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MACROSCOPIC TRAFFIC FLOW MODELS HAVING SOURCE TERMS

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ABSTRACT
In this paper, macroscopic traffic flow model having source terms has been presented. In maximum cases, source terms present the entrance and exit of the roads. So, to demonstrate the effect of inflow, models possessing source terms are extensively presented with their traffic predictions. These predictions are based on the real traffic data taken from the roads. These results can be used for further research in the field of traffic modeling.

Keywords:
Source term, homogeneous flow, traffic prediction

INTRODUCTION

Development and prosperity of the country depends upon the transport infrastructure facility of that country. These facilities improve the living standard of the people. These facilities have direct impact on the common man. In order to enhance the living standard, maximum utilization of all these facilities is necessary. This involves roads, roundabouts, intersections footpaths and all the other facilities that are used by the people. Roads are most important facility that is readily used by the public. Congestion is caused on the roads as they are underutilized.

Traffic modeling is applied in order to use road to its maximum capacity. Traffic modeling is a method in which parallel are drawn from theories and equations and then compare with traffic flow. For example a well known fluid model is compared with the traffic flow. The particle of the fluid is considered as one vehicle. The vehicles on the road are similar to the particles in the fluid. In order to use the road to its maximum capability, different traffic flow models are used. This analyzes the traffic flow on road. Designers use these models for design of any road facility.

There are three types of traffic models macroscopic models, microscopic model and mesoscopic models. The macroscopic model takes into account all the vehicles present on the road, in fact it is the cumulative behavior of the vehicles on the road. The microscopic model considers a single vehicle throughout the modeling process. The mesoscopic models consider both the microscopic and the macroscopic behavior[1].

These traffic models consist of different traffic parameters. These parameters are the speed, density, flow etc. Density is the no of vehicles per unit length. The flow is defined as the no of vehicles per unit time. Headway distance is the distance between two successive cars. Lateral distance is the distance between two lateral cars.

Background:

The first model derived LWR model was late in 1955.LWR model was proposed by Lighthill and Whitham and Richards. An LWR model consists of continuity equation, taken from fluid mechanics[1].

The LWR is given below

$$\sigma_t + (\sigma v)_x = 0 \qquad (1)$$

σ_t is the density while $(\sigma v)_x$ is the flow of traffic

This model is the basis of all the other first order models. This was the breakthrough in the field of traffic modeling. This model is considered as the basic model in the field of traffic modeling.

This model gave the traffic prediction for long infinite road. There is no concept of exits and entrances in this model. This model is based on idealized conditions. This model is further considered in other source term models.

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These models are deduced in order to cover the deficiencies of the original LWR model. Following are the models considered in this paper having the source terms.
The first model is the ahsan model[2], in this model the LWR model is not considered to zero rather to a constant term. This model shows that the difference between the density and the flow is equal to some constant value.

$$\sigma_t + (\sigma v)_x = s \qquad (2)$$

In this research, an amendment of a macroscopic traffic flow model has been given. In almost maximum cases, the source terms represents the exits and the entrances of the single road. In this research to depict the effect of change in the traffic conditions a constant source term is added to the model. Furthermore, finite difference scheme is used in order to discretize the model.
The second model is of Perlman model[3], this model involve a density distribution on the right hand side of the model. This model is given by

$$\sigma_t + (\sigma v)_x = D \qquad (3)$$

This model involves a Heaviside function on the right hand side. This density distribution shows inequilibrium condition which is near reality. Traffic parameters involve in this model characterizes the traffic.
The third model is the Gani model, this model also considers a constant source term. Gani discretized the model by using lax freidrich method[4]. This model addressed the shortcoming of LWR model in a better way. The simulations of all the models is given below.

Green shield model:
Greenshield model is a relationship between density and velocity. Green shield shows how one entity changes with the change of other entity[5].

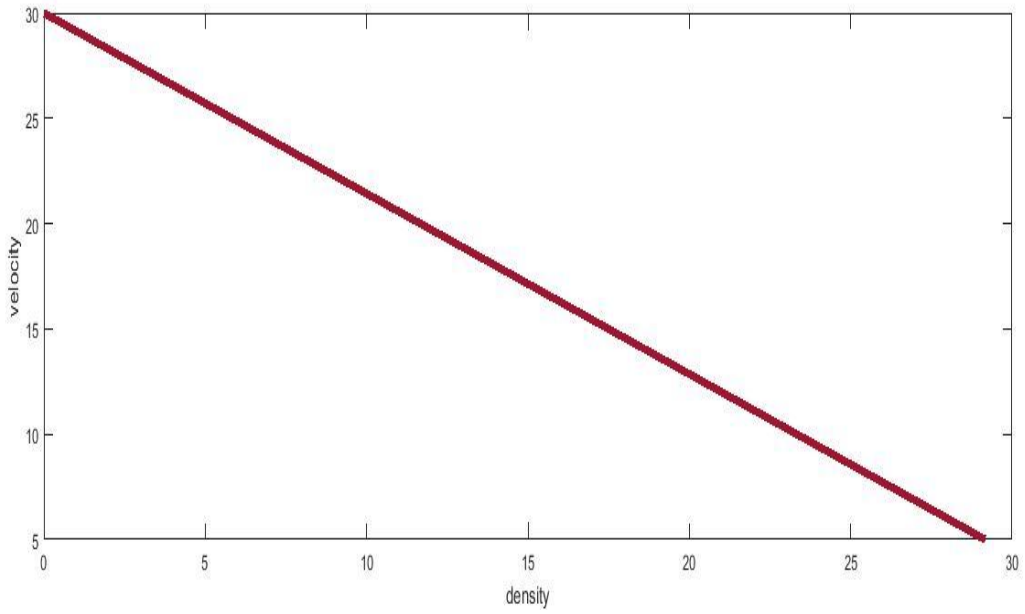

Figure1: Greenshield velocity vs density depiction

This is the depiction of Greenshield model. The linear relationship between the velocity and the density is shown. The maximum velocity is 30m/s. This model shows that with the increase in density the velocity decreases and when the density is less the velocity is at its maximum.

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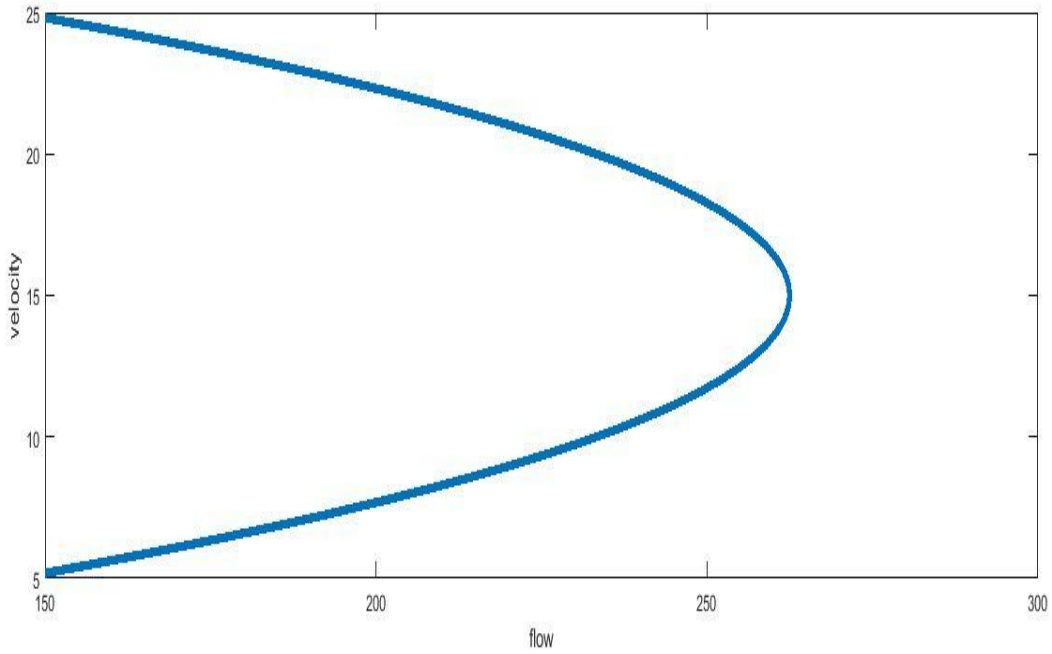

Figure2: Grennsheilds flow vs velocity depiction

This graph shows the relationship between the flow and the velocity. The graph shows changes in the system when velocity fluctuates.

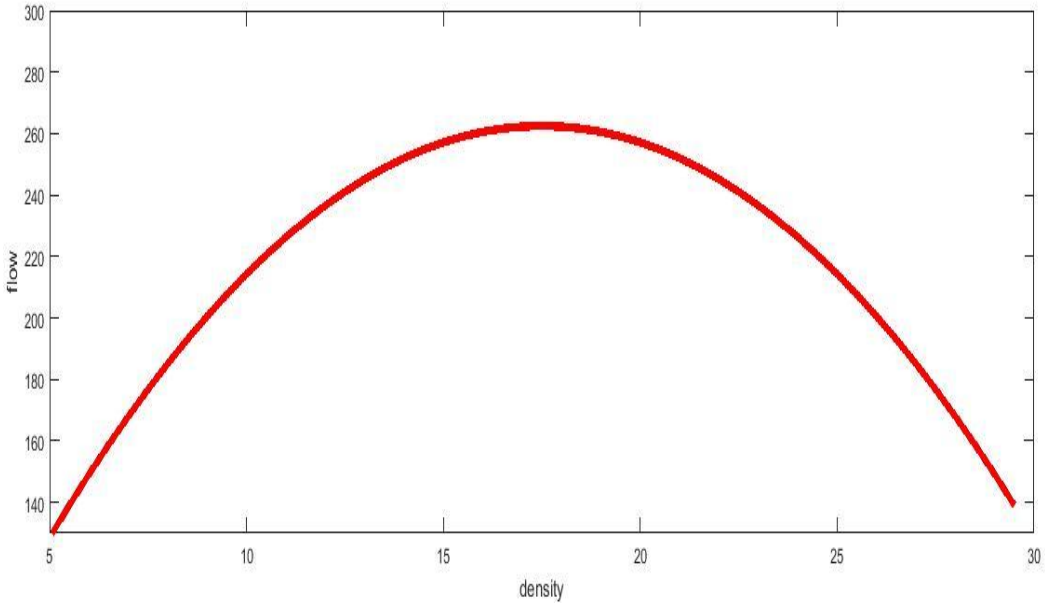

Figure3: Greenshields flow vs density depiction

The third graph shows the relationship of density with the flow of the vehicles. Greenshields model provide the information about how the traffic parameters changes with respect to other parameters.

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SIMULATIONS:

The real traffic data is taken for the validations of all the models discussed above. The quantitative validation [6]of the models is carried out. The traffic parameters are the following

1) Max velocity =36km/hr
2) Max density=170 veh/km
3) Average velocity= 18 km/hr
4) Headway= 10m
5) Initial density 2.3 sin(x)+30

All these models are simulated by the real conditions obtain from the real traffic data. This will show the traffic prediction, how the traffic pattern changes with respect to time. Following are the three models :

1) LWR MODEL
2) GANI MODEL
3) PERLMAN MODEL
4) AHSAN MODEL

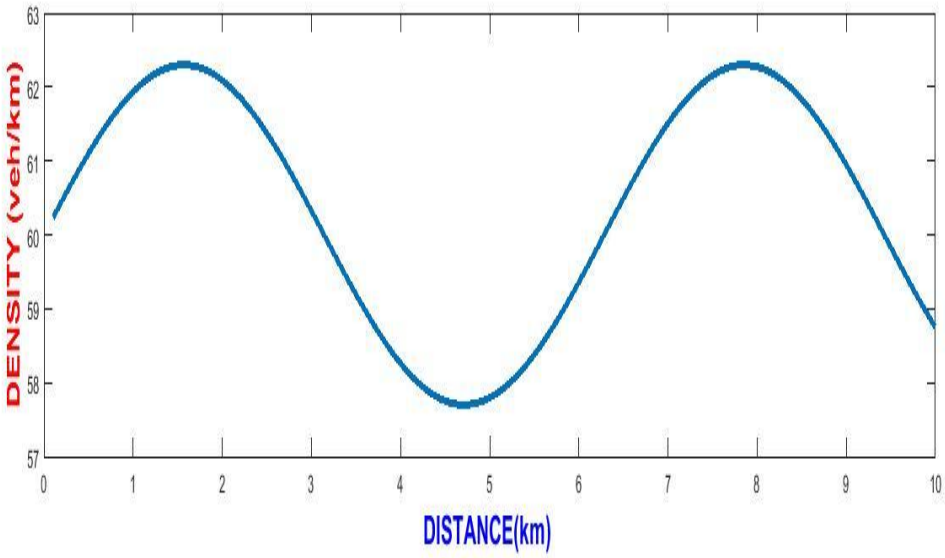

Figure4: Density depiction of LWR model.

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LWR model results are shown. The density changes throughout the patch are depicted. The density increases at the start and then it decreases.

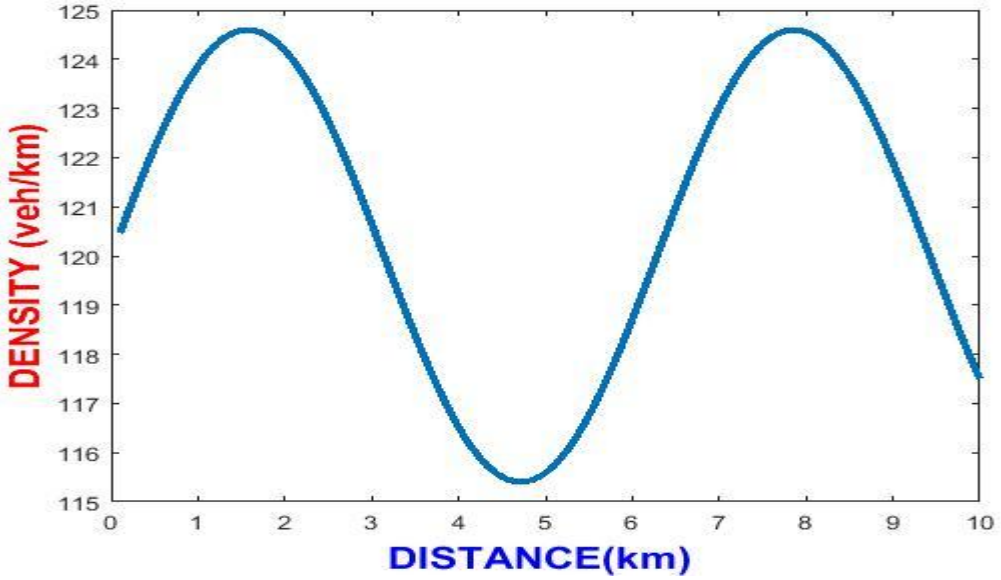

Figure5: Density depiction of Perlman model.

The second depiction is of PERLMAN MODEL the density depiction is changed as compare to the LWR model, as it involves the source term. The maximum density reaches to 125 veh.

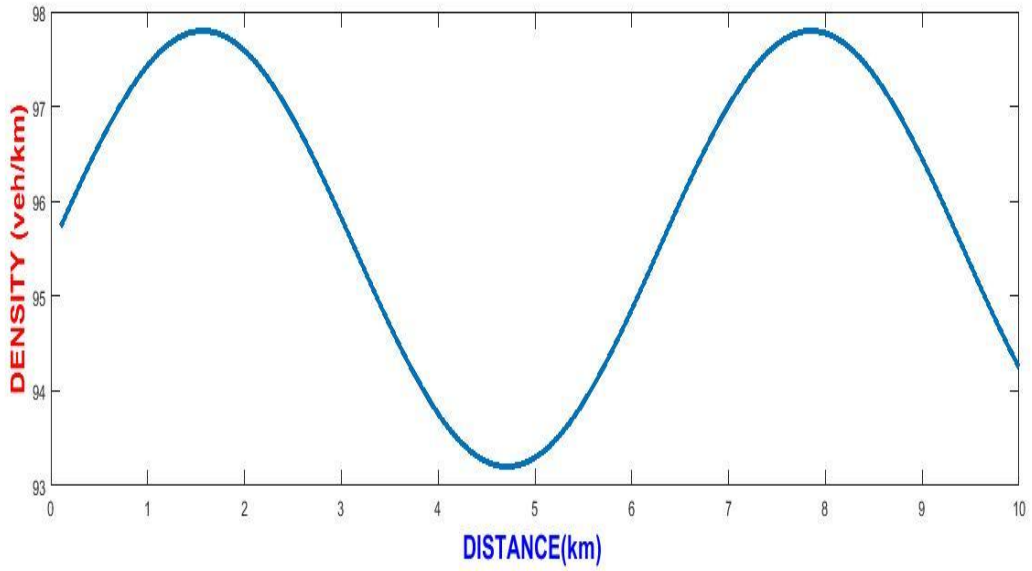

Figure6: Density depiction of Gani model

Similarly to the PERLMAN model, GANI model also depict the traffic. The maximum traffic depicted by this model is 98 vehicles.

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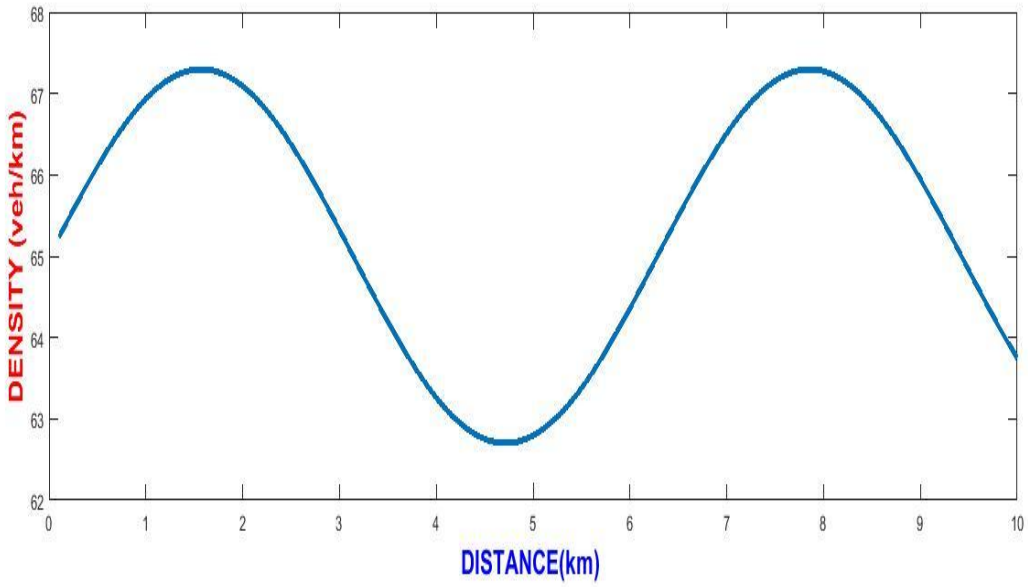

Figure7: Density depiction of ahsan model.

The last graph is ahsan model,. In this model a constant term is added as a source term to the road. The maximum density depicted is 68 vehicles

CONCLUSION

The purpose of this paper was to identify the first order models possessing a source term. This will further provide grounds to show there drawbacks. New models will be made on source term using different analogies. These analogies will be far more efficient in coping the deficiencies of the available models. This will improve the research in the field of traffic modeling.

REFERENCES

[1] D. Vikram, P. Chakroborty, and S. Mittal, "Exploring the Behavior of {LWR} Continuum Models of Traffic Flow in Presence of Shock Waves," Procedia - Soc. Behav. Sci., vol. 104, pp. 412–421, 2013.
[2] A. Ali, L. S. Andallah, and Z. Hossain, "Numerical Solution of a Fluid Dynamic Traffic Flow Model Associated with a Constant Rate Inflow," Am. J. Comput. Appl. Math. 2015, 5(1) 18-26 DOI 10.5923/j.ajcam.20150501.04, vol. 5, no. 1, pp. 18–26, 2015.
[3] C. Perlman, "Mathematical Modelling of Traffic Flow at Bottlenecks," 2008.
[4] M. O. Gani, M. M. Hossain, and L. S. Andallah, "A finite difference scheme for a fluid dynamic traffic flow model appended with two-point boundary condition," GANIT J. Bangladesh Math. Soc., vol. 31, pp. 43–52, 2011.
[5] T. S. Engineering, "Chapter 3 Traffic Stream Models," vol. 2014, pp. 1–11, 2014.
[6] A. Kotsialos, M. Papageorgiou, C. Diakaki, Y. Pavlis, and F. Middelham, "Traffic Flow Modeling of Large-Scale Motorway Networks Using the Macroscopic Modeling Tool METANET," IEEE Trans. Intell. Transp. Syst., vol. 3, no. 4, pp. 282–292, 2002.