Risk Dreamer: Imaging the near futhre in the laten space for IEEE Journals

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***Abstract*—Vehicle platoons the things we should have to uniquely done for this things equipped with cooperative adaptive cruise control (CACC) have the potential to improve traffic stability and reduce congestion. Existing CACC studies mainly focus on evaluating the overall network performance and lack micro-level trajectory cluster observation regarding the impact of heterogeneous CACC platoons on mixed traffic flow. This study implements a simulation framework that creates a realistic mixed traffic flow consisting of manual driving vehicles (HDVs) and heterogeneous CACC platoons (consisting of both cars and trucks) on highway merge areas. By adjusting four influential factors: traffic volume, truck ratio, CACC market penetration rate (MPR), and CACC platoon size, a series of high-resolution trajectory data were obtained for analyzing their influence on traffic flow characteristics. Subsequent analysis, using both quantitative statistical measures and visual demonstrations, revealed that higher traffic volumes and truck ratios lead to an expansion of congested areas. Whereas increasing the MPR of CACC platoons can alleviate this issue by reducing the overall oscillation level and actual traffic density, encouraging more vehicles to change lanes, thus blending clusters of high and low speed vehicles. However, the impact of increasing CACC Platoon size in a small range remains insignificant. This study can serve as a reference for investigating the mechanisms behind the impact of heterogeneous CACC platoons on the mixed traffic flow pattern.**

***Index Terms*—IEEE, IEEEtran, journal, LATEX, paper, template.**

I. Introduction

THRecent years, accelerated urbanization has precipitated a significant escalation in traffic volume, engendering pervasive concerns related to congestion and safety on urban streets and highways [1], [2]. In response to these challenges, the advancement of connected and automated vehicle (CAV) technologies has paved the way for CACC platooning. The CACC platooning system involves a group of CAVs that communicate with each other to maintain a close and stable distance while traveling longitudinally and laterally on roads, thus improving traffic efficiency, energy consumption, and safety [3], [4], [5]. This technology has garnered the interest of many scholars and investors, particularly those in the long-distance hauling industry [6], [7], [8]. However, freight vehicles comprise only a minor portion of overall road transportation, and CAVs will share the roads with HDVs for an extended period [9], [10], [11]. Additionally, existing researches suggest that the effectiveness of the CACC system relies on a relatively high MPR [12], [13]. Therefore, to maximize the use of CAVs on the road, connecting different types of CAVs to form heterogeneous CACC platoons and exploring how it will affect the traffic flow mixed with conventional HDVs has become a compelling area to investigate. Previous research has explored how traffic flow can be improved through the use of CACC systems. Having sufficient MPR for CACC system implementation is found to be crucial in making a positive impact on traffic performance. Bart et al. [14] discuss the impact of CACC on traffic flow characteristics in a highway-merging scenario using simulations. The study shows that at low traffic volumes, different rates of CACC have no significant impacts. However, at high traffic volumes, increased CACC rates improve stability, increase throughput and speed, and decrease shockwave impacts. Appropriate platoon size configuration is another key factor for the CACC system that affects traffic flow throughput and stability. Yao et al. [15] investigated the fundamental diagram and stability of mixed traffic flow with different platoon sizes and intensities of CAVs. Numerical experiments indicate that greater platoon size leads to increased traffic capacity but is harmful to maintaining traffic flow stability. It is suggested that a platoon size of 4 to 6 be used to balance the relationship between traffic capacity and stability. Regarding the impact of adding trucks to form a platoon on traffic flow performance. Calvert et al. [16] found that truck platooning may have a small negative effect on non-saturated traffic flow. However, it has a much larger negative effect on saturated traffic flow. The study recommends improving platoon strategies and suggests that policymakers should only allow truck platooning in nearly or non-saturated traffic. The merging area on the highway is a crucial scenario for evaluating the effectiveness of CACC. Xiao et al. [7] examined the impact of CACC on highway operations at merging bottlenecks. They used realistic data to calibrate the CACC vehicles and found that although the CACC system can increase roadway capacity, it cannot overcome the capacity drop in bottlenecks. CACC also increases flow heterogeneity due to operation mode switching. Trajectory data from mixed traffic flow can provide crucial insights into how CAVs impact the behavior of HDVs. Zhong et al. [17] used high-resolution trajectory data to quantify the impacts of CACC on HDVs. They compared ad-hoc and local coordination clustering strategies and found the latter to be superior in network throughput and productivity. However, local coordination significantly changed the distribution of hard braking events for HDVs. The average lane change frequency increased until a 30In summary, the aforementioned studies have demonstrated the impact of CACC platoons on traffic flow. However, the effects

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are complex and depend on specific circumstances, requiring detailed observations for further investigation. Currently, most microscopic observations of CACC trajectory data focused on shock wave phenomenon and platoon linear stability, neglecting more clues about collective vehicular behavior patterns [18]. Additionally, many of the current studies only involve homogeneous CACC platoons or a single type of background traffic vehicle. This oversimplifies real-world scenarios and disregards the intricacies of interactions among various vehicle types and differences between individual vehicles. To address these issues, the contributions of this paper are summarized as follows. (1) We developed a simulation framework for analyzing the impact of heterogeneous CACC platoons on mixed traffic flow in highway merging areas. Real-world trajectory datasets are used to calibrate vehicle parameters to simulate realistic collective behavior among individual vehicles. (2) The impact of heterogeneous CACC platoons on mixed traffic flow, as revealed by high-resolution trajectory data, is initially quantified through statistical metrics. Subsequently, those findings were further explained in detail through visualizations. The rest of the paper is structured as follows: The simulation models and calibration process are described in Section 2. Followed by the case study and the analysis of its results in Sections 3 and 4. Finally, the conclusion and prospect are presented in Section 5.

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II. Conclusion

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Appendix A
Proof of the First Zonklar Equation

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Appendix B

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Acknowledgment

The authors would like to thank...

References

[1] H. Kopka and P. W. Daly, *A Guide to LaTeX*, 3rd ed. Harlow, England: Addison-Wesley, 1999.

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Michael Shell Biography text here.

John Doe Biography text here.

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