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Multi Layer Perception Type Artificial Neural Network based Traffic Control

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Abstract

Real time traffic control is a main criteria of the urban traffic signal control system, and giving viable ongoing traffic signal control for a substantial complex traffic system is a testing issue. The objective of the work is to find and adjust the timing of signals based on the traffic density. Such a situation arises in a city where outbound vehicles during morning time and inbound vehicles during evening time is more while the vehicular movement in the opposite direction is less. To predict and adjust the timings of the signals on both sides of the road at the same time, Artificial Neural Network technique is used. A real time traffic survey of Light Motor Vehicle, Heavy Motor Vehicle, two and three wheeler vehicular movement in Thanjavur city is done. The number of vehicles (cars, auto, bikes, trucks and buses) and width of the road was given as a input and the output predicted was in terms of timing for the traffic signal at any particular place and for any particular width of the road. The width of the road is also taken into account which is essential in planning a city based traffic consisting of different road widths.

Keywords: Artificial Neural Network, Timings for Traffic, Traffic Control, Width of the Road

1. Introduction

Vehicular travel is expanding all through the world, especially in vast urban territories. Transportation examination has the objective to advance transportation flow of the individuals and merchandise. As the quantity of street clients always increases and assets gave by the current infrastructure are constrained, shrewd control of traffic will turn into an imperative issue later on. However a few constraints to the intelligent traffic control exists. Maintaining a strategic distance for instance is thought to be helpful to both environment and economy.

Autos in urban movement can experience long go times because of incapable traffic light control. Ideal control of traffic lights utilizing refined sensors and astute improvement calculations may be exceptionally advantageous. Streamlining of traffic light exchanging can expand street capacity and traffic stream and can counteract traffic blockages[1,2].

Traffic light streamlining is a complex issue. Notwithstanding for single intersections there may be no ideal arrangements. With multiple intersections, the issue gets to be considerably more unpredictable, as the condition of one light impacts the stream of traffic towards numerous different lights. Another confusion is the way that stream of traffic continually changes, contingent upon the time, the day of the week and the time. Roadwork and mishaps further impact unpredictability and execution. By and by most traffic lights are controlled by settled time controllers[3].

A cycle of setups are characterized in which every single traffic get a green light at same point. The split time decides for to what extent the light ought to stay in every state. Occupied street can get inclination by modifying the part time. The process duration is the length of

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time of complete cycle. In swarmed traffic longer cycles prompts better execution. The balance of the cycle characterizes the beginning time of the cycle with respect to alternate lights. Balanced can be conformed to let a few lights participate, and for instance make green waves. Settled controllers must be adjusted to the particular circumstance to perform well. Regularly a table of time-particular settings is utilized to empower a light to adjust to repeating occasions like surge hour activity.

Setting the control parameters for altered controllers is a considerable measure of work, and controllers must be adapted with new values routinely because of changes in the traffic circumstances. Exceptional occasions can't be taken care of well, since they oblige a considerable measure of manual changes to the framework. fixed controllers could react to arriving activity by beginning a cycle just when movement is disdain, yet such vehicle incited controllers still obliges parcel of tuning. Most research in traffic light control concentrates on adjusting the term or request of the control cycle. In our methodology we let the choice rely upon the real activity circumstance around an intersection, which can prompt considerably more precise control. Obviously our methodology need the data about the current circumstance which can be acquired by sensors along the paths[4]. The routing performance for vehicular networks can be done by using NCTUns[5].

2. Artificial Neural Network for Traffic Signal Control

Artificial Neural Network is a mathematical bundle intended to give experts and students the apparatus to train, predict, visualize and evaluate neural network models. A neural system model is a structure that can be conformed to create a mapping from a given arrangement of data components or connections among the data. The model is trained using the set of data as input, commonly alluded as training set. After effective training, the neural system will have the capacity to perform forecasting, estimation, classification and reproduction of new data from the given set of data[6].

Artificial Neural Network is used in a wide range of applications involving non parametric pattern recognition, non linear filters and statistical regression model. In particular ANN has variety of applications related to traffic control. ANN is used for vehicle classification[7], traffic pattern[8–10], traffic forecasting[11–13], pavement maintenance[14,15], etc. In this article ANN is used to predict the timings of the traffic green signal based on number of vehicles and width of the road. For this ANN is trained with real time data taken in thanjavur district.

3. Problem Statement

In the present system we experience fixed turns of allowing the traffic either in clockwise or in anti-clockwise direction irrespective of the traffic density. Also fixed time allocation is followed. The fixed time is allocated for the particular direction based on survey taken by some traffic experts for different time period.

Let us consider the case where four lanes meet at a traffic junction. A fixed time of 40 sec, 30 sec, 20 sec and 30 sec are allocated for east, north, west and south directions respectively. The total time allocated for a cycle in this case is 120 sec. This time is fixed for a entire day irrespective of the traffic density. If in the east direction for a particular instant of time, only five people are waiting to cross the traffic junction then in the case, the time allocated for that particular direction is more and time is wasted as there is no one to cross the junction, whereas in the other lanes people will be waiting to move. This will lead to congestion problems in the other lanes. But in the case of the west direction, if the density of traffic for that instant of time is high, then the duration of 20 sec is insufficient to clear the traffic. This may leads to traffic congestion problem in this particular direction.

"Priority" is another important factor in traffic light control system the priority basis is not taken into account in today's system. Let us assume that the traffic has been cleared in the east direction. According to the fixed turns of allowing the traffic, north direction is to be processed next. But it is assumed that the density of traffic in that direction is very less when compared to that in the west direction because the accumulation rate is high in the west direction. The present system allows traffic to be cleared in the north direction and then concentrates on the west direction. But within the stipulated amount of time allocated for the north direction, more people will accumulate in the west direction. Thus within the fixed time duration of 20 sec allocated for west direction, only 30% of the traffic will be cleared and an ample amount of time will be wasted in north direction. Hence this method paves way for the traffic congestion problems.

The objective of the project is to prevent traffic congestion problems which occur due to insufficient traffic flow control by priority basis and dynamic time allocation using back propagation type ANN. The priority is assigned based on density of traffic at that instant of time. The priority will be revised once in every cycle. The dynamic time allocation using ANN is also based on the density of traffic and width of the road in particular direction. The lane with high density of traffic is allocated a time duration based on ANN for the green signal and the other lanes are allocated with the respective time duration using ANN based on traffic density.

4. Methodology

4.1 First Phase

The first phase of this project involves classification vehicles using LDR based on the height of the vehicle. A photo resistor or Light Dependent Resistor is device in which resistance will vary based on the light intensity, in such a device resistance will decrease when light intensity increases or vice versa, so this can be easily used for some proximity applications. LDR is made of high resistance semiconductor material so in the presence of light, then the photons are absorbed by the high resistance semiconductor layer, in this case electron gets enough energy to jump into conduction layer. This result in free electron which in turn conduct electricity, and thereby resistance gets reduced. In this project 4 LDR is kept vertically at the side of the road, if the resistance of all the LDR increases then the vehicle crossed will be truck or bus, for car the count will be increased when the resistance of all LDR other than top most one changes, for auto rickshaw resistance needs to changed in the all the LDR other than top two LDR's, other vehicles are counted as bikes or cycles. The data collections about vehicles can be done by other techniques also[16].

4.1.1 Algorithm

1. Set threshold value for 4 LDR's based on voltage obtained in the incident of light. 2. If value (LDR 1 and LDR 2 and LDR 3 and LDR 4) > threshold value, then increase bus count. 3. If value (LDR 1 and LDR 2 and LDR 3) > threshold value, then increase car count. 4. If value (LDR 1 and LDR 2) > threshold value ,then increase auto count. 5. If value (LDR 1) > threshold value, then increase bike count.

This is the algorithm for vehicle classification, in that threshold values are value resistance without vehicle obstruction and obtained values are the values of resistance when vehicles passes across LDR. These counts are used to predict the traffic timings using Artificial Neural Network tool. This technique will eliminate the traffic delays that exits in the present traffic light control.

The flow chart as shown in the Figure 1 explains the control of traffic in north direction assuming that the traffic density is more in north than other 3 direction .Flow chart is same for other directions also. At first the directions are ranked based on the vehicle count, then for the direction with rank 1 the green light will glow for timings that will be given by ANN. By doing this traffic can be controlled with more accuracy. For all other directions red light will glow for timings given in flow chart. The vehicle count will be collected after cycle gets over.

4.1.2 Example

In this example (as shown in Figure 2.) the no of vehicles is more in west direction and so the green light glows for west direction, and red light glows for other three directions. The directions are ranked based on no of vehicles in each directions and for this example west direction is given first rank, north direction is given second rank, south is ranked third and east direction is given forth rank. Green light glows for in the order of west, north, south and east in this example. Respective timings are predicted using ANN tool for all the directions, and the

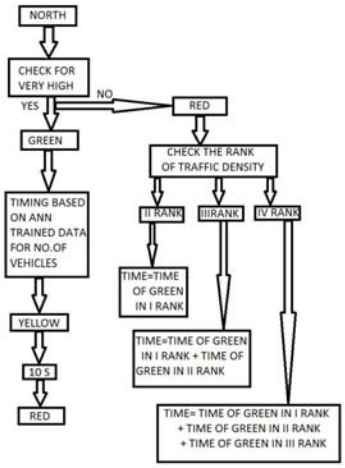

Figure 1. Flow chart for the North direction assuming that the traffic density is high in north direction.

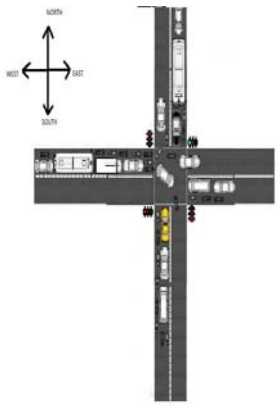

Figure 2. Example for traffic light based on traffic density.

traffic control works based on the flow chart given in previous section.

4.2 Second Phase

In this phase data needs to be send through serial port into matlab in order to predict the timing for the respective no of vehicles. For data acquisition purpose arduino uno is used. For interfacing arduino with matlab matuno[17] package needs to be installed, matlab will serially receive the count from arduino uno through the interface and that output is given to Artificial Neural Network tool to give the timing for that No of vehicles.

For doing this 4 LDR's are connected to the analog pin A0, A1, A2, A3 of arduino uno in order to read the voltage relative to the light intensity. Arduino uno is connected to pc through Universal Serial Bus (USB) wire and gets power from pc. The circuit diagram (Figure 3.) for this is given below.

4.3 Third Phase

Timing of traffic depends upon the weight age of neuron, activation function, No of hidden layer, No of hidden neurons, input parameters and learning algorithm chosen. In order to relate these mentioned variables and timing of traffic, an ANN is developed with input parameters such as No of bus, No of car, No of auto, No of bikes, width of the road. The output obtained is timing in seconds. Total of 140 data is used to train the Artificial Neural Network, 30 data is used for validating ANN and 30 data is used for testing. The short description about the parametres used for prediction is given the Table 1.

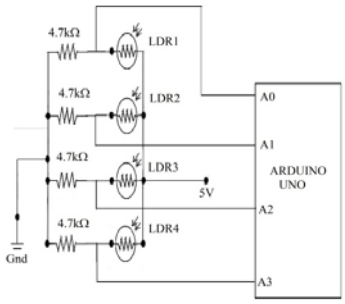

Figure 3. Circuit diagram for counting no of vehicles.

Table 1. ANN parameters

Input Parameters	No Of Bus,No Of Car,No Of Auto,No of Bikes,Width Of The Road
Predicted Parameter	Timings of Traffic Light
Training Algorithm	Levenberg Marquardt based Back propogation
Activation function	Transigmoid
Number of Hidden Layers	ONE
Number of hidden neurons	10

The input data is divided into 3 parts in the ratio of 70%, 15%, 15% for training, validation and training respectively for the prediction of timings of the traffic. Training involves the process of adapting the network to all types of data. It helps the network to understand the relation between input and output.

Training helps the network to predict the timing for all kind of data. An algorithm is followed for training. Back propagation algorithm consist of various type like BFGS (Broyden–Fletcher–Goldfarb–Shanno) (Powell 1976) (*trainbfg*) algorithm and Levenberg-Marquardt algorithm (*trainlm*) (Press et al.). For smallest multivariate function normally Levenberg-Marquardt algorithm (*trainlm*) algorithm is preferred therefore this algorithm is used in this project since it has smallest multivariate data. This algorithm reducing the error between the output obtained from the Artificial neural network and target output obtained from real time traffic signals. Mainly for this feature Levenberg-Marquardt algorithm[18] is preferred for small and moderate size networks. There are many activation functions such as step function, arc

tangent function and sigmoid function but in this project transigmoid activation function is used.

Transigmoid activation function[19] is predominantly used it is easy for working with computation. And the transition of value of the activation function between zero and one is very smooth, but in case of other activation functions this transition is not smooth this will affect the result. The graph is shown in the Figure 4.

The composed neural system contains 10 neurons in the data layer and a solitary neuron in the yield layer. Regression examination is an apparatus to study the reliance between two variables. In the present case, the yield of neural system and the target worth are considered. A regression coefficient close to 1 demonstrates the best conceivable forecast. In a back propagation calculation, the critical angle is the determination of learning rate. A high learning rate is inclined to disparity and low learning rate prompts high calculation time. The determination of learning rate was completed taking into account hard experimentation methodology to acquire the best conceivable result.

The measure of neurons in the hidden layer is changed and tried by experimentation to get the greatest regression coefficient. In the present work one hidden layers each with 10 neurons has the capacity to foresee with the best regression coefficient. The planned neural system is indicated in Figure 5.

This is the schematic representation of Artificial Neural Network of this project; this has 5 inputs, 10 hidden neurons, 1 hidden layer and 1 output.

5. Results

Training data for training artificial neural networks has been taken in Thanjavur for the period of 4 days and the data includes the input for ANN and timing for the traffic. Totally set of 200 data were used to train the ANN.

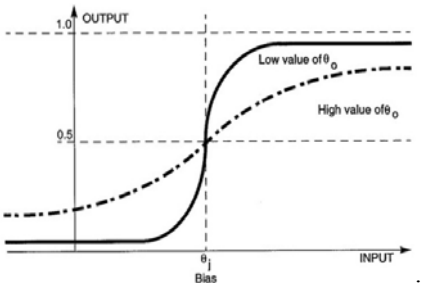

Figure 4. Transigmoid activation function.

The data taken from the traffic signal at Thanjavur were analysed with Back Propagation ANN model in order to predict the timing of traffic. These data were trained with maximum training step of 1000.

The Figure 6 shows the performance plot of fitting tool and the best performance is obtained at the 12th iteration of training and the system seems to be converges at 18th iteration. This shows that the system converges at high speed. Best MSE value is 0.22241 and the MSE value close to zero shows that there is less error in this trained Artificial Neural Network.

The graph (Figure 7.) shows the Regression R value measurements that is correlation between the outputs and target. An R value of 1 means a close relationship and 0 means a random relationship. And in this work the overall regression value is 0.99097 that is close to 1 and so there is close relationship exist between outputs and target.

These results shows the probability of predicting the traffic timing based on input with maximum accuracy

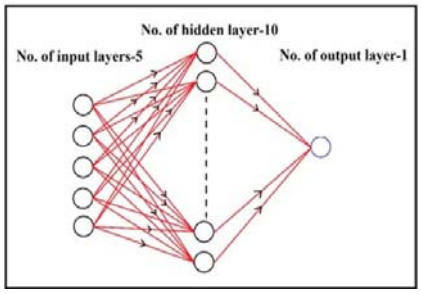

Figure 5. Designed Artificial Neural Network.

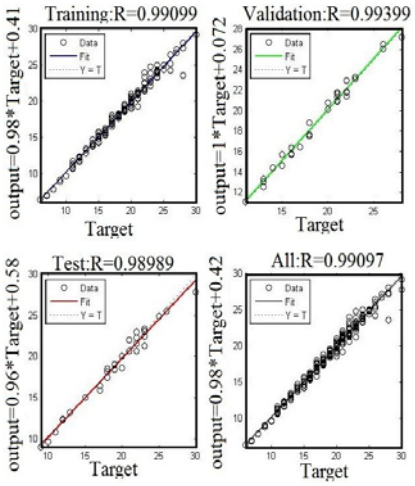

Figure 6. Regression plot for designed Artificial Neural Network.

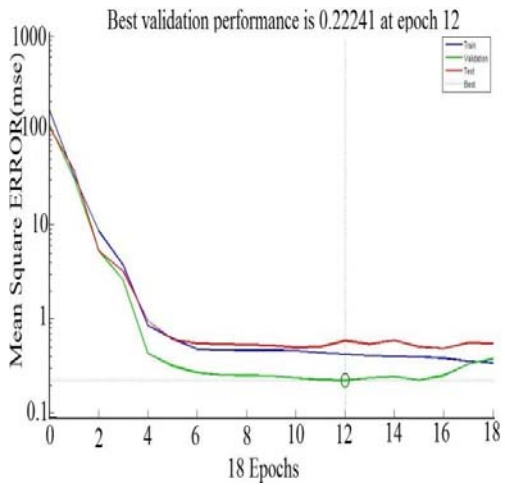

Figure 7. Graph between mean square error vs no of iteration.

and so timings of the traffic signal are predicted correctly for the given number of vehicles and for the given width of the road.

6. Conclusion

From the outcomes it is observed that, the BP-ANN model ended up being a valuable apparatus for anticipating traffic timings. The timings for the traffic is predicted using the inputs like No of vehicles and width of the road by training the input data using Levenberg Marquardt algorithm and ANN fitting tool and in the future ANN needs to be trained with more inputs and by using better training algorithm technique and if possible, integrate fuzzy based inference system to adapt to the fluctuations.

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