KID: 20230310

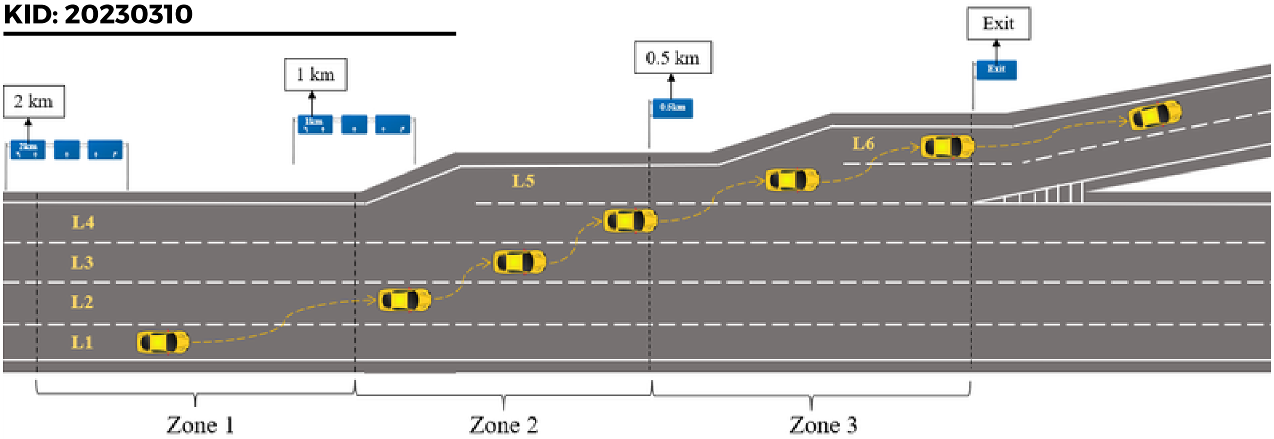

Figure-2: Depiction of Zones

Freeways play a vital role in the roadway transportation system. With rise of traffic volumes and high speeds on freeways have created serious safety concerns and led to traffic crashes or accidents. Globally, over 1.35 million people are killed in road crashes each year. In India, there were 4,12,432 reported road crashes in 2021, with national highways and freeways accounting for a significant portion of crashes (31.2%) and fatalities (36.4%). At the exit of freeway ramps, drivers are often at risk due to the diverging traffic operations, which can create traffic interruptions, unsafe conditions, and improper lane changes that can further aggravate the risk of crashes. According to the National Highway Traffic Safety Administration (NHTSA), human errors were responsible for 93% of traffic crashes, whereas lane-changing was responsible for 27% of all crash events. Statistics have showed that 40% of crashes occur in merging or diverging zones. Due to the diverse operating characteristic of freeways, traffic crashes may generate serious consequences. Therefore, real-time prediction of driver behaviour at critical locations of freeways imparts significant improvement in freeway operating efficiency.

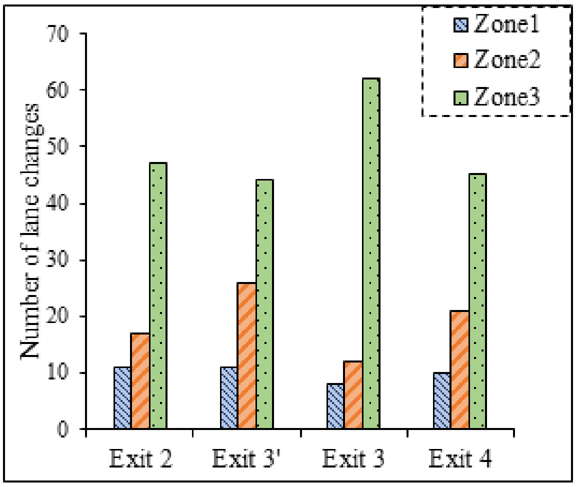

Figure-3: Number of Lane Changes in Each Zone

Conclusion:

The role of exit ramp terminals is to provide smooth diverging operations for off-ramp vehicles from mainstream. The results showed that the intense lane change is taking place 500 m from the entrance gore for all exits. In addition, particularly from L4 to L5 (here L5 indicated the auxiliary lane) is most prevalent in this 500 m zone for all exits. Thus, understanding the significance of lane changes in each zone can avoid the bottleneck conditions near exit areas and contribute to safer diverging operations.

[1] **Ms Aluwala Gayathri**
Research Scholar, Department of Civil Engineering

[2] **Dr Digvijay S Pawar**
Associate Professor, Department of Civil Engineering

Modelling Lateral Acceleration: A Data-driven Approach to Interchange Safety

KID: 20230311

Interchange ramps play a crucial role in road networks as they serve as connectors between multiple freeways or major roads. To ensure efficient transfer of vehicles between different roadways, interchange ramps are designed with horizontal and vertical curves as displayed in **Figure 1**. However, these curvatures make interchange ramps more complex and crash-prone compared to the mainline segments of the freeway.

To improve safety and articulate significant safety schemes, it is important to analyse driver behaviour measures such as speed and lateral acceleration adaptation on ramp interchanges at a microscopic level. Existing studies on speed and lateral acceleration are limited to horizontal curves, and no few studies were found to deal with ramp interchanges in India.

KID: 20230311

To address the current research gap, we developed a model using support vector regression (SVR) to estimate lateral acceleration experienced by the drivers on diagonal, loop and semi-direct ramps of service interchanges using 85th percentile speed () and geometric elements such as curvature, ramp length, grade, and superelevation. To establish these models, the continuous lateral acceleration profiles for 83 drivers were collected using an instrumented vehicle. The developed SVR models exhibited higher accuracy, measured by the values of the coefficient of determination and the root mean square error. **Figure 2** illustrates the model prediction data superimposed with actual data, indicating a good agreement between the proposed model and the actual data.

Further, a sensitivity analysis was performed to measure the relative importance of input features. The results revealed that ramp curvature and ramp length are the two most significant variables that impact lateral acceleration on diagonal and semi-direct ramps. Whereas for loop ramp connectors displayed the highest association with lateral acceleration.

Figure-1: Interchanges on outer ring road (ORR), Hyderabad City: (I) Shamshabad, (II) Nanakramguda, (III) Patancheru, (IV) Kamuni, (V) Saragudem, and (VI) Pedda Golconda

References:
1. Farah, H., Daamen, W., & Hoogendoorn, S. (2019). How Do Drivers Negotiate Horizontal Ramp Curves in System Interchanges in The Netherlands? Safety Science, 119, 58-69.
2. Basu, C., Yang, Q., Hungerman, D., Sinahal, M., & Draqan, A. D. (2017, March). Do you want your autonomous car to drive like you?. In 2017 12th ACM/IEEE International Conference on Human-Robot Interaction (HRI (pp. 417-425). IEEE.

Practical Applications

Lateral acceleration is directly related to the vehicle steering maneuver and therefore decides the comfort of both driver and passengers. Studies on lateral acceleration will aid in identifying near-crash events, black-spots and estimating index parameters for assessing driving behavior. Lateral acceleration is an important driver behavior parameter reflecting the driver's choice of speed and steering angle when negotiating ramp curves. The studies on driver behavior are critical for the development of autonomous vehicles (AVs) controllers and control strategies (Farah et al. 2019) as the driver's acceptance of the AVs will increase if the vehicles are programmed to drive more closely to each driver's preferred driving behavior and driving style (Farah et al. 2019; Basu et al. 2017). The lateral acceleration models developed in this study are based on real world data thus providing quantitative and qualitative support for understanding driver's choice of speed and lateral acceleration on interchanges.

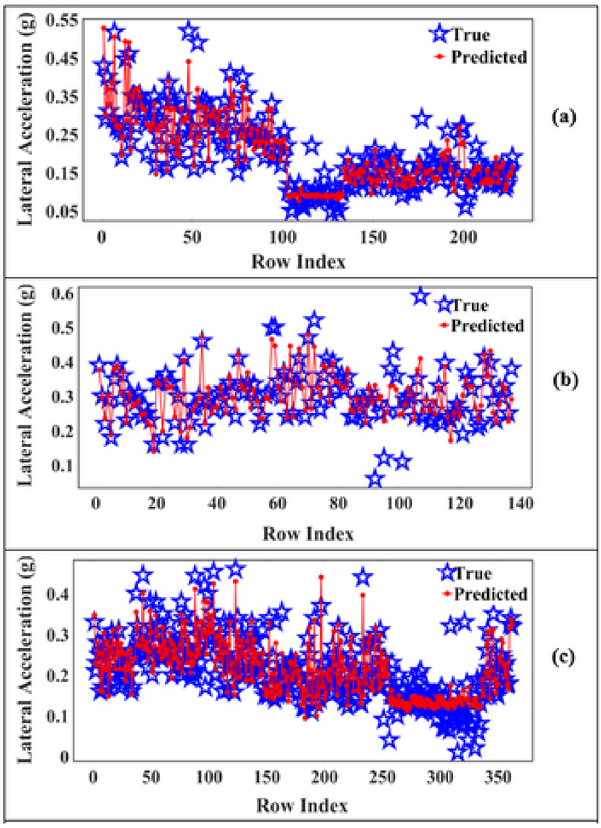

Figure-2: Implementation of the model on the training dataset (a) Diagonal ramps (b) Loop ramps (c) Semi-Direct ramps

[1] **Ms Sarika Pothukuchi**
Research Scholar, Department of Civil Engineering

[2] **Dr Digvijay S Pawar**
Associate Professor, Department of Civil Engineering