

REVIEW PAPER ON USE OF TRAJECTORY OF THE VEHICLE AND IT'S APPLICATIONS

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Abstract – Driving behavior usually describes the driver's intent behind the movement from their current spot on the way to their target spot and this expressively distresses the overall traffic performance of the system. These effects are more noticeable with more lane facilities wherein each driver has a choice to sustain their existing lane or change to the target lane to avoid delays. In this review paper, the trajectory of the vehicle and its various applications are been considered as it is very useful in understanding various microscopic behavior in different scenarios. The paper focuses on various ways of extracting the trajectory of the vehicle Various models were developed to understand the driver following and car-following behavior patterns and also to understand the delay at the signalized intersection as well as the loss of fuel or fuel consumption at the red signal.

Key Words: Trajectory, Signalized Intersection, Mid-Block Section, Acceleration, Deceleration, Delay.

1. INTRODUCTION

Traffic simulation with the help of microscopic models has to turn out to be a significant tool for analysis and development of traffic arrangements. These models allow the traffic engineer to learn and assess the performance of the system, their working level, and some replacements of managing. Models for simulation are also well fitted for various analysis, design, and performance calculations as systems can be replicated without the need to build, interrupt, or extinguish them. The very basic element of these micro-level simulation models is the car-following model which designates the distinct crusade of the vehicles. This work presents an infinitesimal stochastic imitation model that vie with the traffic activities at signalized intersections with semi-actuated signal cycle operation.

In the Indian traffic scenario, the stream is weak-lane controlled and diverse, comprising numerous vehicle types like a truck, motorized three, and two-wheeler and cars.

These reported studies are based on out of date statistics which are collected using traditional and less precise methods. Therefore, this work purposes to study the Acceleration and Deceleration behavior of several vehicle categories using modern devices like the Global Positioning System (GPS) unrestrained style including thoroughgoing acceleration & deceleration enclose.

In the case of a signalized intersection, the crusade of vehicles with high speeding up capability, like a car, is controlled by the existence of vehicles with little acceleration competence like motor-powered three-wheelers, trucks, etc. Due to this, to understand the effect of such circumscribed movements on the design of the extent of red, green & amber at the signal intersection, tailpipe emanation and fuel ingesting, the specific acquaintance of A/D behavior of these vehicles is desired.

Signals of Traffic at-grade junctures of highways inexorably vigor vehicles to stop and wait recurrently and cause stop-and-go waves in taking place traffic in traditional traffic maneuvers. This type of stop-and-go waves is substantially conciliation of traffic efficiency due to its loss time in preparatory from a full stopover, vividly surge vehicle fuel consumption, and secretions due to recurrent and abrupt decelerations & accelerations which likely cause safety perils due to large speed inconsistencies in the identical traffic stream. Intersections consisting of Signals are largely accountable for the most recurrent and deterring bottlenecks on urban roads. The importance of these signalized intersections for urban street traffic efficiency provokes a lot of studies that have engrossed on how to control, adjust, and heighten signal control stratagems to expand the transitory capacity.

TRAJECTORY OF THE VEHICLE

- Longitudinal and lateral coordinates of a vehicle at any time 't' can be evaluated as a real continuous-time function and this is known as the Trajectory of a vehicle.

- Usually developing the trajectory of the vehicle inhomogeneous based traffic conditions is quite less hectic and laborious as compared to the heterogeneous conditions where mixed traffic conditions are prevailing.
- Sometimes due to a lack of discipline under mixed traffic flow, regular trajectories within the intersection are difficult to form which leads to encounters and interactions of different classes of the vehicle [9].
- Due to this interference with each other, vehicular trajectories are equitably irregular and haphazard.
- Even with the help of automated software, there are some time issues concerning its accuracy and precision of coordinates of the vehicle been traced.

METHOD OF EXTRACTION

There are broadly two types of methods for extracting the trajectory of the vehicle by using video graphic data.

1) Automated Software

- This type of software automatically extracts the trajectory of the vehicle using video graphic data.
- The accuracy of this software is a bit less as in the heterogeneous condition it becomes difficult for the software to detect the type of vehicles and extract their trajectories longitudinally as well as laterally.
- This type of software is usually very expensive.

- Due to this the accuracy increases as there is only minimal human errors it is a labor intrinsic work.
- This combination helps in getting the trajectory more accurately as the human inputs the points for the respective class of vehicles in the software and classification is been done base on time frames and vehicle categories.
- Less software is a freeware that can be used for carrying out research work related to this trajectory of the vehicle instead of being very expensive and less accurate for heterogeneous conditions.

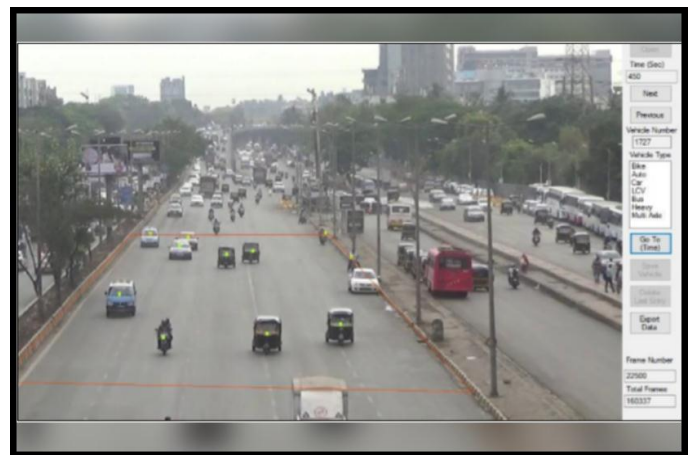


Fig 02: Example of Semi-Automated Trajectory Extraction.



Fig 01: Example of Automated Trajectory Extraction.

2) Semi-Automated Software

- In this type of software, there is a combination of both manual as well as automated software is used to extract the trajectory of the vehicle.
- The video graphic data is been uploaded and manually trajectory of each class of vehicles extracted.



Fig 03: Example of Semi-Automated Trajectory Extraction.

RELATED WORK

Andyka Kusuma et al [1] studied the behavior of drivers at the Weaving section of the road by using surveillance data of traffic. Merging and Diverging area when are designed closely on the road one after another then weaving segments are formed. Car Following and Lane changing behaviors of the driver can be analyzed at the weaving sections which are very complex. Andyka used a locally weighted regression

method for eliminating errors due to data extraction and to maintain the accuracy of the trajectories of the vehicles. It was found that due to the presence of auxiliary lane in the weaving segment the drivers can plan properly about lane changing later after the end of merging and diverging areas instead of forcing themselves at the initial stage of the merging area. The paper classified the lane changing into direct and staggered lane changing types, which analyzed the lane changing of the vehicle and the number of lanes been changed. It was also found that 28.16% of the traffic lead 1 lane-changing later they changed their respective lanes at the initial 50-100 meter. Their results will give some insight into car-following & lane-changing behavior of traffic as a whole at weaving sections which will help in developing various traffic models.

Shan Fang et al [2] studied the planning method of the trajectory by taking into consideration vehicle firmness and its fuel ingesting at the signalized intersection. The fuel consumption and emanations are excessive at the signalized intersection when the vehicle stops at the red signal and the travel delay also increases. The studies proposed a trajectory planning method that contains pre-fixed signals based on the trigonometric model. MATLAB software was used to simulate the reduction in the fuel consumption and emanations of the vehicle transitioning the signalized intersection for the trajectory planning method. After making the market penetration rates and linked vehicles to 100%, it was observed that the fuel ingesting and CO₂, CO, and NO_x absorptions diminution by 34%, 35.1%, 33.9%, and 45.7% correspondingly.

Yanning Wei et al [3] analyzed perilous instant decision procedures by using trajectory at mixed-flow. Events studied were like abrupt decelerating, accelerating, jerking, swinging, and swerving may occur often and might result in probable traffic crashes and conflicts. These events were studied by using high-resolution data of trajectory with the help of entropy theory. And the method was been verified by comparing it with the conventional method and real observations. A 3D analytical method was developed to vigorously categorize events with interactions and eliminating certain constraints of a fixed zone. The study also evaluated variation in driving for not only provincial but also for discrete behavioral physiognomies by the kinematic gauge dispersal and Post-Encroachment.

Luís Vasconcelos et al [4] Calibrated the Gipps Car-following model with the help of trajectory data of the vehicles. This car following model helps in modeling the movement of vehicles (longitudinally). Basic traffic stream variables like speed, density, and flow are used as a macroscopic model to calibrate the model. Data logger with the help of a LIDAR rangefinder was used to collect the trajectory data from the car in the leading and the following vehicle. This aided in getting accurate acceleration and speed measurements. It was found that calibrating with the help of optimization was effective in replicating patterns such as

shying-away and closing-in for a particular segment. But the study had some limitations as it was just observed from a single driver's behavior and not of traffic as a whole and it was done in a homogeneous traffic condition. Their further future scope was analyzing patterns when there are mixed traffic conditions like in the developing countries where heterogeneous traffic is present and the drivers are unaware.

Venkatesan et al [5] used trajectory data set under mixed traffic conditions and later developed a semi-automated tool for groping several characteristics of traffic flow such as acceleration, deceleration, speed, and longitudinal spacing. Typically, the trajectory data is not available freely due to the high fee tangled in data assortment and extraction with various methodological hitches. The study exhibited particularly in the mainstream traffic two-wheelers moved significantly in the lateral path.

Forbes model [6] analyzed the reaction time required for the following vehicle to perceive the conditions to decelerate and apply brakes. A maiden attempt was made considerate to the subsequent nature and modeled a rectilinear car-following model which is built on the speed of the subsequent vehicle and safety distance.

Vincenzo [7] assessed the data on the trajectory of the vehicles and its accuracy by using Next Generation SIMulation (NGSIM) package as a large amount of data is made available freely which opens new prospects in the learning of the traffic flow theories. The premeditated methodology, involved consistency analysis, jerk analysis, and to the wide-ranging set of NGSIM data spectral analysis is applied. The study was more engrossed on the unruly of assessing vehicle paths from detected spots. Application of the NGSIM data permitted to substantiate the categories and bases of the errors in the trajectory information and to enumerate it & diverse accuracy of the various datasets was apprehended. The method for error scrutiny certainly consents the data exactness resulting from different assessment techniques to be captured.

CONCLUSION

- Nonetheless, there are various restrictions of these methods that validate future research work so first, only a single person was cast-off as a driver(test) beside it's imperative to comprehend if the main deductions endure holding with unlike drivers; second, it would be thought-provoking to see if the results from the second method can be enhanced by growing the run extents and by fraternizing different driving environments.
- In conclusion, it is imperative to recognize if the subject drivers, being cognizant that their performances are being documented, have an ordinary driving behavior or,

on the contrary, it is crucial to observe unconscious drivers.

- Lateral movement of vehicles is generally least during the stopped condition (laterally and longitudinally constrained) followed by during free-flow condition, where the vehicles only undergo lateral movement for overtaking purpose or undertaking left or right turn at the intersection.
- The most by lateral movement is observed during congested flow where in addition to the conditions for free flow time added lateral movement is observed due to vehicles trying to position themselves at advantage longitudinally and while trying to overcome the congested flow condition.
- Several factors limit the applicability or accuracy of the existing vehicle traffic behavior models. With the advent of autonomous driving vehicles and connected vehicles in many parts of the world, the technology is still a distance away from being implemented in mix traffic non-lane-based driving conditions.
- Hence, the added advantages and immeasurable potential that the trajectory data holds, the method should be explored and implemented.
- Each approach has some restrictions and limitations, but with precision, wise assured results, and ease in computation, the trajectory-based approach might stand as the best method to estimate the control delay, in addition to the data which can further be used for all types of studies applicable to the study section.
- Maybe, by visualizing the field conditions in terms of numbers comprising of all the conditions, the analysis using trajectory data may lead towards more robust and dependable models for traffic flow and behavior measurement.

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