

Traffic Flow Modeling and Study of Traffic Congestion

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Abstract: Traffic flow modeling is done to study interactions between vehicles and to develop an optimal road network with efficient traffic movement and reduced traffic congestion. Efficient management of traffic is the aim for modeling the traffic flow. While modeling the main focus is on speed, flow and concentration of vehicles. The model discussed in this paper is based on queuing theory. The model can be developed for all types of junctions. Here, the model for a straight lane is developed. The general causes, effects and solutions for traffic congestion are studied in this paper.

Keywords: Traffic flow model, Queue, Traffic survey, Lane capacitance and Congestion

1. Introduction

India has the second largest road network in the world. Road network density of India is 0.66 kilometer per square kilometer of land. The value of density is 0.65 for United States, 0.20 for Brazil and 0.15 for China. Indian roads are a mixture of highways, unpaved roads and narrow roads. Up to 2015, India had placed 24, 000 kilometers of recently built highways connecting major commercial centers, manufacturing and cultural centers.

Traffic congestion is a serious problem facing today. The causes, effects and solutions of traffic congestion vary according to the location. A questionnaire survey may help to analyze the causes effects and solution for traffic congestion to a great extent. One of the important solutions for the traffic congestion is the development of a model which helps in the efficient movement of the traffic. The motivation for this study is the huge increase in the usage of roads which shifted the attention of highway authorities from construction of new roads to maintenance of the existing ones. In order to accomplish this efficient management is required. The model can be used to calculate the length of queue formed on the lane.

2. Critical Review

From the literature survey conducted it is concluded that there are mainly two types of traffic flow models, macroscopic and microscopic models. Microscopic models when compared with macroscopic models are difficult to deal with since the parameters required in the same is large and it deals with individual vehicle data. Where as a macroscopic model is less complicated and it deals with a traffic stream. Hence the proposed model is a macroscopic model.

There are many types of junctions. Many of the existing macroscopic models are not applicable for all types of junctions. But a road channel usually consists of several types of junctions. Hence a model which is capable to manage all types of junctions is important.

3. Data Collection

Initial step for the model development is the data collection. In this study several locations in Ernakulum district, Kerala, India is selected. Traffic volume studies in the sample locations are conducted. The traffic volume data for a working day, a public holiday and a Sunday is conducted for each location and the average of three data is calculated. From the data obtained, the peak hour factor is calculated. The model is applicable only for a congested lane. Hence by calculating the peak hour factor the sample for the modeling are finalized. After finalizing the samples, the traffic characteristics including flow rate, lane capacity and geometry of the road are noted. The causes, effects and the solutions for the traffic congestion are analyzed from a questionnaire survey.

4. Traffic Congestion

Traffic congestion in the road can be defined as the condition in which the number of vehicles in the lane is higher than the lane capacity. The traffic congestion may occur due to various reasons. The primary reason may vary depending on the location. It occurs when the demand exceeds road capacity. The reasons for the traffic congestion include increased number of vehicles in the lane, improper parking, road maintenance work, accident etc. Traffic congestion has got many negative effects. Effects of traffic congestion include wastage of time for the users, delay in reaching the destination, increased fuel consumption, environmental pollution, higher chance of collision etc. The traffic congestion is a serious issue which needs to be checked. Solutions for the problem need to be developed. Some of the possible solutions are parking restrictions, change in school timings to reduce rush hours, traffic counters, better traffic management, speed limit, lane splitting, provision of flyovers, construction of metro, public enlightening programs etc. Development of a model for traffic flow management is a solution to reduce traffic congestion. In this paper the focus is to develop a model which can eliminate traffic congestion and thereby resulting in a uniform flow of traffic. The most appropriate causes, effects and solutions

of traffic congestion vary according to the location. A questionnaire survey can analyze the causes, effects and possible solutions of traffic congestion in a more appropriate manner. Questionnaire survey can be conducted among common people, drivers and traffic experts and the response can be analyzed. Analysis of the questionnaire survey can be done with the help of a statistical expression.

5. Traffic Model and Software used

The traffic model developed is applicable for all types of junctions. It helps in the efficient movement of traffic flow which helps in the reduction of traffic congestion to a great extent. The model helps to calculate the queue length formed in the lane. Here the model for a straight lane is developed. When the flow in the lane exceeds the lane capacity a queue is formed and the propagation of the queue back through the network will affect the smooth movement of traffic flow in the lane. Thus the flow in one part of the lane is dependable on the other part of the lane.

The traffic flow in the lane a-b can be calculated as sum of all flows to node a, the flow entering the lane a-b and negative flow which is leaving the lane. It can be expressed as follows:

$$F(t) = f(t) + f_e(t) - f_l(t)$$

Where, $F(t)$ is the flow in the lane a-b in time t , $f(t)$ is the sum of all flows to node a, $f_e(t)$ is the flow entering the lane and $f_l(t)$ is the flow leaving the lane. In a straight lane mainly three cases are considered.

- i. The traffic flow in the lane is higher than the traffic flow capacity of the lane and no queue is generated.
- ii. The traffic flow in the lane is higher than the traffic flow capacity of the lane and a queue is generated.
- iii. The traffic flow in the lane is lower than the traffic flow capacity and a queue is generated in the lane.

Different equations are to be developed for the above mentioned cases. These three cases are considered in the model formation of any of the junction types. The model can be developed using any of the existing software's.

Several software's can be used to develop the model. Matlab is widely used mathematical software. It is a high level language used by millions of engineers and scientist worldwide.

6. Conclusion

Traffic congestion is a serious social issue which needs special attention. In this paper a model is developed to eliminate the traffic congestion to a considerable extent. Different samples are selected for the study and traffic survey was conducted. From the survey data, it was analyzed whether the selected samples are congested or not and hence the samples were finalized. A study on traffic congestion was conducted. The general causes, effects and solutions for the traffic congestion were discussed. The model as a solution for traffic congestion and to obtain an efficient movement of traffic was

developed. The model for a straight link is developed in this paper.

7. Future Scope

The model can be developed for all types of junctions like three way junctions, four way junctions and roundabouts. Thus a channel comprising of all types of junctions can be modeled to obtain a better traffic management. The model can also be developed in the future to determine the best maintenance strategy for the lane.

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