**Abstract:** The increased pollution created by automobiles stopped in heavy traffic in big cities is highly costly as compared to when traffic moves freely. Self-driving car technology has come a long way in recent years. Assisted and semi-automated driving technologies are now available, with optimistic estimates for completely autonomous vehicles in the future decades. As the environment changes, congestion relief in situations including driverless or semi-autonomous vehicles faces new opportunities and obstacles. The goal of this research is to improve intersection traffic flow by allowing vehicles to travel freely and securely. One of the most stressful components of any transportation network is intersections. Because the hubs' function is to coordinate several traffic patterns, each with its own set of goals and preferences, this tension is inherent. The problem was solved by creating three ways for modeling any intersection, identifying the paths with the fewest possible points of confusion between their in and out directions, and using queueing theory to optimize the vehicle arrival rate for maximum intersection performance.

**Introduction:** Intersections are frequently traffic barriers in a city's road network. The management of intersection traffic has long been a prominent research topic. Traditionally, signals have been employed to allow conflicting traffic streams’ rights of way. Several studies have been conducted to optimize traffic signals that are either fixed-time control, actuated control, or adaptive control to improve the efficiency of transportation networks [1]. Nonetheless, signal delays continue to put substantial pressure on urban transportation networks. In the United States, for example, 16 billion vehicle hours of delay are predicted on major highways [2]. With the advent of CAV technology, new avenues for traffic control have become available. Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications, for example, enable the transmission of real-time traffic information from intersections to vehicles for trajectory planning, as well as the collection of comprehensive vehicle trajectory data, including speeds and locations, for signal control.

Signal optimization with real-time CAV trajectory information is a simple application [3] that complements infrastructure-based detector data. To reduce energy/fuel use, emissions, delay, and other issues, CAV trajectories can also be optimized by adjusting vehicle speeds or acceleration rates in response to predetermined signal timings. [4]. There is also some literature [5] on a unified framework for optimizing both traffic signals and vehicle trajectories simultaneously. Under the assumption of ubiquitous CAVs, signal-free junctions have been proposed in which vehicles negotiate traffic lights through cooperative communication with one another. The study of reserves is a vital subfield of philosophy. An intersection manager and vehicle agents make up the reservation-based system. Each incoming vehicle agent requests a specific time slot from the junction manager so that it can proceed through the intersection in the manner of its choosing. Due to concerns with previous bookings, the request must be approved or declined by the intersection manager. Simple but effective methods, like the "first come, first served" (FCFS) strategy [6], the "auction strategy" [7], and the "platooning BATCH approach" [8], determine the order in which vehicles receive maintenance.

Furthermore, because of unequal traffic on main and smaller roads, the regularly used FCFS technique may result in hunger at an intersection and, as a result, traffic jams. Batch processing of reservation requests was presented as an improvement over the FCFS mechanism for enforcing liveness criteria [8]. Despite significant efforts to manage CAVs at intersections, the advantages of reservation-based control over conventional signal control have yet to be proven, particularly at peak demand levels and have not been thoroughly explored. However, comparisons were drawn using concrete numerical examples. Changes to three numerical parameters can have vastly different effects on the final result. Therefore, it would be more persuasive to compare these two control systems in a logical manner, such as by employing queueing theory to analyze latency and throughput at signalized junctions. Furthermore, due to the rule-based nature of reservation-based control, vehicle trajectories are not optimized, so system optimality is not guaranteed.

Constructing a constrained nonlinear optimization model with a focus on safety to reduce trajectory overlap has received a lot less attention than the shift from reservation-based to optimization-based approaches. There was a focus on achieving the best possible acceleration and deceleration from the vehicle. A hybrid of the active set method and an optimizer was used to solve this model. However, due to this intractable objective and the complex nonlinear model, optimal efficiency cannot be achieved. Researchers [9] found that there are three distinct areas for different types of trajectories at an intersection. The team then presented an interior-point-solved constrained nonlinear optimization model for minimizing vehicle delay. Optimization was performed only for newly loaded vehicles; all previously calculated trajectories were saved as backups. [10] used the cell transmission model to develop a lane-based traffic flow model and offered a linear programming strategy for controlling traffic lights at intersections without human intervention.

This study fills these gaps in the literature by using queueing theory to assess the efficacy of reservation-based control and by proposing a practical model for CAV management at isolated crossings. The best maintenance schedule for this problem is then determined using an optimization model.

**Reference**

1. Ahn, H. and Del Vecchio, D., 2016, April. Semi-autonomous intersection collision avoidance through job-shop scheduling. In *Proceedings of the 19th International Conference on Hybrid Systems: Computation and Control* (pp. 185-194).
2. Azimi, R., Bhatia, G., Rajkumar, R.R. and Mudalige, P., 2014, April. STIP: Spatio-temporal intersection protocols for autonomous vehicles. In *2014 ACM/IEEE international conference on cyber-physical systems (ICCPS)* (pp. 1-12). IEEE.
3. Bahram, M., 2017. *Interactive maneuver prediction and planning for highly automated driving functions* (Doctoral dissertation, Technische Universität München).
4. Behrisch, M., Bieker, L., Erdmann, J. and Krajzewicz, D., 2011. SUMO–simulation of urban mobility: an overview. In *Proceedings of SIMUL 2011, The Third International Conference on Advances in System Simulation*. ThinkMind.
5. Campos, G.R., Falcone, P., Wymeersch, H., Hult, R. and Sjöberg, J., 2014, December. Cooperative receding horizon conflict resolution at traffic intersections. In *53rd IEEE Conference on Decision and Control* (pp. 2932-2937). IEEE.
6. Guney, M.A. and Raptis, I.A., 2020. Scheduling-based optimization for motion coordination of autonomous vehicles at multilane intersections. *Journal of Robotics*, *2020*.
7. Hafner, M.R., Cunningham, D., Caminiti, L. and Del Vecchio, D., 2013. Cooperative collision avoidance at intersections: Algorithms and experiments. *IEEE Transactions on Intelligent Transportation Systems*, *14*(3), pp.1162-1175.
8. Jang, K., Vinitsky, E., Chalaki, B., Remer, B., Beaver, L., Malikopoulos, A.A. and Bayen, A., 2019, April. Simulation to scaled city: zero-shot policy transfer for traffic control via autonomous vehicles. In *Proceedings of the 10th ACM/IEEE International Conference on Cyber-Physical Systems* (pp. 291-300).
9. Kamal, M.A.S., Taguchi, S. and Yoshimura, T., 2016. Efficient driving on multilane roads under a connected vehicle environment. *IEEE Transactions on Intelligent Transportation Systems*, *17*(9), pp.2541-2551.
10. Keskin, M.F., Peng, B., Kulcsar, B. and Wymeersch, H., 2020. Altruistic control of connected automated vehicles in mixed-autonomy multi-lane highway traffic. *IFAC-PapersOnLine*, *53*(2), pp.14966-14971.