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An Optimized Way to Deliver Goods by Using Multilayer Artificial Neural Network Model

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Abstract: This paper provides way to understand the use of Multi-layer Artificial Neural Network (MANN) Model for getting vehicles flow prediction and finding optimum path to deliver goods based on the vehicles flow data during limited time period. In this manuscript, we design someMulti-layer Artificial NeuralNetwork Model with average speed of vehicles, number of vehicles running on road, time, density of vehicles, day, number of dumb vehicles on the road and many other variables as input variables. We can take some other conditions which are not used in previous studies. Several conditions will not easily predict like behavior of driver, sudden road blockage, rainy seasons, festivals demand and etc. We can observe the least density of vehicles on the road then the vehicle driver selected best predicted way for delivery of the goods. The route of vehicle is decided according to the reliable and high-quality result of Multi-layer Artificial Neural Network Model.

Keywords– Artificial Neural Network, vehicle flow data, data prediction, MATLAB, ANN Tool.

1. Introduction:

At the present time, all world are facing the problem of heavy rush on the road. India is also facing such problem. In india, serveral organization having very shortage of labour. India has very limited resourses like every developing country. So the transportation problem becomes very major problem in such countories. At this time, there are huge rush of vechicles on the road then the chances of several accidents happen may be increase. This is the main reason of blockage of roads. The main aim of this paper is to find out the best predictive route for vechicles from origin to destinations. Most of the cities of India are faced mixed traffic rush because there are several type of vehicles present on the road with mixed speed. Different vehicles have different speed on the road. In the cities, traffic congestion is very big issue for any organization. For solving such problem, it must be deliver timely and very accurate information about the traffic to the drivers. On the baisic these information, the drivers will select the route for delivery of the product.

2. Literature Review:

In this section, we explain the literature review of MANN models for Transportation Problems:

A research paper on finding Route and Destination Prediction in Intelligent Transport SystemsUsing Neural Networks represented by Thomson J. et. al.[1] in 2014. In this paper, the author said that intelligent transport system missed some important part like prediction for route

and destination based on the past routes. The information related to the past routes is very useful for traffic congestion, traffic control, upcoming traffic ratio and etc. when a car is running on the road and we can predict the future location of that car then we can manage the traffic congestion. According the author, GPS and Google Map are best applications which provide a good data source for users and also discussed several algorithms and methods for predicting route based on the past route information.Bugday E. et. al. [02], 2018, represented a research paper on Predicting forest road network Suitability Mapping using various Applications of Artificial Neural Network System based on ANFISusing GIS. In this paper, the author described about the different factors which effects the planning of forest road networks. It is very necessary to support the maker who take the decision, consider the best suitable criteria for the process of planning of making roads in forest areas. They explain something about the Forest Management Chief which is the smallest unit in Turkey. This unit evaluated the nine criteria affecting the planning of forest road network by using Geographic Information System (GIS) and Adaptive Network Fuzzy Inference System (ANFIS) and also developed six distinct forest road network models. The important point is that the AUC value of these six models is between 0.654 and 0.845. The most factors used in development of models can be utilized by the decision makers. Sustekova D. et. al. [2], 2013, presented a research paper on "Artificial Intelligence Applications especially the neural networks use in the road transport". In this paper, the author explains all possible use of neural networks and lots of extension of artificial intelligence in each and every possible field like transport, pattern recognisation and also explains about the recent application using Artificial Intelligence (AI) for the road transportation efficiency. Artificial intelligence equipments and their capability are suitable for problematical transportation systems. In point of fact, artificial neural networks may be explained as considerable related computing system release to decrease and following implementation of information while simulating human brain finding data for the phase of learning process and storing of such data using inter neural relations. Neural networks are generally usefulness approximator. In present time, many problems are not having identified functions. So neural networks developed very fastly because it only handles such type of problems. But the main disadvantage of neural networks is that it required very huge hardware support and also learning course of action may get hold of very much extensive time.A research paper on Route prediction using trip observations and map matching represented by Arya A. et. al. [8]in 2013. In this paper, they usedsome special location data traces (LDT)likes Mobile Signals,GPS etc. of their past trips of vehicles to builda specific algorithm for predicting the route of that vehicle. They are mainly focus on route prediction, not predicting road segments. Past researches for route prediction use for raw LDT and decomposed of data into short term trips for route predictions. They introduced a further step to alter the trips decomposed of LDT points to road network edges. For this, an algorithm requires to use of road networks. This paper shows that the effectiveness in storage capacity and time complexity achieved without losing the accuracy. Therefore, LTD has inbuilt less accuracies due to limitations of hardware devices. This paper represents the results of algorithm for prediction of routefor the data.

3. Data Collection and Analysis:

Due to limited time, we may get very small data set related to research. For getting data, we used some video cameras which are planned on the National Highway. Data were collected. We selected four data points on different routes for getting data on national highway between 10:00 AM to 11:00 AM for one week like Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday. NH-24 becomes six lane Highway so recently construction work continue on it. After some years, this Highway will become 8 lane Highway. Several flyovers are constructing very fast. We develop 01 data set for half hours on each data point per day on different route. Some data sets develop per day on both data points. Finally we get some data sets for one week. Now, we analysis these videos very deeply then divided the rush of vehicles in 15 categories like Trucks with different tires, Bus, Jeep, Cars, Bikes, Scooters, cycles, auto riksha with battery, auto riksha with CNG/Petrol, loaded Tractors, unloaded Tractors, Riksha with riksha pooler (Human), vehicles with using animals, road roller, JCB machines. We assume speed of each category of vehicles according to the entry and exit time of vehicles in videos using distance cover in video 30 meter. After that find the average speed of every vehicle and volume of the traffic is assumed that simply counting the numbers of the vehicles passed in the video. We also generate data setwhich contains approximate 2000 samples data.

S. No.	**Name of Vehicles**	**Approximate Speed**							
		Route-1		**Route-2**		**Route-2**		**Route-2**	
		Min. Speed	**Max. Speed**	**Min. Speed**	**Max. Speed**	**Min. Speed**	**Max. Speed**	**Min. Speed**	**Max. Speed**
1	Trucks with different tires	30	70	20	50	35	60	30	50
2	Bus	40	65	35	60	40	65	40	65
3	Jeep	55	80	50	70	40	60	55	80
4	Cars	50	90	50	80	40	60	50	90
5	Bikes	45	70	45	60	45	65	45	70
6	Scooters	35	60	35	50	35	55	35	60
7	Cycles	10	15	10	12	08	10	12	15
8	Auto riksha with battery	15	25	15	20	15	20	15	25
9	Auto riksha with CNG/Petrol	35	50	30	50	35	40	35	50
10	Loaded Tractors	35	45	30	45	35	40	35	45
11	Unloaded Tractors	40	70	30	70	40	60	40	70
12	Riksha with riksha pooler (Human)	10	20	08	15	10	12	10	20
13	Vehicles with using animals	04	08	03	06	02	04	04	08
14	Road roller	05	15	04	10	05	10	10	20
15	JCB machines	25	35	20	40	30	40	15	40

Table-1: Approximate minimum and maximum speed of various vehicles in both directions

S. No.	Name of Vehicles	Approximate Volume							
		Route-1		Route-2		Route-2		Route-2	
		Min. no. of vehicle	Max. no. of vehicle	Min. no. of vehicle	Max. no. of vehicle	Min. no. of vehicle	Max. no. of vehicle	Min. no. of vehicle	Max. no. of vehicle
1	Trucks with different tires	20	70	25	50	16	80	20	80
2	Bus	10	50	12	40	06	50	12	50
3	Jeep	10	18	11	10	08	20	15	20
4	Cars	40	100	45	80	20	90	45	60
5	Bikes	50	120	55	80	50	70	55	90
6	Scooters	30	60	20	50	40	60	15	50
7	Cycles	10	30	05	20	15	30	00	20
8	Auto riksha with battery	20	30	22	20	25	30	00	20
9	Auto riksha with CNG/Petrol	35	55	20	35	45	55	10	45
10	Loaded Tractors	40	60	30	40	44	60	10	50
11	Unloaded Tractors	20	30	20	25	25	30	10	20
12	Riksha with riksha pooler (Human)	01	10	01	11	01	10	00	10
13	Vehicles with using animals	05	10	05	12	03	10	00	10
14	Road roller	02	04	01	03	00	02	00	04
15	JCB machines	02	04	00	02	00	04	00	04

Table-2: Approximate minimum and maximum volume of various vehicles in both directions

4. Artificial Neural Network Model:

We use Multi-layer Artificial Neural Network (MANN) model. It is used for the data prediction of traffic flow. We use two hidden layers in this model. Some data sets used for analysis purposes. Every data set contains 37 characteristics that is average speed of fifteen vehicles,

number of fifteen vehicles, day, time, density of vehicles, dump vehicles, total traffic flow, average speed of vehicles. In our model, we use total traffic flow, average speed of vehicles, time as a input data and density of vehicles as output. We can use some initial name to each characteristic like Number of Trucks with different tires as NTT, Number of Bus as NB, Number of Jeep as NJ, Number of Cars as NC, Number of Bikes as NBI, Number of Scooters as NS, Number of Cycles as NCY, Number of Auto riksha with battery as NAB, Number of Auto riksha with CNG/Petrol as NACN, Number of Loaded Tractors as NLT, Number of Unloaded Tractors as NUT, Number of Riksha with riksha pooler (Human) as NRP, Number of Vehicles with using animals as NVA, Number of Road roller as NRR, Number of JCB machines as NJCB, Average Speed of Trucks with different tires as ASTT, Average Speed of Bus as ASB, Average Speed of Jeep as ASJ, Average Speed of Cars as ASC, Average Speed of Bikes as ASBI, Average Speed of Scooters as ASS, Average Speed of Cycles as ASCY, Average Speed of auto riksha with battery as ASAB, Average Speed of auto riksha with CNG/Petrol as ASAC, Average Speed of loaded Tractors as ASLT, Average Speed of unloaded Tractors as ASUT, Average Speed of Riksha with riksha pooler (Human) as ASRP, Average Speed of vehicles with using animals as ASVA, Average Speed of Road roller as ASRR, Average Speed of JCB machines as ASJCB, Day as D, Time interval as T, density of vehicles as DV, dump vehicles as DUV, total traffic flow as TTF, average speed of vehicles as ASV. We know that there is no restriction on the number of input and output variables in Artificial Neural Network modeling. Presently, there is no general methodology to design the MANN architecture. In this, we can find the minimum density of vehicles on the road. Then the drivers select such road. For this, we can develop MANN model with different number of hidden neurons and also trained with the training data. We use MATLAB software for training and testing of the data. Firstly, we divide the datasets in to two parts with ration 70% and 30%, first part is used for training of first 40 minutes data and second part is used for testing of last 20 minutes data. So, 236 and 100 datasets are used for training and testing of the data for MANN model. After this process, we will measure the performance of MANN model with minimum testing error and different number of hidden neurons. If we got the model with suitable number of hidden neurons then such model apply on the special dataset A which having large number of sample data with random time interval.

This is MANN Architecture:

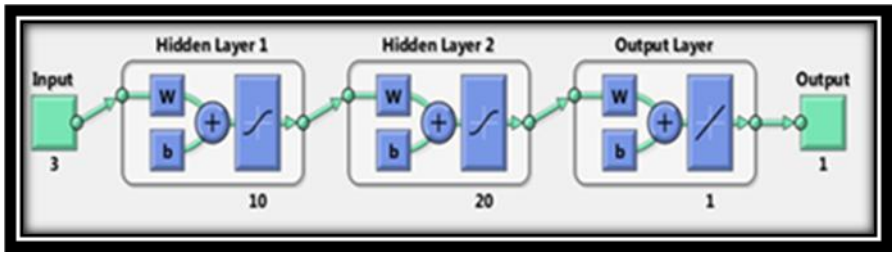
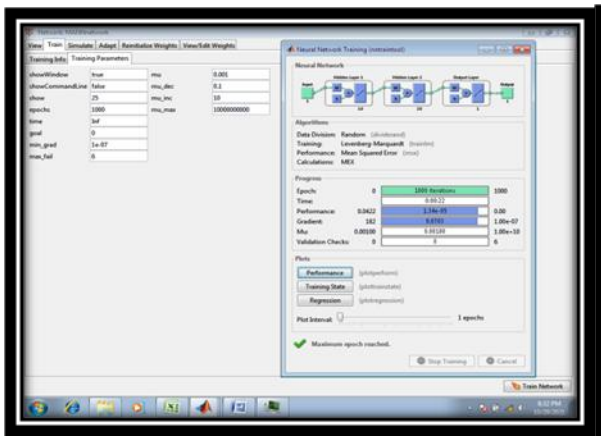


Fig. 1: Multilayer Artificial Neural Network Architecture

5. Result and Discussions:

(a) MANN Model Training Process: we use trainlm() function to train our model.



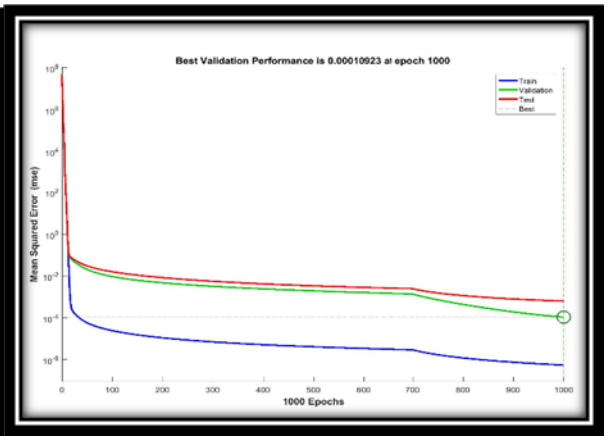
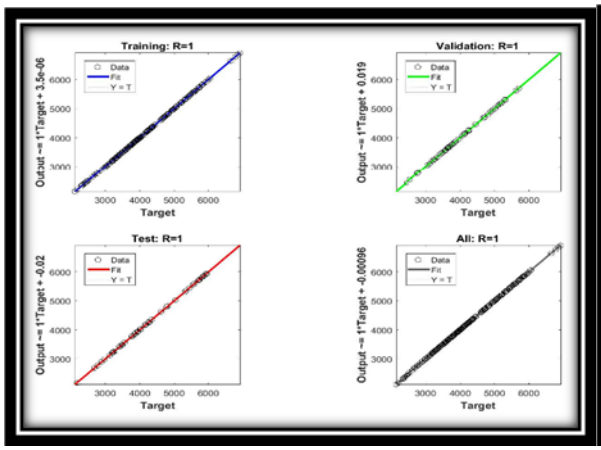


Fig. 02: MANN Training Process Fig. 03 : Training Process Performance Graph



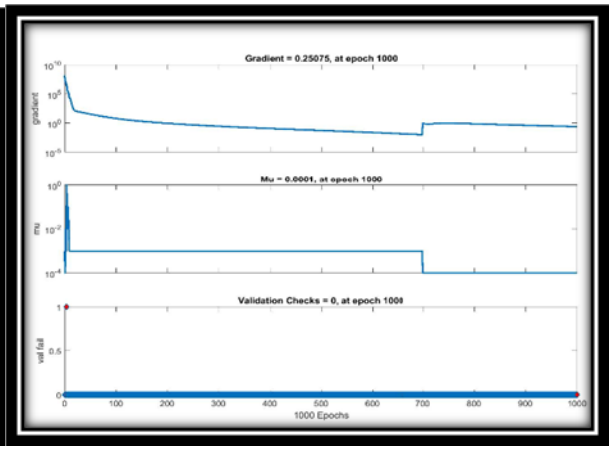
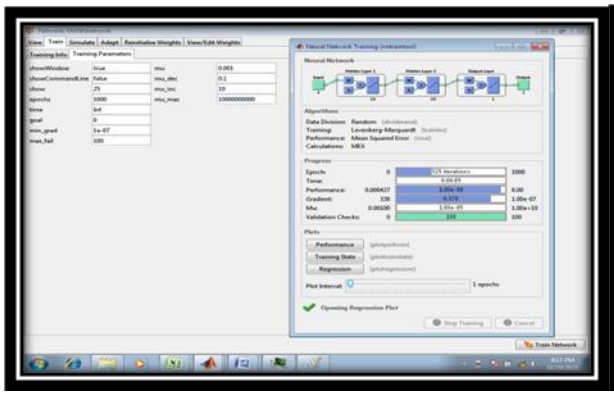


Fig. 04 : Regression GraphFig. 05 : Training State

(b) MANN Model Testing Process: we start the testing of our model with the datasets.



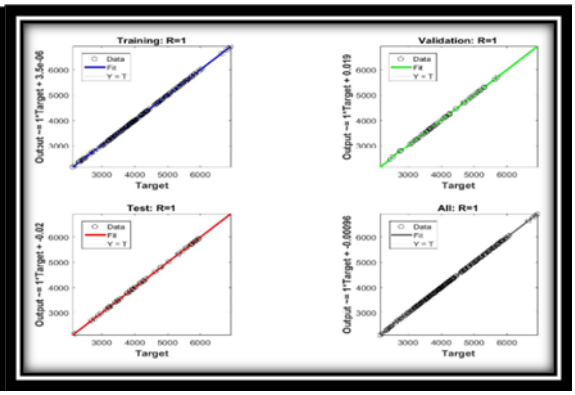


Fig. 06 : Training State Fig. 07 : Regression Graph

The detail of multi-layer artificial neural network model with various parameters is given below:

In Train-1: There is 2 numbers of Hidden layers, 10 numbers of hidden neurons for first layer and 20 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000

number of cycles, 100 number of testing or checking datasets used. Then we get 0.0045 as training root mean square error and 0.01945 as testing error.

In Train-2: There is 2 numbers of Hidden layers, 110 numbers of hidden neurons and 120 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0053 as training root mean square error and 0.03225 as testing error.

In Train-3: There is 2 numbers of Hidden layers, 120 numbers of hidden neurons and 130 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0124 as training root mean square error and 0.03532 as testing error.

In Train-4: There is 2 numbers of Hidden layers, 140 numbers of hidden neurons and 150 numbers of hidden neurons for second layer, 336numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0332 as training root mean square error and 0.04233 as testing error.

In Train-5: There is 2 numbers of Hidden layers, 145 numbers of hidden neurons and 148 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0253 as training root mean square error and 0.02925 as testing error.

In Train-6: There is 2 numbers of Hidden layers, 160 numbers of hidden neurons and 170 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0458 as training root mean square error and 0.04278 as testing error.

In Train-7: There is 2 numbers of Hidden layers, 180 numbers of hidden neurons and 190 numbers of hidden neurons for second layer, 336 numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0622 as training root mean square error and 0.04426 as testing error.

In Train-8: There is 2 numbers of Hidden layers, 185 numbers of hidden neurons and 190 numbers of hidden neurons for second layer, 336numbers of training datasets, 1000 number of cycles, 100 number of testing or checking datasets used. Then we get 0.0753 as training root mean square error and 0.04827 as testing error.

According to the performance, artificial neural network model with 145 hidden neurons and minimum testing error provide the best prediction route.

The following graphs (Fig. 08 and Fig. 09) show that our MANN Model provides the minimum training root mean square error and testing error on train number 05.

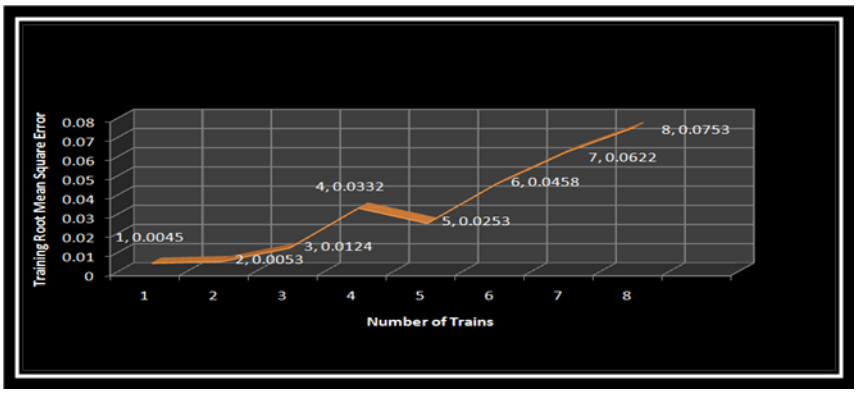


Fig. 08: Comparison Graph between TRMS error and no of trains for MANN Model

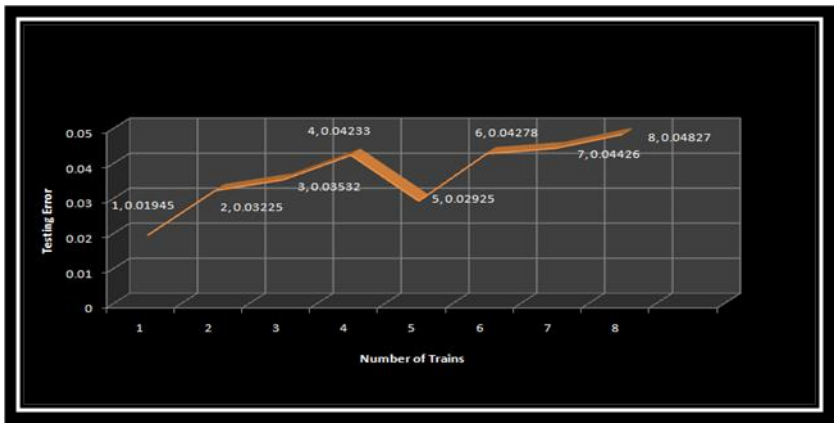


Fig. 09: Comparison Graph between Testing error and no. of trains for MANN Model

Now, we use our MANN model with dataset. First of all, we use some sample data as training and some sample data as testing of dataset A.

First of all, we take 100 sample size then we get 100 percentage performance of training data set and only 40 percentage performance of testing data set. In this process, execution time of sample data set is 0.98 sec and training time of data set is 8.35 sec.

Again, we take 200 sample size then we get 99.42 percentage performance of training data set and only 42 percentage performance of testing data set. In this process, execution time of sample data set is 1.01 sec and training time of data set is 9.03 sec.

Again, we take 400 sample size then we get 98.63 percentage performance of training data set and only 46.50 percentage performance of testing data set. In this process, execution time of sample data set is 1.20 sec and training time of data set is 10.21 sec.

Again, we take 500 sample size then we get 98.25 percentage performance of training data set and only 62.60 percentage performance of testing data set. In this process, execution time of sample data set is 2.03 sec and training time of data set is 13.88 sec.

Again, we take 800 sample size then we get 97.93 percentage performance of training data set and only 70.56 percentage performance of testing data set. In this process, execution time of sample data set is 2.80 sec and training time of data set is 15.23 sec.

Again, we take 1000 sample size then we get 97.87 percentage performance of training data set and only 88.34 percentage performance of testing data set. In this process, execution time of sample data set is 3.35 sec and training time of data set is 17.65 sec.

Again, we take 1200 sample size then we get 97.56 percentage performance of training data set and only 92.45 percentage performance of testing data set. In this process, execution time of sample data set is 4.89 sec and training time of data set is 19.17 sec.
Again, we take 1500 sample size then we get 97.39 percentage performance of training data set and only 96.34 percentage performance of testing data set. In this process, execution time of sample data set is 5.20 sec and training time of data set is 22.12 sec.
Again, we take 1800 sample size then we get 97.20 percentage performance of training data set and only 98.67 percentage performance of testing data set. In this process, execution time of sample data set is 6.67 sec and training time of data set is 24.22 sec.
Again, we take 2000 sample size then we get 96.83 percentage performance of training data set and only 99.23 percentage performance of testing data set. In this process, execution time of sample data set is 8.45 sec and training time of data set is 25.87 sec.

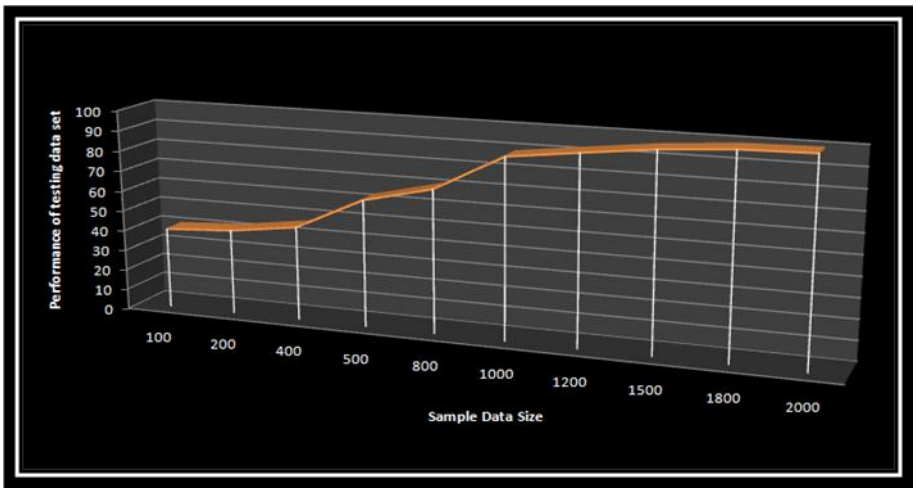


Fig. 10: Graph between Sample Size and Performance of testing data set

Here, from the Fig. 10, we observe that when the number of sample size is increased then the performance of testing dataset is improved. We know that the performance of MANN model is near about 75% then we can say that MANN model has good performance. In this, we can observe the least density of vehicles on the road then the driver selected such road to deliver the goods.

6. Conclusion:

In this paper, we can build up a multi-layer artificial neural network model for solving issue related to road transportation system for discover the optimized way but we know that the several conditions cannot be predefined like behavior of drivers, sudden road blockage, various seasons, snow falls and many more. This is an attempt to make clearMANN model with MATLAB software. Mainly, for this research, we can examine as much of density of vehicles on the road then the vehicle's driver selected best way to deliver the goods.

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