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Highway Compliance Monitoring System using Artificial Neural Network

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Abstract: In Civil engineering domain, a way determining a highway lifespan is to take a complete spectrum of axle loads and calculate the appropriate equivalence and depreciative factors. Also, vehicle weights are measured by stopping them to measure their axle loads or using the wheel weighing pad as the case may apply. This paper however dived into the use of existing experience data of road pavement lifespans before damages or failure before maintenance or repair. It uses Artificial Neural forecasting model in a supervised learning in Matlab environment with an application developed. The results are evaluated based on mean squared error, fitting and validation performance.
Keywords: Highway Lifespan, Artificial Neural Network, Road pavement failure, Matlab and Regression plot.

I. INTRODUCTION

Road deterioration is a phenomenon bound to happen to every road pavement as long as they are being plied. Several thousands of lives and properties worth several million dollars are lost as a result of frequent motor accidents, caused by failed highway pavements in Nigeria[5].

The condition of area roads affects the speed, efficiency and ultimately the cost of transportation. In recent years, considerable research effort has been concentrated on the measurement and prediction of dynamic wheel loads. An equivalent effort has been concentrated on static analysis of road structures and their failure mechanisms. Very few investigators have examined the relationships between dynamic wheel loads of heavy vehicles and road surface deterioration. Also, it's being discovered, that the world is currently at large on the exact time and period, in year, about road deterioration occurrences. The primary aim of dynamic road loading legislation is minimization of road surface damage.

So it is essential that these relationships be understood. Only then can road-damage-related vehicle tension design controls be introduced, at the same time, government can make adequate preparation, to tackle the road pavement depreciation occurrence so that accidents can be minimized while budget expenses are maximized. This paper work uses ANN to derive a forecasting model that predicts future road depletion ad deterioration.

II. RELATED WORKS

A neural network is a system of many simple processing elements that usually operates in parallel whose function is determined by network structure, connection strengths, and the processing performed by the computing elements or nodes [1]. Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract patterns and detect trends that are too complex to be noticed by either humans or other computer techniques. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze.

This expert can then be used to provide projections given new situations of interest and answer "what if" questions. The failure of highway pavements had been a common occurrence on the Nigerian highway system since the colonial period [6]. All civil infrastructures have a definite life span. In other words, all structures may fail at some point, and this includes the vast network of road pavements in the US and some part of the world. Approximately 2% of lands in US are paved [4], this consists of flexible, rigid and composite pavements.

In order to ensure that pavements achieve the purpose for which they 'were designed they ought to be maintained regularly and at very little cost to the road user. The US Government spends about $100B/year on highway construction; delays caused by traffic cost road users approximately $38B/year [3]. Road maintenance and rehabilitation form the largest percentage of this figure. It is therefore necessary to curtail the high cost of maintenance to road users by developing measures to decrease the loss generated when roads cannot be duly utilized.

III. EXPERIMENTAL SET UP

The Neural Network Fitting *nntool* available in MATLAB 8.5.0 (R2015a) is used to carry out the analysis on the weather data using Artificial Feed-Forward Neural Network with back-propagation principles [2]. Our research started with the simple feed-forward back propagation model having explored the importance of the ANN at its unit level that is the artificial neuron. These Artificial neurons are the building blocks of all such ANNs and to understand their potential has been our main study.

A. Data Specification

The main aim is to create and train a network that can predict the Lifespan duration (in years) of the high way before pavement depletion and deterioration, for given set of vehicle counts in various weighted categories. Our study examined only the count of vehicle as a scaler bias, b is added to transform individual number counts. The model once created can be fed with any set of given weighted vehicles category count number. We used data statistic available at Federal Road Maintenance Agency (FERMA) and National Bureau of Statistics and Federal Ministry of Work.

B. Input Variables

The dataset consist of 300 samples of 3 elements in a 3x300 matrix, corresponding to count of Light vehicle, Count of Medium vehicle and Count of Heavy vehicle in 300 days within a given period in time. Out of the 300 set of samples, 70% sample called *training data* are randomly selected by *nntool* for training the neural network. 15% samples called the *validation data* measure the generalization of the network by feeding it with data it has not seen before. The remaining 15% samples called the *test data* give an independent measure of the performance of the neural network in terms MSE (Mean squared error). It is the square of the difference of the predicted value and the target, hence always positive. In order to be accurate in its prediction, the network expects larger number of dataset. Even so the validation and testing is adjustable, NN Matlab documentation discourages it, as it is the best possible division the network can use.

C. Neural Network

A typical feed forward with back propagation network should at least three layers, an input layer, hidden layer and output layer. The training method employed is Levenberg-Marquardt *(trainlm)* which is a network training function that updates weight and bias values according to Levenberg-Marquardt optimization. Trainlm is often the fastest back propagation algorithm in the toolbox according to matlab NN documentation, and is highly recommended as a first-choice supervised algorithm. As expected, the Network has 3 inputs namely, Count of Light vehicle, Count of Medium vehicle, and count of Heavy vehicle. The network makes use of 10 hidden Neurons, as shown in figure 1, which provides better accuracy. The output is only 1, which refers to the lifespan (in years) of the highway. Also, The NN recommended *validation set* is not adjusted as it is the best possible division the network can use and NN Matlab documentation discourages it. Figure 1 shows the generated NN for the current problem and result of the training phase.

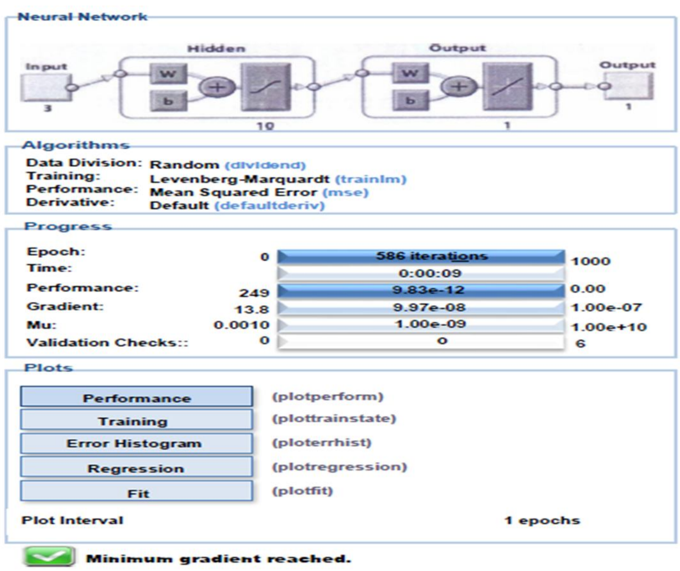

Figure 1: Network training results

1) *Maximum Mu reached:* Mu, is a parameter of the traimlm algorithm and measures the adapting/learning rate of the network. Maximum Mu reached means the learning rate has reached its maximum and further trainings will lead to a validation stop or mostly, a minimum gradient.
2) *Minimum Gradient Reached:* Gradient is the direction of change of the values. Our algorithms implement gradient descent to find local minimum and hence the term 'minimum gradient' which is predefined.

IV. RESULTS AND DISCUSSION

A. Training Accuracy

The training accuracy is validated the by the regression plot, shown in figure 2. The outliers, which are data points where the fit is significantly worse than the majority of data, are good indication of error rate as stated in literatures. Outliers determines if data is bad, or if those data point are different than the rest of the data set. If the outliers are valid points, but are unlike the rest of the data, then the network is extrapolated of this point. From the observation in figure 2, it is safe to conclude that, there are negligible values of error between the training and the predicted data, hence the training of the network is successful.

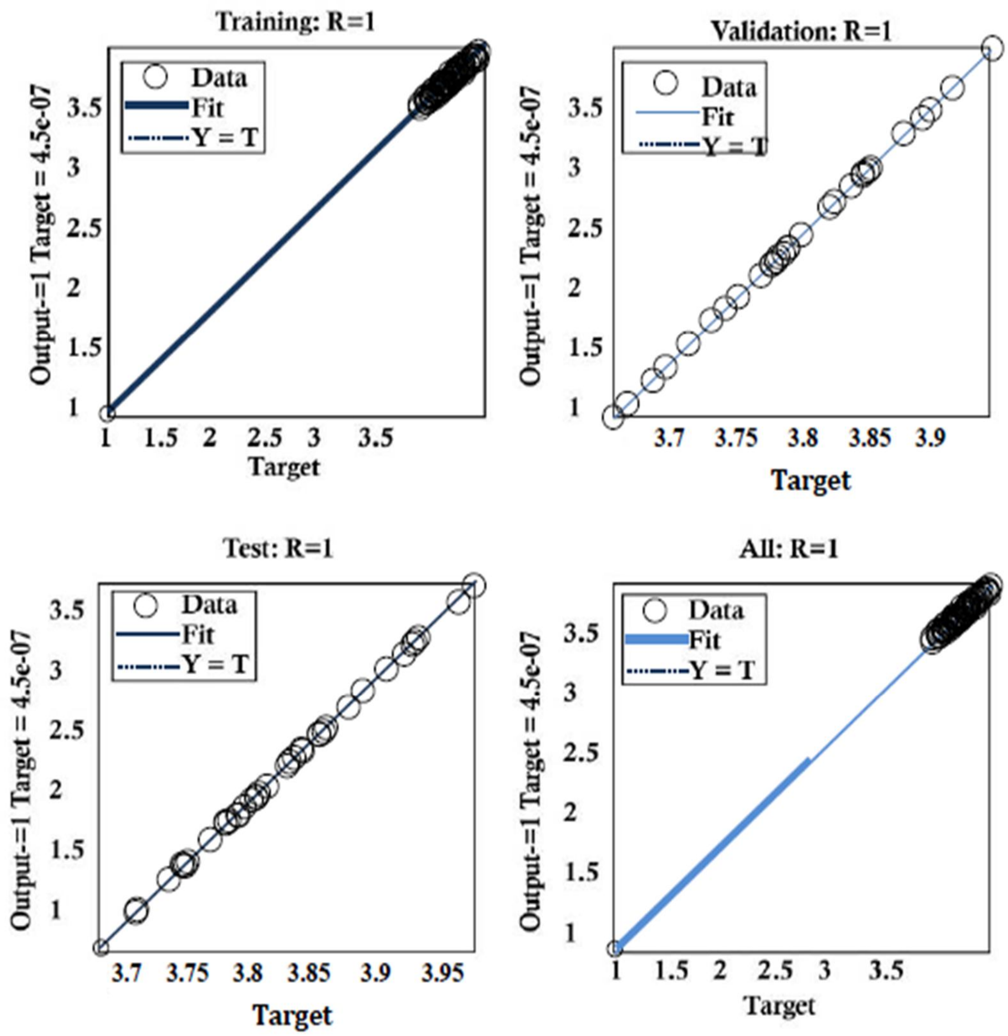

Figure 2: Regression plot

Also, from the regression plots display in Figure 2, the network outputs with respect to targets for training, validation, and test sets. For a perfect fit, the data should fall along a 45 degree line, where the network outputs are equal to the targets. For this problem, the fit is reasonably good for all data sets.

B. Means Squared Error (mse) and Fitting

mse tends to amplify the impact of outliers on the models accuracy. In our experiment, the mse is relatively negligible as shown in figure 3, the validation mse curve seems to closely follow the test mse curve confirming good generalization with the best Validation Performance of 3.4954e at epoch 607.

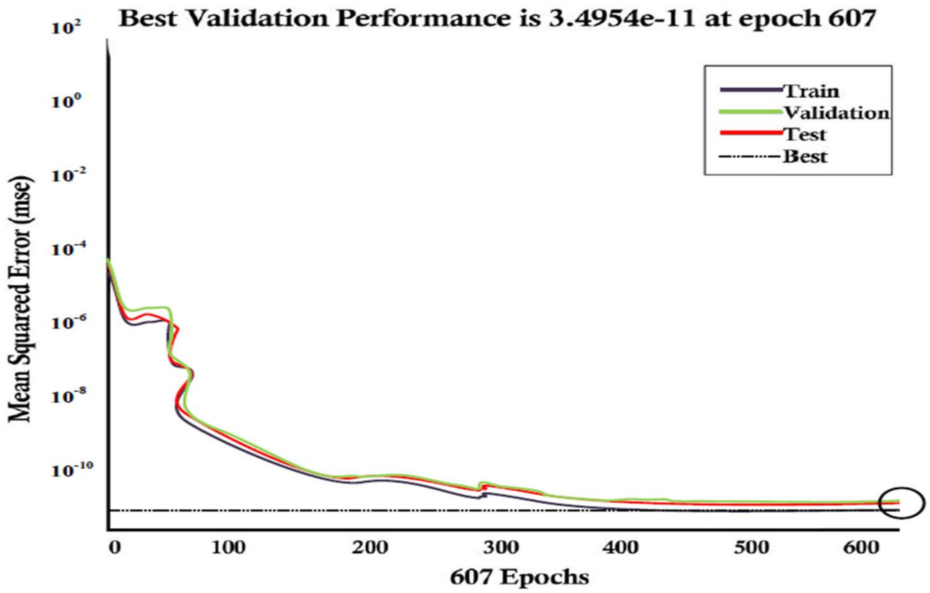

Figure 3: Best Validation performance

C. Program Output

Application was written in Matlab language, using the UI controls, which is enables access between the user and Neural network. Output display of the application is shown in Figure 4a and 5b. The green region represents how much time it will take the road to ultimately fail, the GUI also offers a textual explanation of the result in both percentage and years. A brief comment of the result is given also given. Figure 4b shows a display of warnings and advise once the lifespan of the high has elapsed.

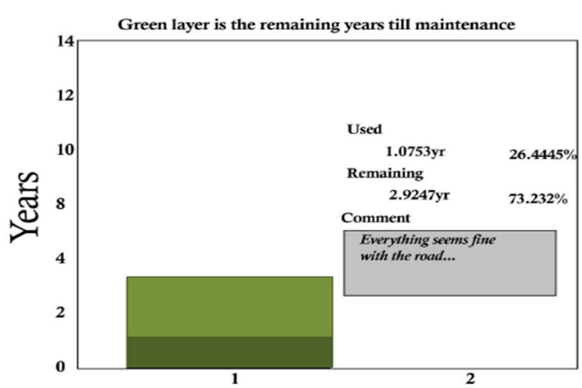

Figure 4a: Network Program Output displaying elapsed and remaining number of years

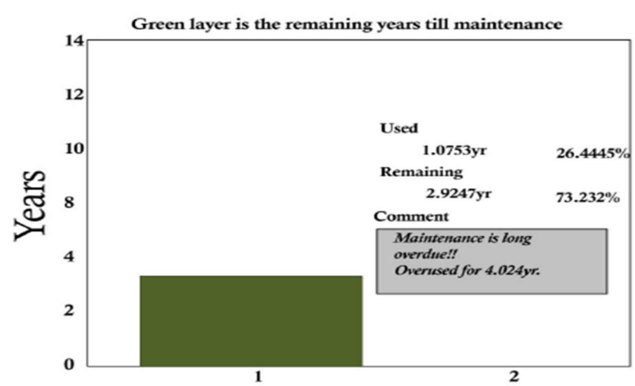

Figure 4b: Network Program Output displaying elapsed number of years

V. CONCLUSION

This study has been able to forecast the future road condition. Roads and other public utilities can be managed and kept in service using experience data rather than doing the long, boring engineering calculation which somewhat can be unreliable. The Neural Network was able to establish a linear relationship between the parameters even though it was somewhat complex to comprehend by a normal human user. There is almost a perfect linear relationship between the volume of traffic and the life cycle of the road, provided, those related to Natural disaster and accidents are assumed.

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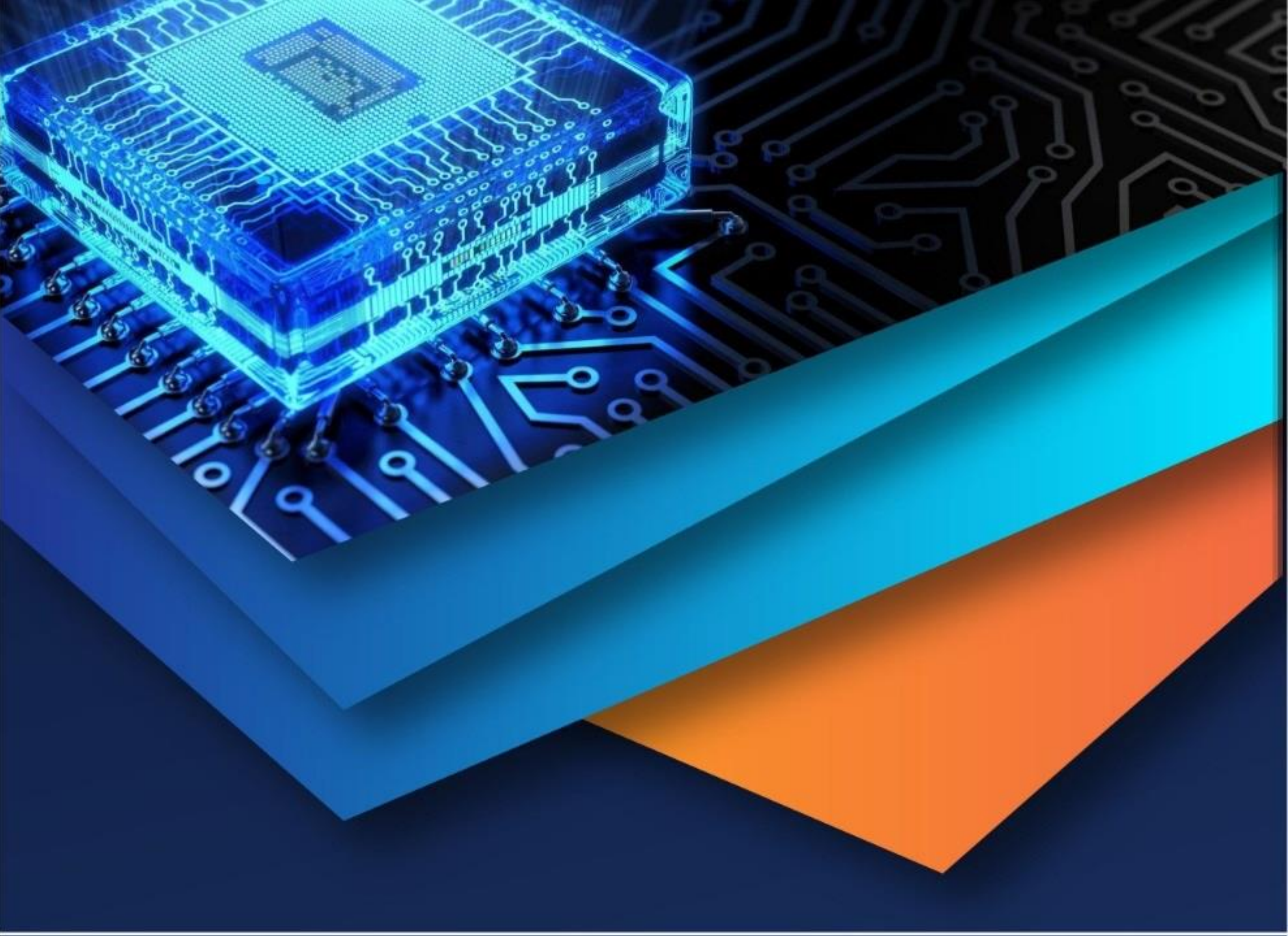
REFERENCES

[1] DARPA (1988). Neural Network Study 31. AFCEA International Press, Fairfax, VA.
[2] Matlab 8.5.0 (2015a). The Math Works Inc., Product Help-Neural Network Toolbox.
[3] National Research Council (U.S.). Transport Research Board. (2001) Strategic highway research: Saving lives, reducing congestion, improving quality of life. Special Report; 260. ISBN 0-309-07243-3.
[4] Pocket Guide to Transportation, (2003). US Department of transportation.
[5] Jegede G. (2000) Effect of soil properties on pavement failures along the F209 highway at Ado-Ekiti, south-western Nigeria. Construction and Building Materials. Vol 14, Issues 7-7, P. 311-315.
[6] Chukweze H. Pavement failures caused by soil erosion. Proc. 2nd Int. Conf. Case. Histories in Geotech Engng. St. Louis, Pap. No. 5.000 936]9.



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