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A Review Paper on Study of Lane Changing Behaviour Due To U-Turns at An Uncontrolled Median Opening

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ABSTRACT: Driving is a highly intricate task which comprises of various subtasks and is associated with combination of driver's perception, cognition and motor response. The lane changing action is regarded as one of the subtasks of driving and is defined as an action of lateral shifting of the vehicle to the next adjacent lane. It comprises of critical aspects like lower-level control in the form of steering and acceleration, monitoring by maintaining situation awareness and by decision making about when to change the lane. Lane changing is influenced by driver behavior and traffic flow. Mandatory Lane Change is performed in order to follow a specified path whereas Discretionary Lane Change is accomplished with an intention of achieving better traffic conditions. The present study is carried out to assess the lane changing pattern due to control of access on urban highways.
KEYWORDS: Lane change, Access control, Median opening, limited priority situation, Game Theory.

I. INTRODUCTION

The escalating volume of vehicular traffic, has hampered the transportation infrastructure. As a result, there is a need to build highways as multilane roads and upgrade the existing ones to meet the increased vehicular traffic demand. The multilane roads provided with raised medians segregate the traffic moving in opposite direction and provide access to adjacent property through median openings, where the vehicles make a U-turn and reverse the direction of travel. When a vehicle intends to perform U-turn at the median opening, it waits for a safer gap to merge with the main stream of traffic. But if the volume of traffic in main stream is more, the U-turning vehicles driver tends to accept shorter and unsafe gaps in order to overcome waiting. This compels the mainstream traffic to reduce their speed, change the lane or perform both actions. This discourteous behaviour of U-turning drivers results in 'Limited Priority Situation' where the priority of main traffic stream gets shared. During this action there are chances of occurrence of conflicts.

By proper enforcement, motor vehicle administration and driver education these conflicts can be prevented. By proper design and engineering of highways with due consideration to access control on highways during its design, a greater highway safety can be imparted by eliminating the risk of traffic interference.

1.1 Access control

Access control can be defined as the right of possessor or resident of adjacent property to make use of a highway which is under public authority either fully or partially.

<u>Full Access Control</u>: The through traffic is given priority by making it accessible with only some public roads. Crossing at same level and direct connectivity by driveways to private properties is not allowed.

<u>Partial Access Control</u>: Additional degree of accessibility is provided to through moving traffic by connecting with some public roads along with certain driveway connectivity to private property and limited at grade crossing is allowed.

1.2 Need for Access control

Un-controlled access to highways reduces the level of service and increases the chances of accidents. Right turning movements from and into the main highway are dangerous particularly.

If effective access control is not exercised during design of highway, ribbon development occurs. Interference to traffic from residential and commercial establishments increases, that results in congestion. Number of accidents increases due to increase in conflict points. Also, the speed drops and level of service gets reduced. The great expenditure spent in building a highway facility becomes functionally obsolescent soon. Hence access control can combat an unregulated way of ribbon development in urban fringes.

Access control can be either full or partial. The degree of access control exercised depends on the level of service suggested, accident recurrence, legal considerations, traffic pattern, cost of vehicle operation, travel time, land use, and the ease of access to owners of adjacent property.

II. LITERATURE REVIEW

Many fact-finding investigations have been carried out earlier to study the purpose and aspects of lateral shifting of vehicles under a variety of circumstances. P.G Gipps was first to develop a mathematical model for lane changing behaviour using a micro simulator. He laid the foundation for future studies.

P.G Gipps (1986) suggested a model that was dependent on the decision made by driver during lane change in an urban roadway condition. Before any lane changing action there exists three questions about the possibility, necessity and preferableness of lane change.

Toledo et al. (2003) developed a combined lane changing model by using detailed vehicle trajectory data. The results of the study indicate that the selection of the lane by driver is influenced by path plan variables and neighbouring traffic conditions. The study resulted in a robust and more generalised model which can be applied for any urban freeway section.

Lv, W. Song (2013) defined a model on process of lane changing where the general lane changing behaviour is differentiated by considering the merging

Shaban (2012) studied lane changing behaviour on arterial streets under high traffic volumes. The study was carried out on road sections with closely spaced signalized intersections which suffered delay problems due to lateral shifting of vehicles. This study disclosed that the spacing between intersections affect the lane changing distance and as these spacing increases, the lane changing distances also increases.

L.Wan et al. (2011) described an algorithm that determined the reference vehicle trajectory for free lane changing manoeuvre. The algorithm uses sensing signals like the velocity of each vehicle, the relative distance between vehicles as variables and approximates the positions of host and surrounding vehicles after completing lane changing manoeuvre.

Van Winsum et al. (1999) used a fixed based driving simulator in order to study the relationship betweenexamined the relation between theoretical information and vehicle response during lane-changing operation. The experiment consisted of eight drivers executing 48 lane changing operation with different speed, on roads of different width of lane and with different directions of traffic. The results demonstrated three states of lane change that were in sequence and it is carried out in a flexible way within safety margin. It was found that width of lane did not influence the dependent variables.

Laval and Daganzo (2006) studied lane changing in freeway traffic streams. At the time of their study there were qualitative speculations and empirical evidence for freeway lane changing but a quantitative understanding of its impacts on traffic flow was not clear and this study attempted to fill this gap. They developed a hybrid approach to overcome these problems. This model combined the best features of microscopic and macroscopic models suggested that vehicles that change lane create voids in traffic streams which reduce traffic flow.

Salvucci and Liu (2002) have attempted to substantiate the picture of lane-changing behaviour by analysing the time taken for changing lane in terms of the driver's control and eye movement behaviour. The investigation was based on data collected on eye-movement of driver. This has resulted in developing and validating a rigorous integrated model of driver behaviour.

Talebpour et al. (2015) implemented the game theory. According to this approach, games are of two types; first when the driver is sure about the decision of the other driver and the second when the driver is not sure about the decision of another driver.

Ali et al. (2019) according to them the connected environment solves many problems related to traffic safety, efficiency, mobility and environmental impact. The connected environment means where a driver comes to know the prevalent and forthcoming driving situations the probable unexpected hazards related to lane change. It gives real time information about the neighbouring traffic which helps to tackle intricate driving actions like lane change.

Ali (2007)collected high-quality vehicle trajectory data by using CARRS-Q, an advanced driving simulator for applying to game-theory.

Liu (2009) concluded that this approach was effective in capturing vehicle interactions at freeway merging sections and had a high accuracy of prediction of action of vehicles.

Hill et al. (2015) performed 726 combined total freeway lane changes by driving an instrumented vehicle and this result was used for analysis of lane changing at merging sections

Malaya Mohanty and ParthaPratim Dey (2020) evaluated the lane changing behaviour of approaching through vehicles due to U-turns at median opening at different U-turning traffic volume. The study involves direct application of Markov's process for predicting the lane changing tendency of main traffic stream due to U-turns. Markov's process is being applied for space rather than time. The applicability of Markov's process for assessing lane changing behaviour is tested by comparison of field data and the results obtained from Markov's process. This comparison has revealed a remarkable level of accuracy. These results show that Markov's process can be used as an effective tool in Intelligent Transportation System and traffic management.

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