

# Traffic Flow Control by using Ann Based Designing Toll Plaza Configuration

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**Abstract** - Computer simulation is one of the popular approaches to the design of toll plazas. Toll plaza configurations such as toll collection methods, number of toll booths, and types of vehicles have been studied in the literature. Traffic flow types can be another influential factor when designing toll plazas, especially in case that traffic flow information is not available, but only the estimate of traffic volumes. Few studies have reported the effect of traffic types on toll plaza performances. In this article, aANN simulation method is used to analyze the sensitivity of toll plaza performance for different types of traffic flow. Two traffic patterns, deterministic and probabilistic traffic flow, is considered. This study is based on a proposed project for building a toll Plaza in the indirectly. The estimated future traffic counts for the toll bridge are used to study the difference between the two traffic patterns.

**Keywords**- Modeling and simulation, traffic flow types, electrical toll collection, toll plaza, performance measures.

## I. INTRODUCTION

Simulation-based approaches have been applied to various system optimization problems in industries. In the literature, some examples include cellular manufacturing processes (Hachicha et al., 2007), preventive maintenance scheduling (Alfares, 2002), risk-based decision making (Cao and Wang, 2003), supply chain diagnostics (Kao and Huang, 2008), flow shop scheduling (Katten and Maragoud, 2008) and toll plaza configurations (Sadoum, 2005). Although simulation approaches are popular and powerful, it should be emphasized that simulation is just one of possible experiments for an interested system. Thus, simulation analysis requires a careful process of designing a conceptual model of a real or proposed system for a given set of conditions (Kelton et al., 2007). It is essential that the functionality of the system as well as associated conditions should represent the system as close as possible in order to produce reliable results from simulation analyses. As discussed by Zhou et al. (2007), designing a conceptual model needs a formalization and representation of knowledge across different domains such as application, simulation, and implementation.

## II. THE TOLL PLAZA

### 1. Types of Toll Plazas

Roadways on which tolls are collected are almost always so-called controlled access highways, which can only be entered and exited from designated access points, and are usually fully grade separated from other roads. There are three primary systems for collecting tolls on tolled highways. The interaction between the number of tollbooths and congestion is most obvious when the barrier toll system is used. In this case, vehicles may enter and exit

the mainline roadway without paying a toll, but at certain locations along the highway there are toll plazas at which all vehicles must stop and pay a toll.

### 2.2 Types of toll collection:

There are two types of toll collection systems available. These are:

- (i) Open Toll System, and
- (ii) Closed Toll System.

#### Open toll system:

In an open toll system, not all patrons are charged a toll. In such a system, the toll plaza is generally located at the edge of the urban area, where a majority of long distance travelers are committed to the facility, with a minimum likelihood of switching to the parallel free route, or at the busiest section of the toll way [2]. Patrons are identified by their category and pay a fixed toll for it. The local traffic around the plaza either gets rebate or can use a service lane. The general layout of an open toll collecting system is highlighted in Fig. 2.1

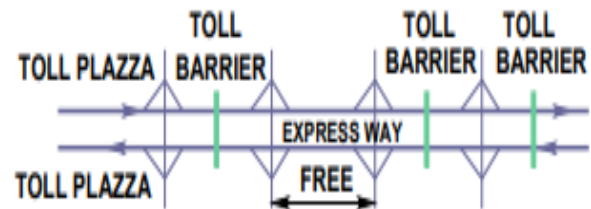


Figure 1 Open Toll System

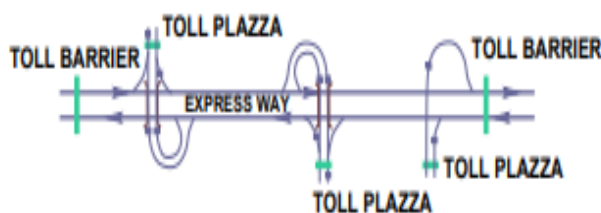


Figure 2 Closed Toll System.

### III. MOTIVATION FOR THE STUDY

The need for this study is primarily to solve the problems related to operational toll roads, as users of these roads frequently complain about the very functioning of the system and are utterly dissatisfied with the way the operators collect hefty toll amount but fail miserably in providing quality service across several mandated quality parameters. As bad roads are detrimental to regional growth, monitoring of toll road infrastructure facilities is required. The assessment of performance levels of operational parameters and services gives the status of roads and fixes the responsibility of the agencies involved in road maintenance and management.

#### 1. Problem specification

Traffic volumes are increasing on roadways and it is becoming very costly to continue adding additional toll lanes to meet increasing traffic needs. Some toll facilities have identified the fact that plaza problems on toll roads cannot be solved simply by constructing more toll lanes. There is an inherent delay associated with dedicated ETC lanes, since vehicles are required to reduce their speed before traveling through the plaza.

This reduced speed is a source of travel time delay for each vehicle. The reduced speed is required since these dedicated ETC lanes utilize traditional toll lanes that have lane widths of 10-14 feet. Thus only limited number of vehicles will be passed at a time. The problem inspects three major areas in the active field of electronic toll system. They are high security registration plate for vehicle classification and checking, queuing model by electronic classy card systems for reducing queue waiting time and web services for report generation.

**2. Need of Time scheduling to control Vehicles density and Air Pollution-** Motor vehicles emit toxic and carcinogenic compounds that are known to cause cancer in humans. Hydrocarbons and nitrogen oxides contribute to smog, which damages lung tissues and aggravates respiratory disease. Smog can also inhibit plant growth and damage crops and forests. Motor vehicle pollution also contributes to the formation of acid rain and global warming.

Air pollution accounts for about 6 percent of deaths each year in Austria, France, and Switzerland, according to a study published in the Lancet medical journal. The study found that half of the those deaths can be attributed to pollution from vehicles. The researchers also calculated that the health cost of vehicle pollution in the three countries totaled 1.7 percent of the gross domestic product.

### IV. DATA COLLECTION PROCESS

**1. The Road User Satisfaction Survey:** It was planned to elicit views and gather feedback on road attributes and other concerns of various stakeholders particularly vehicle users or vehicle operators. The Road User Satisfaction (RUS) survey aimed to capture perceptions and expectations of travelers on above mentioned service parameters employed. It has two parts: the first part deals with personal details / attributes of the travelers and the second part covers the questions on the subject of the study. In the first part of the survey, the questions deal with the data variables mostly related to mode of travel, purpose of travel, willingness to pay toll etc. as these characteristics are expected to influence the commuters' assessment of roadway services. The second part of the questionnaire deals with the evaluation of the service parameters with the help of data which are measured by devising an appropriate scale for seeking users' opinion variables.

#### 2. Sample Locations:

- The road way segment approximately of about 15 kilo meters on National Highway 4 connecting RAU-PITHAMPUR ROAD, Rau - Pithampur Road, Rau, Indore, Madhya Pradesh passing through toll plaza at near Pune road.
- The road way segment approximately of about 15 kilometers on National Highway 4 connecting DEWAS-INDORE passing through toll plaza, IDTL Toll Plaza, Plethico Pharmaceuticals Ltd., Manglia, ManglayaSadak, Indore, Madhya Pradesh.

### V. PROPOSED METHOD

#### 1. Artificial Neural Networks – Introduction

Artificial Neural networks (ANN) or neural networks are computational algorithms. It intended to simulate the behavior of biological systems composed of "neurons". ANNs are computational models inspired by an animal's central nervous systems. It is capable of machine learning as well as pattern recognition. These presented as systems of interconnected "neurons" which can compute values from inputs.

A neural network is an oriented graph. It consists of nodes which in the biological analogy represent neurons, connected by arcs. It corresponds to dendrites and synapses. Each arc associated with a weight while at each node. Apply the values received as input by the node and define

Activation function along the incoming arcs, adjusted by the weights of the arcs

## 2. Advantages and Disadvantages of Neural Networks

Let us see few advantages and disadvantages of neural networks:

- Neural networks perform well with linear and nonlinear data but a common criticism of neural networks, particularly in robotics, is that they require a large diversity of training for real-world operation. This is so because any learning machine needs sufficient representative examples in order to capture the underlying structure that allows it to generalize to new cases.
- Neural networks works even if one or few units fail to respond to network but to implement large and effective software neural networks, much processing and storage resources need to be committed. While the brain has hardware tailored to the task of processing signals through a graph of neurons, simulating even a most simplified form on Von Neumann technology may compel a neural network designer to fill millions of database rows for its connections which can consume vast amounts of computer memory and hard disk space.

## 3. Proposed Toll plaza system Flow chart

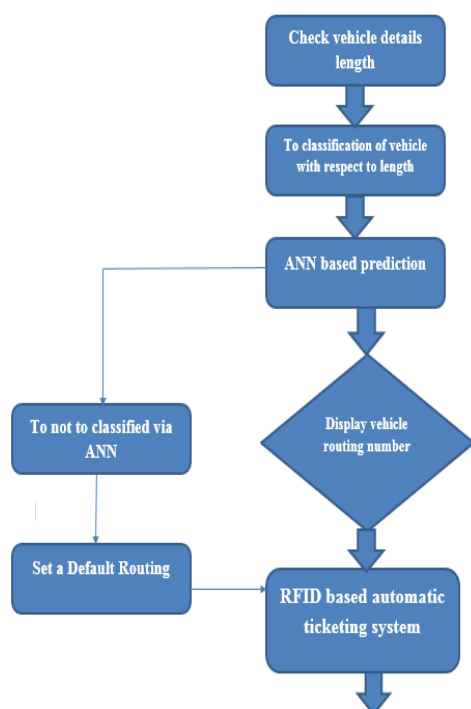


Figure 3 Proposed Toll plaza system.

## 4. Proposed Toll plaza system Algorithm Steps:

**Step 1:** Firstly set each vehicle length for to come in toll plaza road.

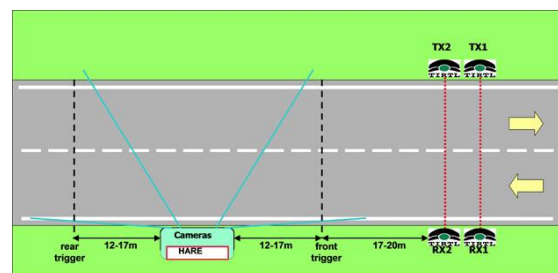


Figure 4 vehicle length detector system.

**Step 2:** Then also set a data in Artificial Neural Network for classification purpose.

**Step 3:** When any vehicle to come in toll plaza then 10-50feet distance to check vehicle length. Then to classified a class form in vehicle categories. Hence each categories to set a different path behalf on vehicle length.

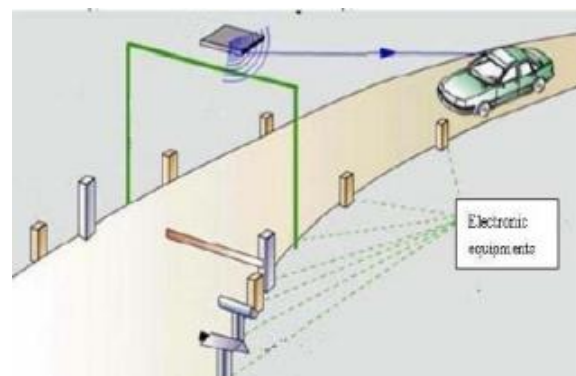


Figure 5 Working module.

**Step 4:** These class to display in LCD system. Hence vehicle deriver to select a his categories path then toll plaza system (to base on RFID and Automatic) generate a payment slip.

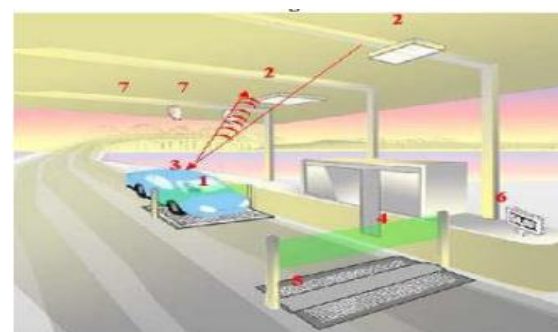


Figure 6 Working module.

**Step 5:** In this process When a not classified a vehicle length then to choose a default path. Hence this process to consume less time period across toll plaza system and pollution generation.

## VI. RESULT AND SIMULATION

### 1. Why Matlab?

Matlab is intended primarily for Mathematical Computing. Matlab contains a huge collection of predefined algorithm which is used for image processing. An algorithm can be tested immediately without recompiling it again. Matlab provides an interactive environment which help you to work innovatively with your data and helps to keep track of the files and variable etc.

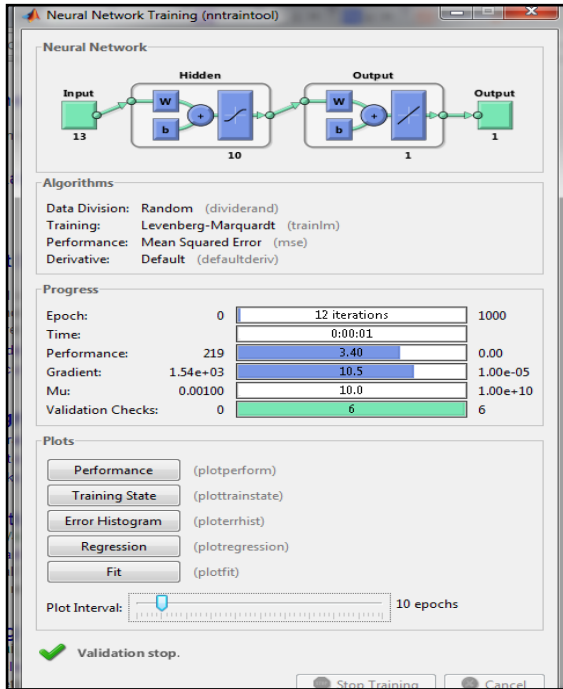


Figure 6 NN Validation State.

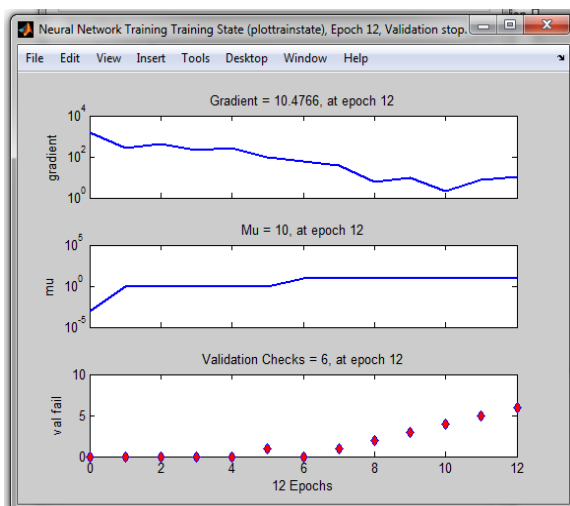


Figure 7 NN Training State.

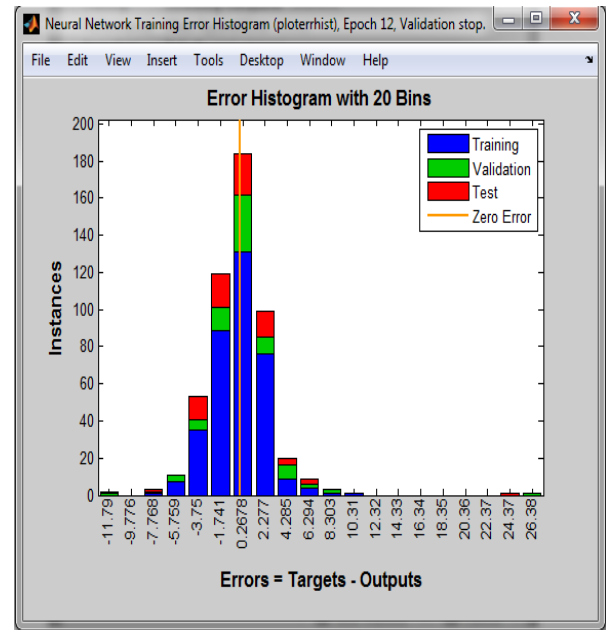


Figure 8 Error of histogram.

MSE Analysis represent histogram for multiple layer option. The irregular result provide to neural network. So 0.2678 Error histogram with 20 bins is the highest value of this graph represent

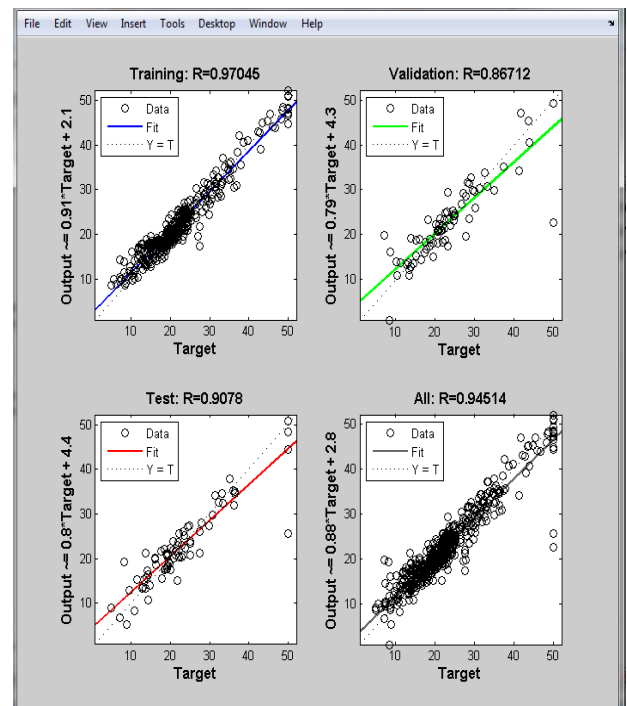


Figure 9 output Error.



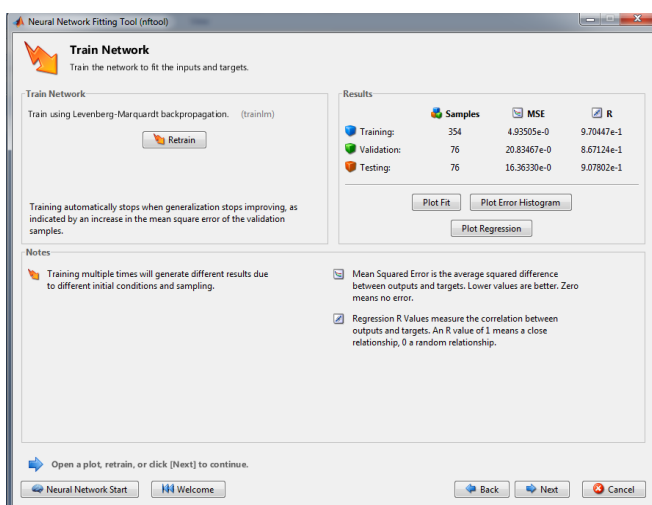


Figure 10 Import data.

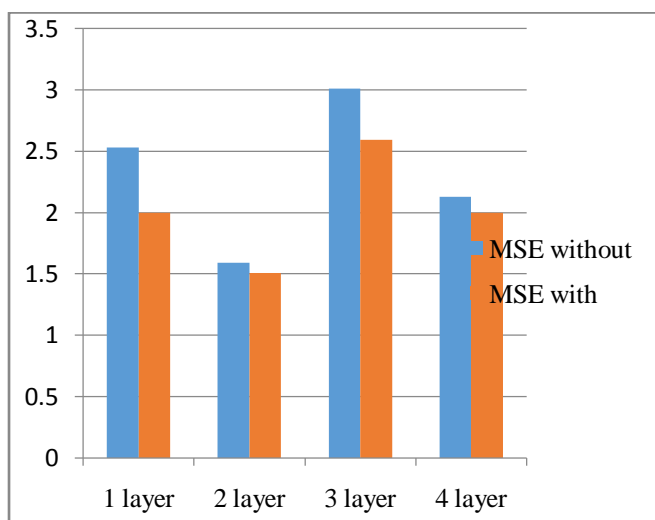


Figure 11 MSE Layer of Analysis Neural Network.  
The previous chapter introduces the proposed methodology. This chapter describes the related future work and schedule plan of excursion.

Table 1 MSE Analysis of Neural Network

Layers	MSE Analysis Without Neural Network	MSE Analysis With Neural Network
1Layer Training	2.53	0.2678
2Layer Training	1.59	-0.127
3Layer Training	3.01	0.739
4Layer Training	2.13	-0.1447

Table 2 Accuracy and Precision of base paper and our proposed work.

S.N.	Accuracy Base paper	Proposed ANN based Accuracy
1.	96.37(GA)	99.24

The previous chapter introduces the proposed methodology. This chapter describes the related future work and schedule plan of excursion.

Table 3: MSE (Mean square error), SD(Standard Deviation) and Class of base paper and our proposed work.

## VII.CONCLUSION OF PROJECT WORK

In this chapter we clearly understood the role of transport and its importance. It clearly emphasis the problems concerned with the toll system due to increasing transport facilities. In our country there are different strategies of toll collection is already available. This study elaborates the techniques in improving the ETC system by different methods.

**1. Congestion reduction --** The toll transaction rate is highly increased due to the use of ETC systems. Since the vehicles do not stop at the toll facility, the throughput is highly increased. This has considerable effect on the congestion of the toll plaza. As the proportion of the ETC user increases the congestion in the manual as well as the automatic lanes is also reduced. The average number of vehicles waiting in the queue reduces and so the average waiting time is reduced.

**2. Increased Capacity --** It is observed that the capacity of the electronic lane increases by three fold. The toll plaza would be able to accommodate the increasing traffic without requiring building additional lanes.

## VIII.FUTURE WORK

### 1. Automatic Toll Collection

The RFID Readers mounted at toll booth will read the prepaid RFID tags fixed on vehicles' windshield and automatically respective amount will be deducted. If the tag is removed from the windshield then cameras fixed at two sites at toll plaza take snaps of the front and back number plate. Since every vehicle registration ID is linked to users account, toll can be deducted from the account bank directly.

### 2. Vehicle Theft Detection

When vehicle is stolen the owner registers complaint on the website with its registration ID and unique RFID tag number. Now when stolen vehicle passes by the toll plaza, the tag fixed on it is matched with the stolen vehicle's tag in the database at the toll booth.

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