PERFORMANCE COMPARISON OF MATLAB AND NEURO SOLUTION SOFTWARE ON ESTIMATION OF FUEL ECONOMY BY USING ARTIFICIAL NEURAL NETWORK

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Abstract: In the world, scientific studies increase day by day and computer programs facilitate the human's life. Scientists examine the human's brain's neural structure and they try to be model in the computer and they give the name of artificial neural network. For this reason, they think to develop more complex problem's solution. The purpose of this study is to estimate fuel economy of an automobile engine by using artificial neural network (ANN) algorithm. Engine characteristics were simulated by using "Neuro Solution" software. The same data is used in MATLAB to compare the performance of MATLAB is such a problem and show its validity. The cylinder, displacement, power, weight, acceleration and vehicle production year are used as input data and miles per gallon (MPG) are used as target data. An Artificial Neural Network model was developed and 70% of data were used as training data, 15% of data were used as testing data and 15% of data is used as validation data. In creating our model, proper neuron number is carefully selected to increase the speed of the network. Since the problem has a nonlinear structure, multi layer are used in our model.

1. Introduction

Since the advent of the diesel engine over a century ago, a huge number of research studies have been conducted to improve the engine performance, decrease the engine fuel consumption and reduce the unwanted exhaust emissions. The oil crisis of the 1970s accelerated the interest of using alternative fuels for diesel engines although diesel fuel has remained as the main fuel [1].

ANN technique has been used for modeling the performance of various thermal systems [2−5]. Recently, ANNs have been applied to estimate various performance parameters of internal combustion engines. This approach was used to predict the performance and exhaust emissions of diesel engines [6,7]. Several studies may be found in different areas of science making use of artificial neural-network [8]. The ANN approach has been applied to predict the performance of various thermal systems. [2]

In this study of a work already in Neuro Solution program using data on fuel economy with the help of Matlab NNTOOL convergence has been made.

2. Modeling with the ANN

Engine characteristics as the number of cylinders, displacement, power, weight, acceleration and vehicle production year and a miles per gallon (MPG) values as data is used. 70% of the data are the training data values, 15% are the test data and the rest are validation data. Training for data entry in the matlab environment can be transferred after transpose "input" will be saved with the name. Same target values in the "target" will be saved with the name. Test data input and target values "test_input" and "test_target" names, validation of data input and target values "validation_input" and "validation_target" is saved as. In this study, type of network as feed-forward back prop, education function trainlm as the performance criteria used as the MSE, and this was accepted as constant parameters. Experience and experimentation has been identified as 3, after the number of layers. One will be used between layers of neurons and activation function is the selection of.

The architecture of the ANN for the engine with the input and output parameters is schematically illustrated in Fig.1. The input layer has six neurons corresponding to the three input parameters: cylinder numbers, displacement, engine power, engine weight, acceleration and distance with one-gallon fuel. The number of neurons must be considered in selection. Increase in the number of neurons slows down the neuronal network. This is why we try to capture the optimum number of neurons.
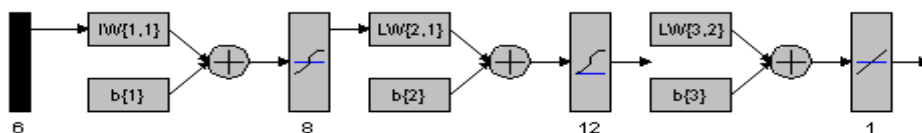

Fig.1. Structure of the ANN for modeling the test

The performance of an ANN model is noticeably affected by the number of hidden layers and the number of nodes in each hidden layer. By trial and error with different ANN configurations, the optimal number of hidden layers and that of neurons in the hidden layer were selected as one and five, respectively. The activation function in the hidden and output layers was chosen as hyperbolic tangent sigmoid function.

In order to develop an ANN model for the engine, experimental data was divided into training data, test sets and validation data. While 70% of the data set was randomly assigned as the training set, the remaining 15% was employed for testing the performance of the ANN predictions. The input vectors with three variables and their corresponding target vectors with six variables in the training set were presented to the network for training it in three separate groups.

The training set of each group consisted of 63 input-output pairs, corresponding to 70% of the data set containing the results of 20 tests in each group. Using the training process was terminated when the maximum number of epochs was exceeded or the performance goal was met. Finally, the input vectors from the test data set were presented to the trained network and the network predictions were compared with the experimental outputs for the performance measurement.
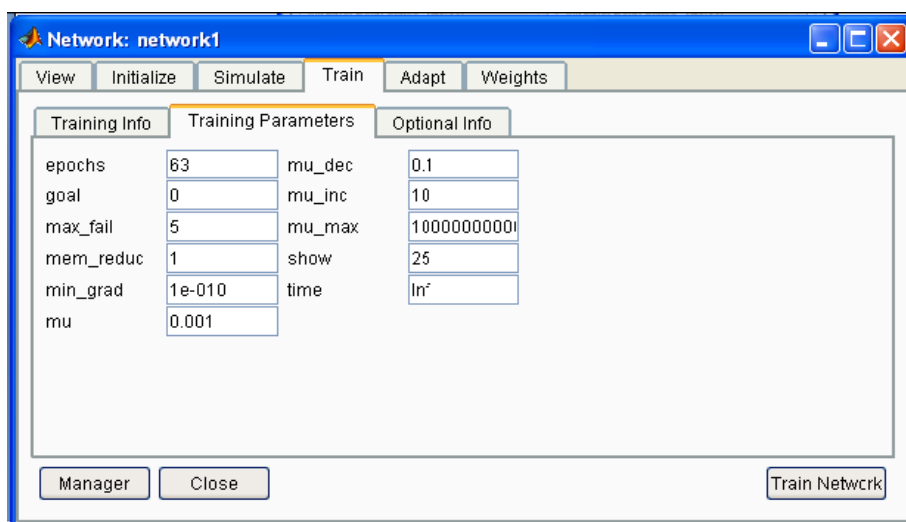

Fig.2. Training parameters are entered

The test data set contained 6 input-output pairs for each group, corresponding to the 15% of the data set containing the results of 63 tests in each group. The computer code for training the ANN and measuring its performance was implemented under MATLAB environment.
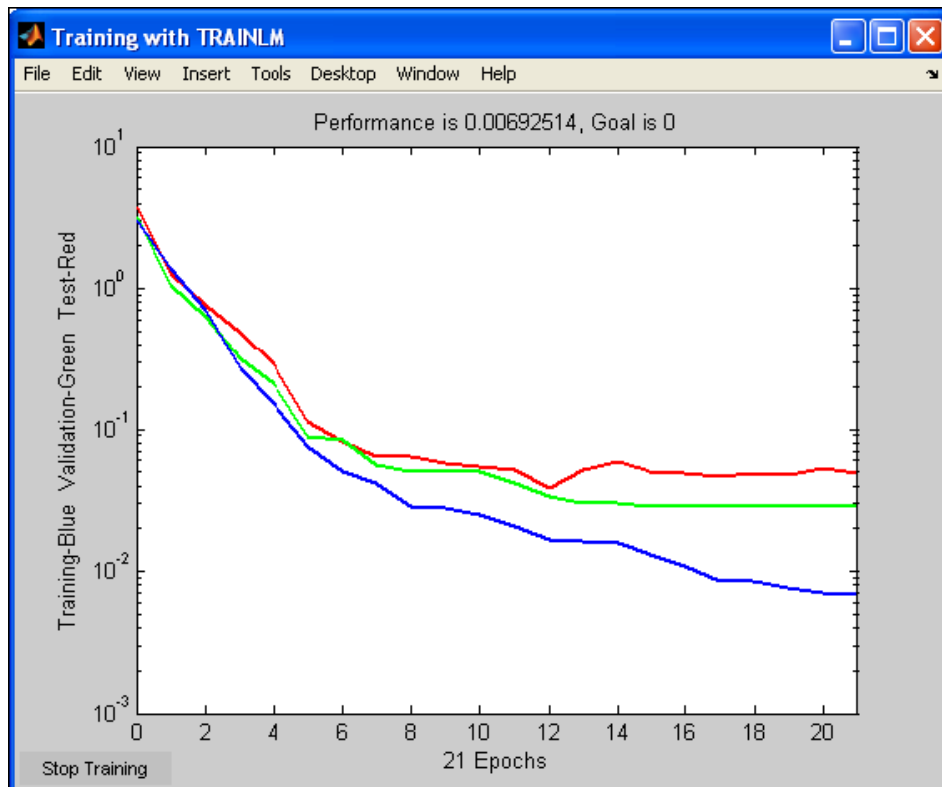
Fig.3. Network error values in Matlab

Under the training curve of Figure 3 test curves that are seen as having less value error. The above network has a problem such as going to memorize. The error in the program for solution of neuron 2.33601×10^{-4} obtained better results have been obtained (Figure 4).
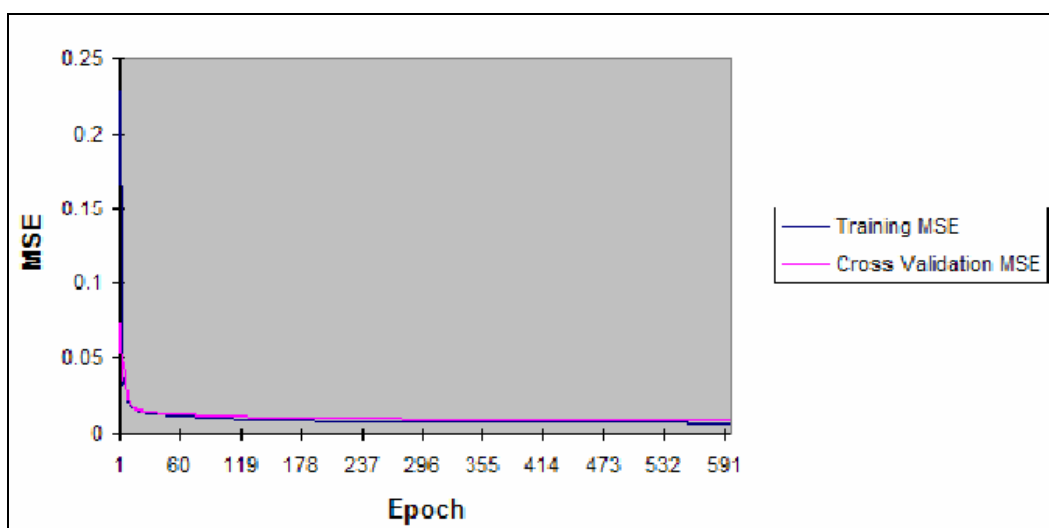

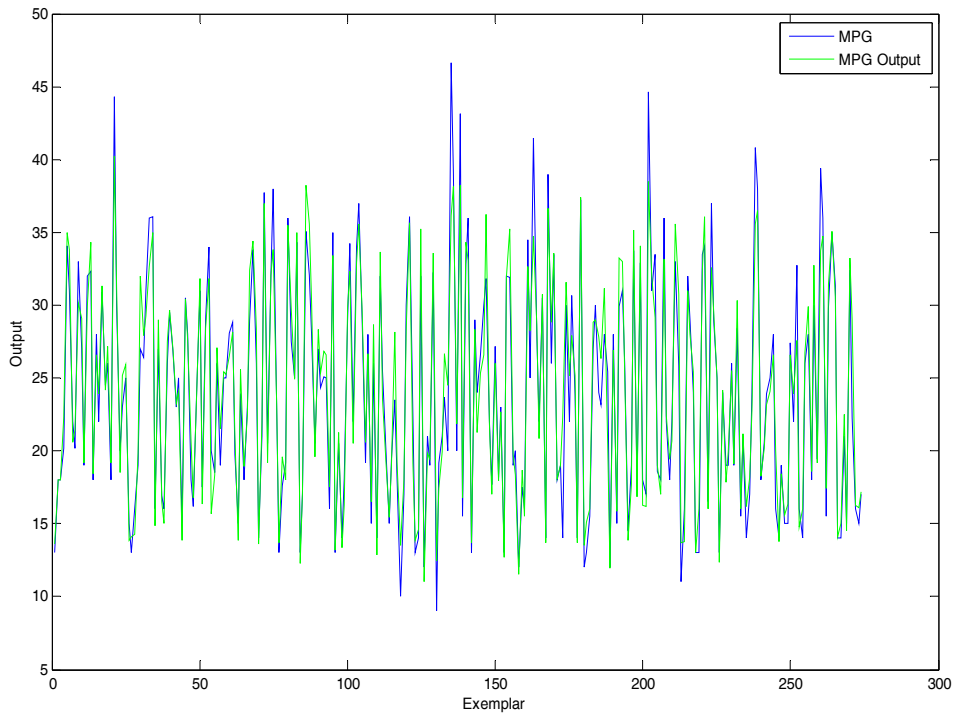Fig.4. Network error values in Neuro Solution

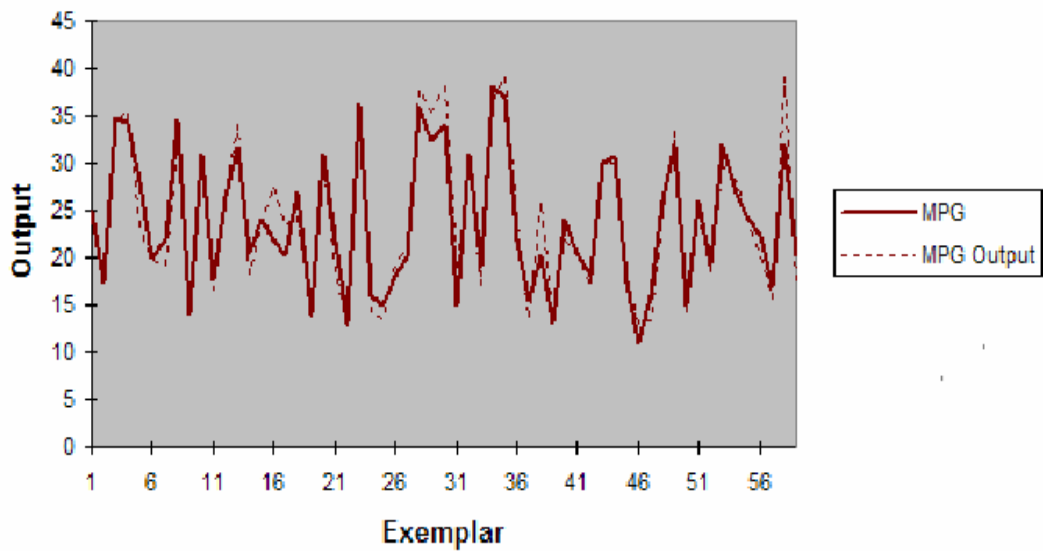Fig.5. Desired output and actual network output in Matlab

Fig.6. Desired output and actual network output in Neuro Solution

As seen in Figure 5 and figure 6 desired values are reached but some peak points couldn't be reached. It is not possible to reach actual values one to one. Purpose is to reach for the nearest target. This data set excluded from the next peak value is considered, as seen in Figure 7 result in suspension of the target value has been opposed.
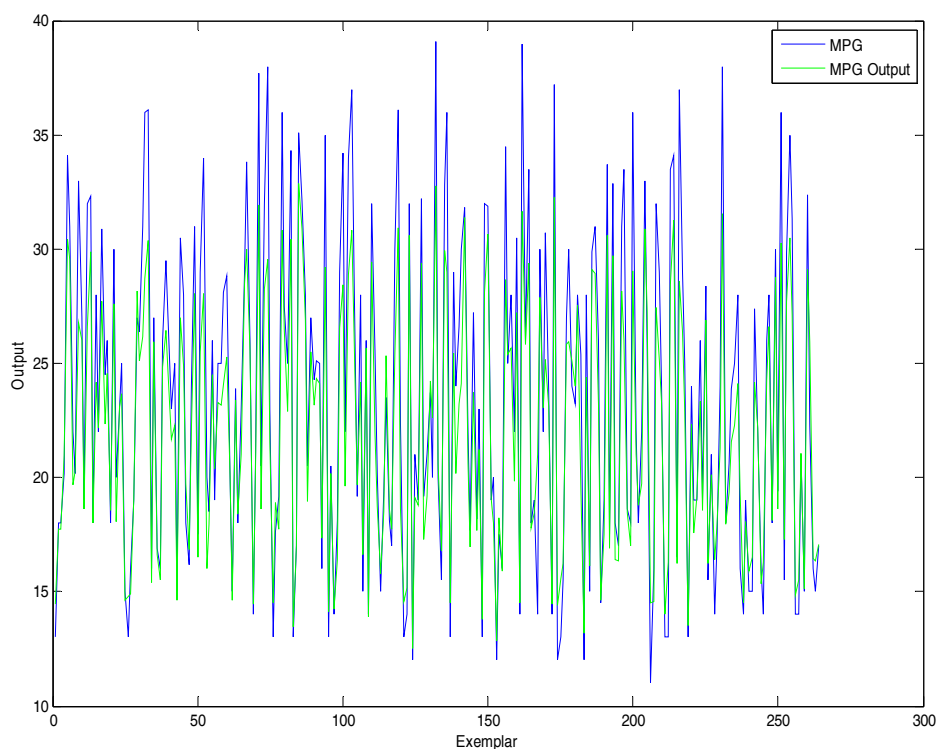
Fig.7. Desired output and actual network output in Matlab after deleted peak values

The ANN is trained, any data input from outside the training set according to the values to generate output. This process is called simulation. During the simulation normalized inputs are simulated in ANN. Be obtained from the value for normalizing the output value will be converted back to normal values are obtained. The following section shows how to make the simulation process:

input(:,275)=[8;302;139;3570;12.8;78];

a=premnmx(input);

b=sim(network1,a);

c=postmnmx(b,mintn,maxtn);

result=c(:,275)

result = 19.3208   (in Matlab)

result= 20.2 (in Neuro Solution).

Final result have been obtained in Neuro Solution

3. Results and Discussion

Comparisons between the ANN-predicted and experimental output parameters of the engine are shown in Figs 1–7. The comparisons in all graphics were made using data only from the test set, which was not introduced to the ANN during the training. In this work we show that ANN can be trained with engine characteristics and target MPG values. Here, we trained ANN to simulate the data set from outside the engine to the engine characteristics by estimating the MPG.

Acknowledgement

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