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PLO-AIM: Potential-Based Lane Organization in Autonomous Intersection Management

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Abstract : Traditional management models of intersections, such as no-light intersections or signalized intersection, are not the most effective way of passing the intersections if the vehicles are intelligent. To this end, Dresner and Stone proposed a new intersection control model called Autonomous Intersection Management (AIM). In the AIM simulation, they were examining the problem from a multi-agent perspective, demonstrating that intelligent intersection control can be made more efficient than existing control mechanisms. In this study, autonomous intersection management has been investigated. We extended their works and added a potential-based lane organization layer. In order to distribute vehicles evenly to each lane, this layer triggers vehicles to analyze near lanes, and they change their lane if other lanes have an advantage. We can observe this behavior in real life, such as drivers, change their lane by considering their intuitions. Basic intuition on selecting the correct lane for traffic is selecting a less crowded lane in order to reduce delay. We model that behavior without any change in the AIM workflow. Experiment results show us that intersection performance is directly connected with the vehicle distribution in lanes of roads of intersections. We see the advantage of handling lane management with a potential approach in performance metrics such as average delay of intersection and average travel time. Therefore, lane management and intersection management are problems that need to be handled together. This study shows us that the lane through which vehicles enter the intersection is an effective parameter for intersection management. Our study draws attention to this parameter and suggested a solution for it. We observed that the regulation of AIM inputs, which are vehicles in lanes, was as effective as contributing to aim intersection management. PLO-AIM model outperforms AIM in evaluation metrics such as average delay of intersection and average travel time for reasonable traffic rates, which is in between 600 vehicle/hour per lane to 1300 vehicle/hour per lane. The proposed model reduced the average travel time reduced in between %0.2 - %17.3 and reduced the average delay of intersection in between %1.6 - %17.1 for 4-lane and 6-lane scenarios.

Keywords : AIM project, autonomous intersection management, lane organization, potential-based approach
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