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Target Classification: An application of Artificial Neural Network in Intelligent Transport System

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Abstract- **This paper deals with classification of different types of targets (vehicles) in Intelligent Transport System, MATLAB (version 7.9) is used here as the simulation platform and Supervised Artificial Neural Network is used as the soft computing tool for classification, here targets are classified on the basis of returned energy to the Radar or Radar Cross Section (RCS) values taken at different aspect angles.**
Keywords- **Classification, Intelligent Transport System (ITS), Radar Cross Section (RCS), Artificial Neural Network (ANN), Matlab**

I. INTRODUCTION

Accident avoidance is the main objective in ITS, to achieve this goal classification of different types of targets are necessary and provide this information to whole transport system. So that every target (vehicle) can be able to know that which type of vehicle precedes or recedes it. Classification task of different types of targets is achieved by considering a unique feature which is common to all the targets to be considered for classification. When different types of targets are exposed to radar in the transport system then for each frequency and aspect angle from the radar there is a RCS value for each of the target and these RCS values are different for different targets at the same frequency and aspect angle. These RCS values of the targets received in the radar receiver are considered here as the unique feature for classification.

Rest of the paper is organized as follows: in section II, how data are collected for classification, in section III, Pre-processing of data is shown, in section IV, Result analysis is given and section V, concludes the paper

II. DATA COLLECTION

For classification we have considered here four types of targets (vehicles), they are

1. Light Vehicle
2. Van
3. Truck
4. Bus

Side views of the above targets are shown below,

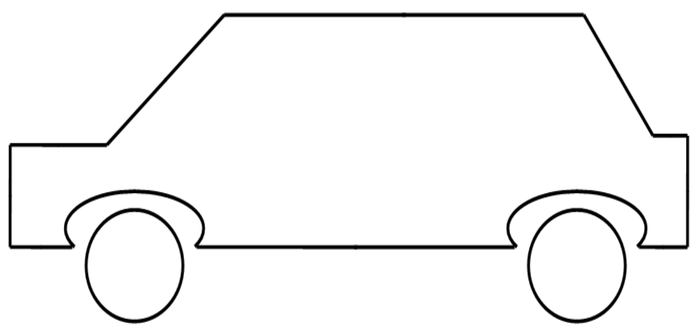

Figure 1. Light Vehicle

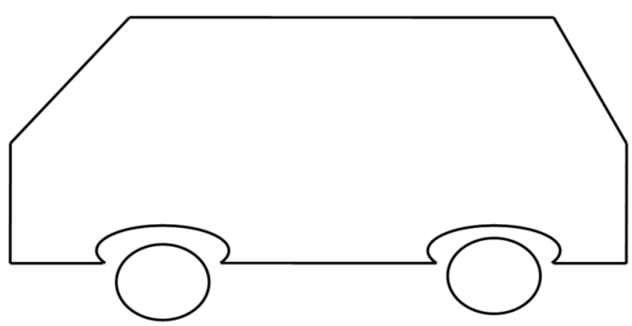

Figure 2. Van

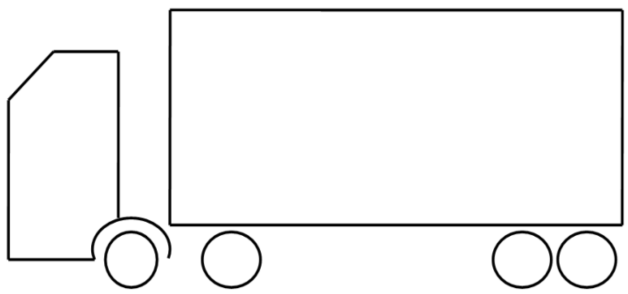

Figure 3. Truck

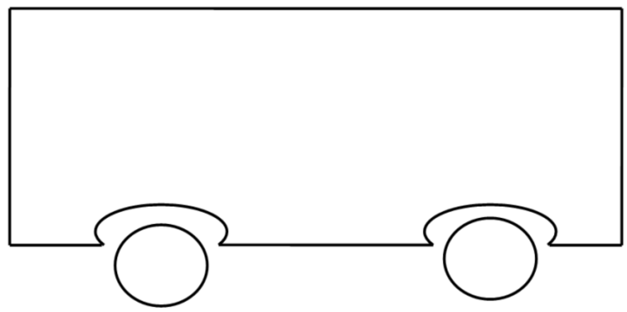

Figure 4. Bus

Using the above four figures RCS values at different aspect angles and frequencies are simulated in the MATLAB,for each target twenty different values of aspect angles in the range of 1 to 10 radian and twenty different values of frequencies in the range of 22 to 29 MHz(short range radar frequency range) are taken under consideration to collect the RCS values of those targets. So by this process we had total eighty numbers of RCS values which were fed to the neural network classifier as the input parameters. Now for the targets or desired values for the classifier we have assigned four real numbers in the range of (-1 & +1) to the four different targets, like

Light Vehicle $\rightarrow$ -0.25
Van $\rightarrow$ -0.5
Truck $\rightarrow$ 0.25
Bus $\rightarrow$ 0.5

Network Parameters	Corresponding Data
Learning rate	0.1
Epochs	261
Error goal	10^{-6}
Overall Correlation coefficient 'R'	0.99697
Hidden Layer activation function	Tan sigmoid
Output Layer activation function	Linear

These above values are arranged in a vector in such a way so that target values of a particular vehicle in the target vector should be in the same position of its corresponding RCS values in the Input vector.So, finally I had

Input to the classifier $\rightarrow$ 1×80 vector of RCS values.

Target to the classifier $\rightarrow$ 1×80 vector of real numbers within the range of (-1 & +1)

III. DATA PRE-PROCESSING

Pre-processing of input or training data includes normalization of the data within a specific range as the values in the input vector are large enough (in the range of $10^4 m^2$ to $10^6 m^2$), it may increase the complexity of the classifier. So it is preferable to normalize the data in the input vector to make the data of input vector in a small range, There are many statistical data normalization methods available which can be applied to ANN Classification, here the equation used for the normalization is given below,

$$D = \frac{D_{current-value}}{D_{\max}}$$

Where,

$D_{current-value}$ $\rightarrow$ it is the element of input vector at a particular instant.

$D_{\max}$ $\rightarrow$ maximum value of elements in the input vector.

IV. RESULT ANALYSIS

We have presented here the results using two functions in the Neural Network toolbox, they are

1. .newff
2. newpr

Both are using Back-propagation as their learning algorithm.
To classify with "newff" function we have taken one neuron for input and four neurons for output layer and two hidden layers, both of which consist of twenty-five neurons. So the structure of the network with respect to the layers is [1 25 25 4].
Table below shows the network parameters after training (using **newff** function)

Table 1. Network parameters and data for newff function

Performance Plot

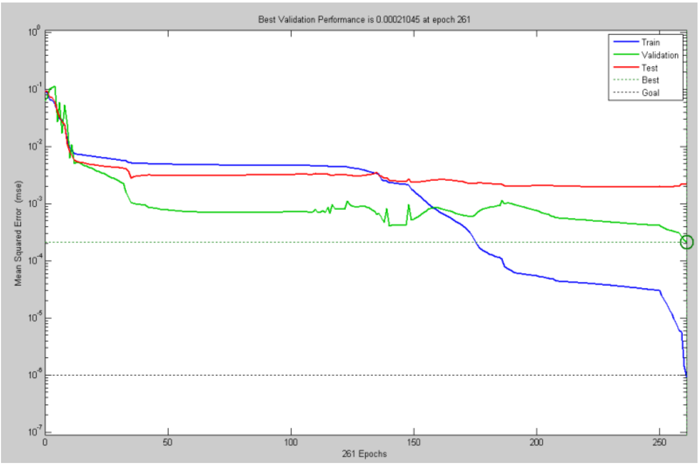

Figure 5. Performance Plot using newff function

Regression Plot

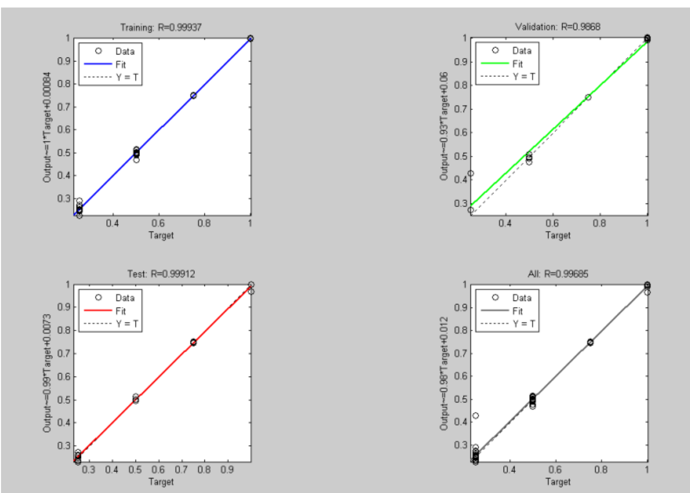

Figure 6. Regression Plot using newff function

From the Performance plot it is clearly seen that error-goal (blue colored line) is reached during training at 261 epochs.

Regression Plot is to perform a linear regression between the network outputs and the corresponding targets, from the Regression plot it is clearly seen that the output tracks the targets very well for training, testing, and validation, and the R-value is over 0.99697 for the total response.

To classify with "**newpr**" function we have one neuron for input and four neurons for output layer and two hidden layers, consisting of fifty-five and thirty-five neurons respectively. So the structure of the network with respect to the layers is [1 55 35 4].

Table below shows the network parameters after training (using **newpr** function)

Network Parameters	Corresponding Data
Learning rate	0.1
Epochs	9968
Error goal	10^{-4}
Hidden Layer activation function	Tan sigmoid
Output Layer activation function	Tan sigmoid

Table 2. Network parameters and data for newpr function

Performance Plot

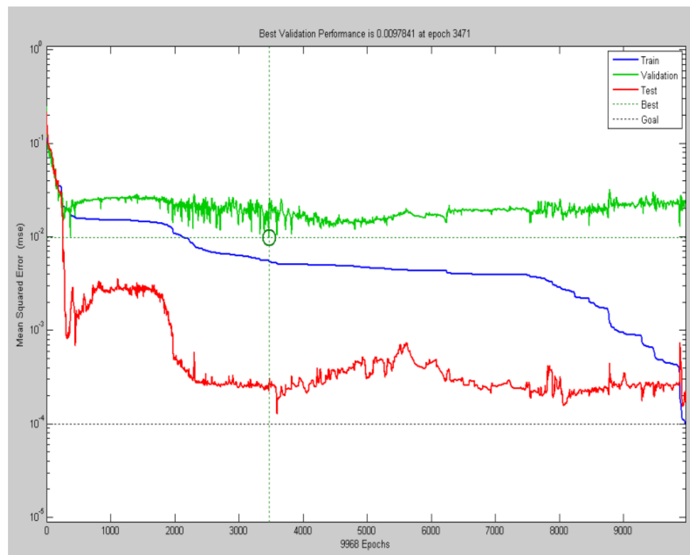

Figure 7. Performance Plot using newpr function

From the Performance plot it is clearly seen that error-goal (blue colored line) is reached during training at 9968 epochs.

Confusion Plot states that the diagonal cells in each table show the number of cases that were correctly classified, and the off-diagonal cells show the misclassified cases. The blue cell in the bottom right shows the total percent of correctly classified cases (in green) and the total percent of misclassified cases (in red). The results for all three data sets (training, validation, and testing) show very good recognition and overall classification accuracy is 98.8%.

Confusion Plot

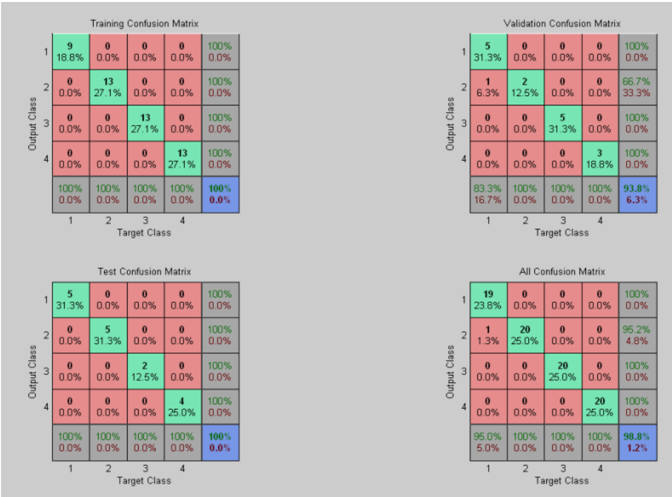

Figure 8. Confusion Plot using newpr function

V. CONCLUSION

This paper approached to classify four different types of vehicles using the concepts of Supervised Artificial Neural Network, From the Regression plot and confusion plot, it can be clearly concluded that four types of different targets are classified correctly. and for classification using 'newpr' function is more GUI friendly than classification using 'newff' function.

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