aspect); Hidden: 8; Output: 1 (EQ (Earthquake) magnitude) [3].
- Activation function: Tan-sigmoid, Purelin.

P-Wave, a compressional architecture design with artificial neural network (ANN), can determine the seismic activity from inner earth crust. The number of neurons is a back-spreading technique for determining seismic activity, and shaping with the help of an input neuron, a hidden layer and an output layer [4], [6].

Data: It has been observed that the number of parameters

are strongly correlated, so they are discarded to obtained the fine result set in weight matrix [6], [7].

III. Result

TABLE I
A Small Scale Data Set Taken from Upper Edge of Threshold

	Target Values	MSE	R
Training	23	5.00928e-0	5.35663e-1
Validation	5	4.50956e-0	9.12694e-1
Testing	5	10.79139e-0	-5.04703e-1

Bayesian class and Back-propagation training method are used here.

This ANN study predicted earthquakes and earthquakes fall. According to this study between histograms, ANN did not predict earthquakes and earthquakes fall. 4.0 and above thresholds are taken in a systematic parabolic manner according to map sampled focal point, other sample focal points are taken just reverse parabolic in order to get extreme corrected back propagation method in ANN (Fig. 2 (a)) result. The final RMS value just below 4.0 of threshold is observed. The sample points are taken in order to keep in mind that the tectonic activities of Eurasian plate and Indian plate opposite movement affect the tectonic activities of the sampled area.

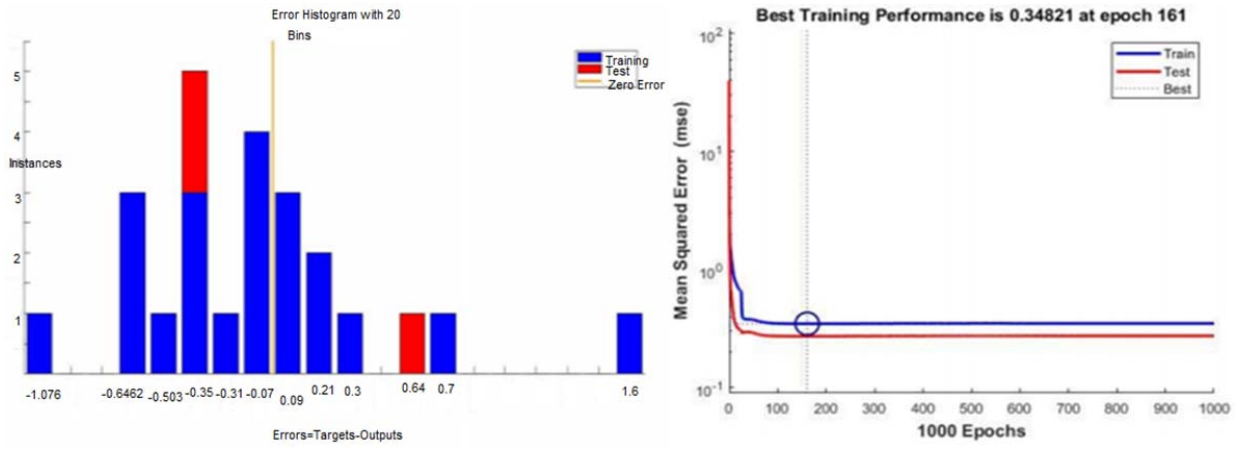

Fig. 2 (a) Final Result of ANN classifier

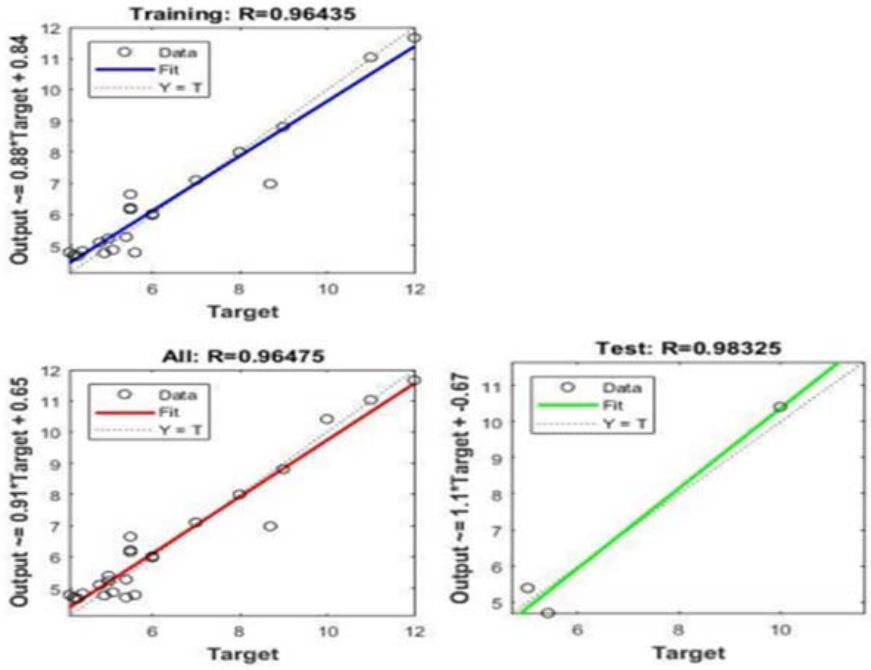

Fig. 2 (b) Regression factor for overall

The regression (Fig. 2 (b)) factor for overall class verifies the tectonic activities of the region of its extreme correct in nature. By artificial neural network prediction techniques it has been found that the frequency occurred is very accurate and closest match to regression.

Input and Target Output Parameters

Fault lines have very complex constructions. When the formation of the earthquakes is examined, it can be seen that

many factors should be studied along with it. That is why the structure of the model is built with as much parameters as possible. Slope and aspect along with bathymetric value plays an important role for occurrence of an earthquake.

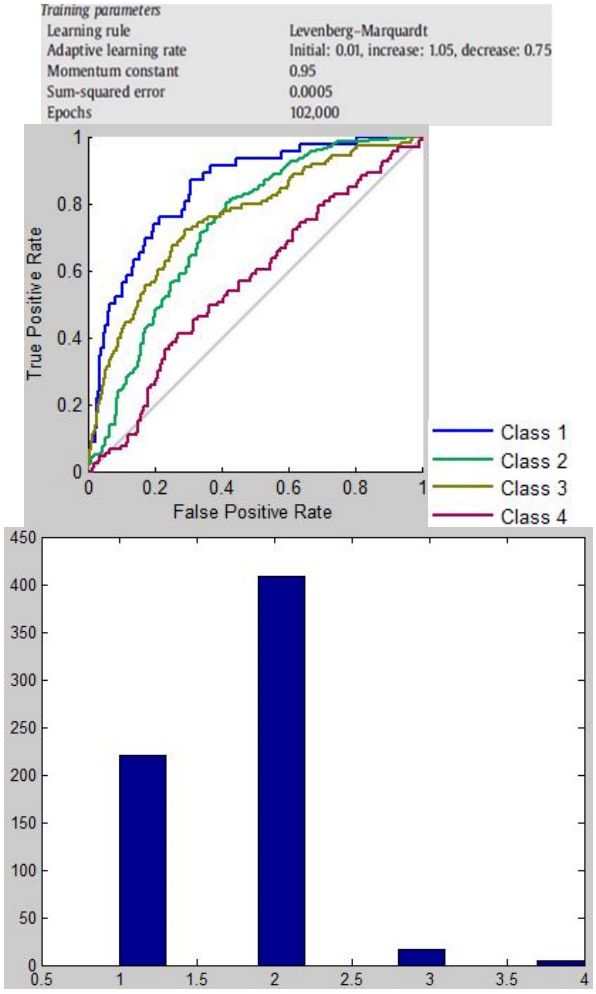

Fig. 3 Result Graph & Regression factor for overall class

IV. Discussion

Seismic wave prediction is a difficult and tedious process. The frequency of the thresholds can be analyzed in any range based on data from laboratory experiments and previous bridges. It has been observed that on the mass scale destruction, the seismic activity from inner most earth crust, due to continental drifting is necessary case study, to showcase in public domain. But it has been observed that the mass scale destruction due to tsunami happened by this phenomena. So the scale of threshold for that level prediction is required to prevent these types of mass scale destruction [5].

- Here from Fig. 3, it can be easily interpreted that the classified ANN (shown in class) predicts that earthquake prediction on the outskirts of China, Bhutan, Sikkim is the most accurate. This is due to the fact that China is the most influential factor in the figure.
- As we all know ANN is just only a classifier and it cannot predict seismic parameter, but about the values it can tell that study area can follow which particular type of pattern it has.

V. Conclusions

- The magnitude of the earthquake is predicted for the Sikkim, it can be predicted in the future, with respect to the earthquake of the same magnitude [1].
- Predicting earthquake is a difficult task because occurrence of earthquakes also depends on several random factors of nature and those factors are unknown to human beings.

In the future study, the electromagnetic observations can be included for the prediction of the earthquake. Total electron content (TEC) is one of the main parameters used in electromagnetic observation [8], [9]. GPS observations are the main tool for measuring the TEC. GPS observations can create the ionospheric structure in 3-D format [10]. Several other methods of remote sensing technology can also be incorporated as the future scope of this work. Optical remote sensing has several limitations, and it can be mostly used for rapid assessment of damages in an epicentral zone of the earthquake region. Microwave remote sensing application like InSAR (Interferometric Synthetic Aperture RADAR) is limited due to high data cost and complex analysis. But the thermal data generated from the TIR (Thermal Infrared) sensor of the satellite are emerging as an alternative for earthquake analysis. Thermal anomalies research in seismic faults is developing in the direction of seismic activity monitoring and close integration with ground observations. Emitted longwave radiation observations demonstrate promising results, but data accumulation is required. In the coming days, these kinds of satellite remote sensing-based analysis will be used in a more prominent manner for earthquake prediction. The generation of the data from the remote sensing analysis is tough, and it requires complex analysis and mathematical abilities.

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References

[1] Rai, Durgesh. C., Singhal, Vaibhav, Mondal,Goutam, Parool, Neha, Mitra, Keya, 2012. The M 6.9 Sikkim Earthquake of 18 September 2011. Current Science 102.

[2] Reyes, J., Morales-Esteban, A., Martínez-Álvarez, F., 2012. Neural networks to predict earthquakes in Chile. Applied Soft Computing 13,1314-1328

[3] Moustra, Maria, Avraamides, Marios, Christodoulou, Chris, 2009. Artificial neural networks for earthquake prediction using time series magnitude data or Seismic Electric Signals. Expert Systems with Applications 38, 15032-15039

[4] Marcin Polkowski, Nr albumu: 251328, Simulation of wave fronts and amplitudes of P and S-waves in spherically symmetric Earth model using ray approach, Uniwersytet Warszawski Wydzia Fizyki.

[5] Mogi, K. Earthquake prediction. United States: N. p., 1985. Web.

[6] Singh, T N, Kanchan, R, Saigal, K, Verma, A K, Prediction of *p*-wave velocity and anisotropic property of rock using artificial neural network technique, Journal of scientific research,VOL.63,January 2004.pp:32-38.
[7] Hogstrom K, A study on strength parameter for aggregate from south western Sweden rocks, Res Rep (Chamer Univ of Technology, Goteborg, Sweden) 1994.
[8] Tronin, A.A., 2010. Satellite remote sensing in seismology. A review. Remote Sensing 2, 124-150.
[9] Hayakawa, M. ed., 1999. *Atmospheric and ionospheric electromagnetic phenomena associated with earthquakes*. Terra Scientific Pub. Co..
[10] Liu, J.Y., Chen, Y.I., Chen, C.H., Liu, C.Y., Chen, C.Y., Nishihashi, M., Li, J.Z., Xia, Y.Q., Oyama, K.I., Hattori, K. and Lin, C.H., 2009. Seismoionospheric GPS total electron content anomalies observed before the 12 May 2008 Mw7. 9 Wenchuan earthquake. *Journal of Geophysical Research: Space Physics*, *114*(A4).
[11] Liu, J.Y., Tsai, Y.B., Ma, K.F., Chen, Y.I., Tsai, H.F., Lin, C.H., Kamogawa, M. and Lee, C.P., 2006. Ionospheric GPS total electron content (TEC) disturbances triggered by the 26 December 2004 Indian Ocean tsunami. *Journal of Geophysical Research: Space Physics*, *111*(A5).
[12] M. Palakal and M. Zoran, "Feature extraction from speech spectrograms using multi-layered network models," in *IEEE International Workshop on Tools for Artificial Intelligence*, Fairfax, VA, USA, 1989 pp. 224,225,226,227,228,229,230.doi: 10.1109/TAI.1989.65324
[13] R. Mukhaiyar and R. Safitri, "Implementation of Artificial Neural Network: Back Propagation Method on Face Recognition System," 2019 16th International Conference on Quality in Research (QIR): International Symposium on Electrical and Computer Engineering, Padang, Indonesia, 2019, pp. 1-5, doi: 10.1109/QIR.2019.8898276.