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Prediction of Construction Site Monitoring Performance By Using Artificial Neural Network

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Abstract : Forecasting project performance is one of the most difficult tasks in predicting whether the project will be successful. The successful performance of construction project cannot be achieved without challenges and obstacles. To meet these challenges and hit these obstacles, an organization must have a clear awareness of its performance. Project manager spend most of his time for developing and updating of reports instead of execution and to take in-time decision to finish the work within prescribed time scale. The development of an artificial neural network tool that will help the project manager in this task. Artificial neural networks (ANNs) would seem to offer a potentially powerful tool for estimating project control parameters from current project conditions. ANN's were found to learn from the relationships between input and output provided through training data and could generalize the output, making it suitable for non-linear problems where judgment, experience and surrounding conditions are the key features.

***Key Words**: Artificial Neural Network (ANN), MATLAB, Project performance.*

1.INTRODUCTION

The Construction industry is very huge and mixed industry which plays a vital role in the progress of any nation. Construction projects are complicated, multidisciplinary and time-consuming in nature. They may involve the participation of owners, designers, contractors, subcontractors, specialists, consultants, etc. The number of participants also increases with the size of the project. It is commonly agreed that for a construction project to be fulfil it has to be completed on time within budget and according to the specification. Most current project control systems measure quantitatively cost and schedule status and forget other important aspects of project performance like quality, safety, project team satisfaction, and client satisfaction which are also as important as cost and schedule. Forecasting project performance is one of the most demanding tasks in predicting whether the project will be successful. The traditional planning and controlling methods practiced in the construction industry demand the project Manager to base the estimate of various control parameters (e.g., cost, quality and schedule variances) on status reports that become available from time to time. Project managers evaluate these status reports to predict the variations in these control parameters over the duration of the project. These methods are satisfactory, but when hundreds of tasks have to be precisely choreographed, these predictions become difficult to make. For effective control, project managers have to corn-pare the performance of future work against the original baseline estimate to identify likely problems and possible solutions. The goal of this paper is to review these new projects that use Artificial Intelligence to improve project success or that can simply predict it. ANN as a concept was existing for a long time however its application in civil engineering started in late 1980's primarily in construction activities. ANN's were found to learn from the relationships between input and output provided through training data and could generalize the output, making it suitable for non-linear problems where judgment, experience and surrounding conditions are the key features. ANNs typically comprise of 3 layers i.e input layer with input neurons, hidden layer as shown in fig 1

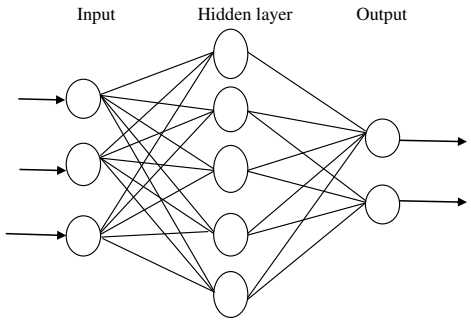

Fig 1 Input , Hidden ,Output layer

with hidden neurons and output layers with output neurons originally future prediction in construction industry has been done from the point of view of expert judgement, based on the opinion of those who are analyzing the project, the experts. There is a study that uses artificial intelligence to make a model of this expert knowledge so technology could ease the identified risks. With use of ANN even less experienced managers can make important decision related to construction site monitoring performance very efficiently.

2.CONCEPT OF ARTIFICIAL NEURAL NETWORK

Neural networks are composed of simple elements operating in parallel. These elements are inspired by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. We can train a neural network to perform a particular function by adjusting the values of the connections (weights) between elements. Commonly neural networks are adjusted, or trained, so that a particular input leads to a specific target output. Such a situation is shown below. There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically, many such input/target pairs are used, in this supervised learning, to train a network.

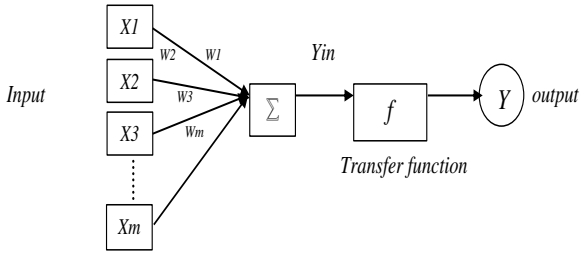

Fig 2 Flow of ANN

function the above general flow of artificial neural network, the net input can be calculated as follows

yin = x1.w1+x2.w2+x3.w3… xm. Wm

i.e., Net input yin= ∑mi xi. Wi

The output can be calculated by applying the activation function over the net input.

Y=F (yin)

Output = function net input calculated

2.1Transfer functions: A sigmoid function is a mathematical function having a characteristic "S"-shaped curve or sigmoid curve. A standard choice for a sigmoid function is the logistic function shown below:

F (x)=1/(1+e^(-x))

The input which may have any value between plus and minus infinity and the output into the range 0 to 1. The main reason for using sigmoid function is because it ranges between 0 to1. So, it is specifically used for models where it has to predict the probability as an output. Since probability of anything ranges only between the range of 0 and 1, sigmoid is the right choice. The function is differentiable. That means, the slope of the sigmoid curve can be find at any two points. The logistic sigmoid function can cause a neural network to get stuck at the training time. This transfer function is commonly used in back propagation networks, in part because it is differentiable.

F=0 then y=0.5

F>0 then y=1

F<0 then y=0

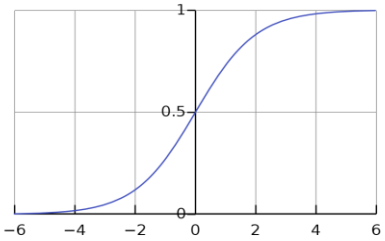

Fig 3 sigmoid function

2.2 Feed Forward ANN: A feed-forward network is a simple neural network involving of an input layer, an output layer and one or more layers of neurons. Complete evaluation of its output by revising its input, the power of the network can be observed base on group behavior of the connected neurons and the output is decided. The main advantage of this network is that it learns to evaluate and recognize input patterns. The feed forward neural network is the simplest type of artificial neural network developed. In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes and to the output nodes i.e. from input to output only. There are no cycles or loops, feedback in the network. The output of any layer does not affect that same layer in such networks. Feed forward neural networks are straight forward networks that associate inputs with outputs. They have fixed inputs and outputs. They are mostly used in pattern generation and classification.

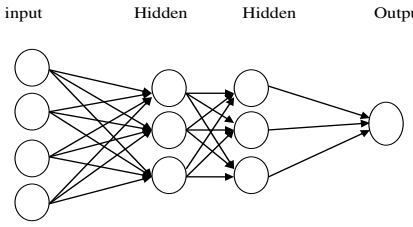

Fig 4 Multilayer feed forward neural network

2.3 The back-propagation Algorithm : Back propagation is a supervised learning algorithm, for training neural network. Information is an ANN is stored in the connection weights which can be thought of as the memory of the system. The purpose of back-propagation training is to change iteratively the weights between the neurons in a direction that minimizes the E defined as the squared difference between the desired and the actual outcomes of the output nodes, summed over training patterns and the output neurons. The algorithm uses a sample by sample updating rule for adjusting connection weights in the network. One iteration of this algorithm can be written as

x k +1= x k – αk g k

where

x k= is a vector of current weights and biases,

g k= is the current gradient.

αk= is the learning rate a training sample is presented to the network.

The signal is then fed in a forward manner through the network until the network output is obtained. The error between the actual and desired network output is calculated and used to adjust the connection weights. Basically, the adjustment procedure derived from a gradient descent method, is used to reduce the error magnitude. The procedure is first applied to the connection weights in the output layer followed by the connection weights in the hidden layer next to output layer. this adjustment is continued backward through to network until connection weights in the first hidden layer are reached. The iteration is completed connection weights in the network have been adjusted.

3. PROCESS OF METHODOLOGY

Based on the literature review, various factors have been identified which may consider while construction site monitoring at project work. All those 30 factors are identified to focus on, which generally affect performance of project on construction field. Questionnaire survey is conducted to determine the level of importance given to these attributes during making the decision. Questionnaire survey is chosen as the ideal procedure for determining level of importance of the attributes as the respondents were situated in Amravati. Questionnaires are prepared by adding the respondent profile which collects general information such as name, education, age working experience. The next set of questions is targeting the Identified Factors from construction site monitoring which affect project performance. Hence, each respondent has to answer the questions according to their understanding, knowledge and experience of that project. This simple and straight method is selected to collect the data from the construction site. Starting neural network tool, one window appears on the screen naming, select data. This is for the selection of the data from either from workspace or from collected dataset. The data was then imported to MATLAB and network formed using the nntool function. NNTOOL opens the Network window as shown in fig. 1 which allows you to import, create, use, and export neural networks and data. The network type selected for the training was feed-forward back-propagation because it is good for non-linear fittings. Trainlm was the training function adopted because it is the fastest backpropagation algorithm in the toolbox. Trainlm function updates weight and bias values according to Levenberg-Marquardt optimization. The learning functionality used was the Learngdm and this function takes several inputs. Learngdm is the gradient descent with momentum weight and bias learning function. The performance function e.g. Mean square error (MSE), the number of layers, the number of neutrons and the transfer function e.g. tansig are all selected accordingly in order to create the network. After successfully creating a network, the next step is to train the network. Training of the network was performed using the Levenberg-Marquardt backpropagation algorithm as it is very fast. For the given set of inputs, a set of targets are decided. Using the random weights, the network calculates some outputs using transfer functions (i.e logsig). The calculated outputs are compared with the targets to obtain the network error. The connecting weights are adjusted to reduce the errors using the same learning rule. a regression curve showing the relationship between the outputs and targets for training, validation and testing stages. There is an excellent correlation between the output and target datasets for the training, validation and testing stages.

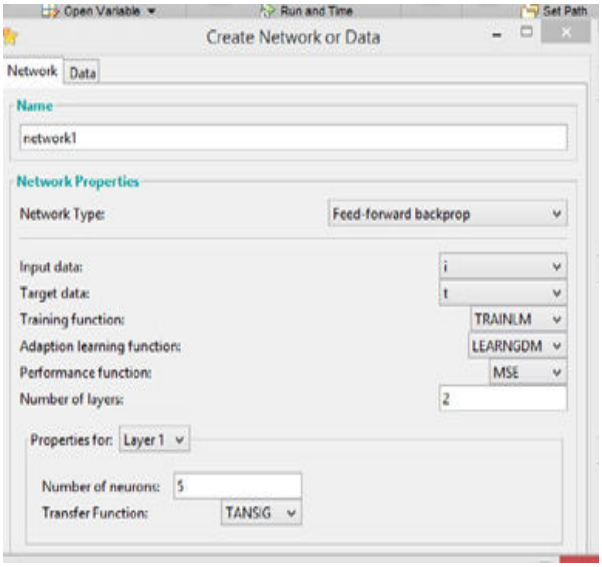

Fig 5 Typical ANN network window

After filling the necessary information train the model as shown in the fig 6

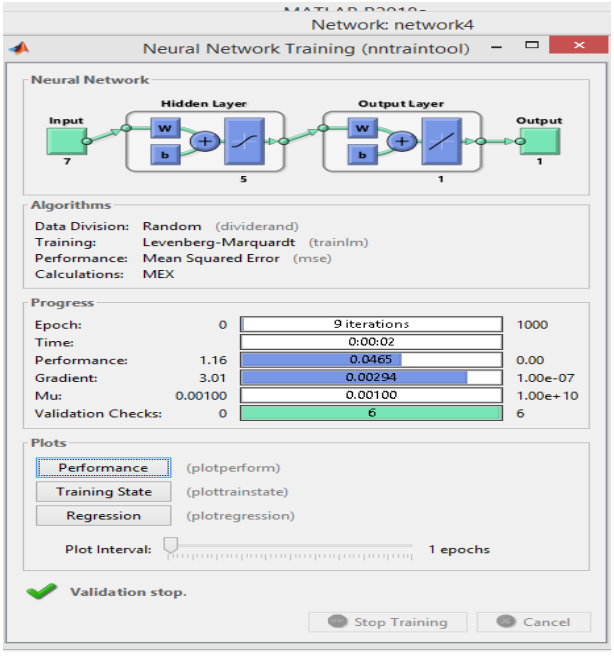

Fig 6 Training of ANN

After training the network the required results are given below.

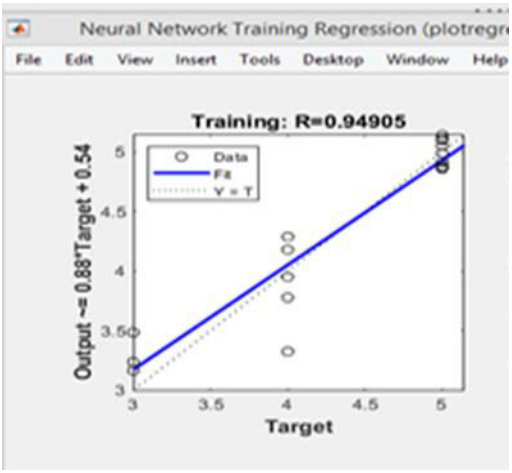

Fig 7 ANN- (1) Regression with Traning data

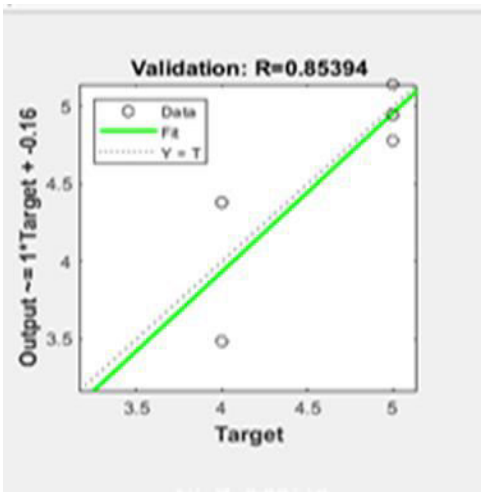

Fig 8 ANN- (1) Regression with Validation data

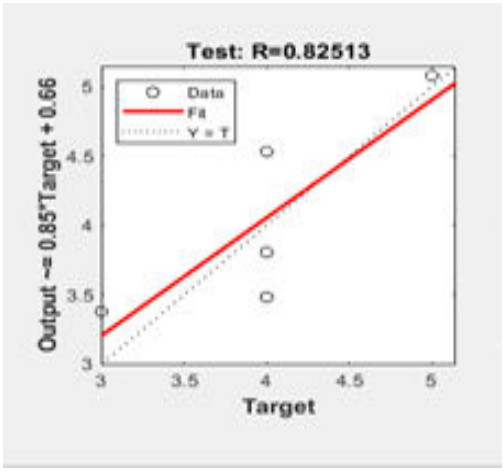

Fig 9 ANN- (1) Regression with Testing data

In case of more accurate results, retraining of the network can be carried out. Retraining the network will change the initial weights and biases of the network and may produce an improved network after retraining. The best validation performance is 0.062379 at epoch 8. As shown in fig 10

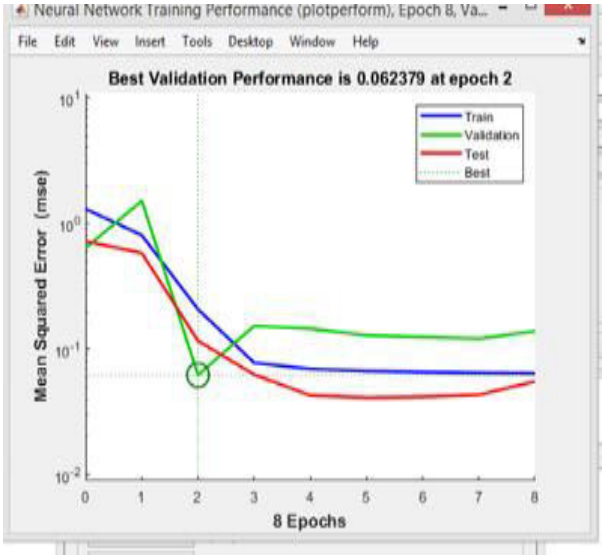

Fig 10 best validation performance

4. RESULT AND CONCLUSION

The network was decided to consist of two hidden layers with 5 neurons with feed forward back propagation network. The best validation performance is 0.062379 at epoch 8. Results are calculated for ANN- (1) the result of training, the record values of R, MSE, RMSE values are found as 0.94905,0.08065 and 0.2839 respectively. During testing, these values are found as 0.82513, 0.23642 and 0.4862 respectively. the result of validation, the values of R, MSE, and RMSE 0.85394, 0.0885 and 0.2974 from validation. As shown in following table 1 From the results, as the training R values higher and nearly closer to one and lower values of MSE and RMSE ensures good prediction. Therefore, it is concluded that the neural network model's performance is not ideal but approximate.

Table 1 Statistical Values of the ANN-(1)

Statistical Parameters	ANN-1		
	Training data	Validation data	Testing data
R	0.94905	0.85394	0.82513
Mean Squared Error	0.08065	0.0885	0.23642
RMSE	0.2839	0.2974	0.4862

For construction site monitoring prediction in the cost, schedule, quality area the predicted values are approximate to the target values.

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