Title: A semi-autonomous algorithm for multi-vehicle collision avoidance at intersections with multi-conflict points

According to the National Highway Traffic Safety Administration (NHTSA), an average of 92 people died each day in the United States in 2012 because of car crashes [1]. To reduce the number of car crashes, the U.S. Department of Transportation (USDOT) and car companies have started initiatives to employ vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication technology to allow vehicles to exchange information with each other and cooperate to avoid car crashes [2].

Exploiting this technology, we design a semi-autonomous algorithm, called a supervisor, to prevent collisions at an intersection. More precisely, at each time-step, the supervisor determines possible future collisions among approaching vehicles and overrides the vehicles if such collisions are detected. In applications such as humans driving vehicles, full autonomy is not an option. Therefore, determining timing of an override is an essential problem. The most significant challenge of the problem is to mitigate computational complexity, because the supervisor must determine, within a time step, usually 0.1 sec, whether an override is necessary at this moment.

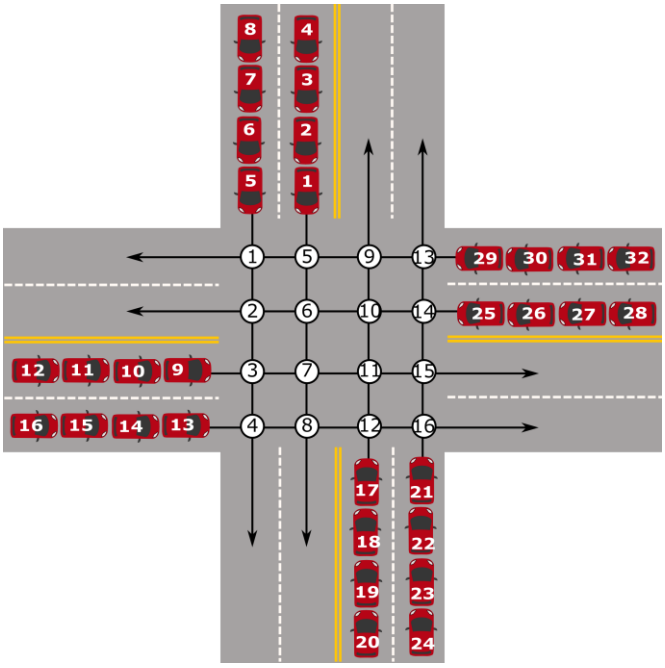


Figure 1: An intersection is modeled as multi-conflict points.

In our previous work, a supervisor assumed that the intersection was modeled as one conflict point [3-6]. Because of this assumption, the supervisor may override vehicles even when collisions are geometrically impossible. Thus, in this work, we relax the above assumption and extend the supervisor to multiple conflict points. The particular scenario that we consider is that vehicles with first-order

dynamics follow prescribed paths at an intersection, as shown in Figure 1. The computational results show that this supervisor is less restrictive than the previous one, and can consider multiple vehicles within 0.1 sec.

Whereas this work can be applicable to a general intersection model, it is restricted to first order vehicle dynamics. For practical uses, we must design a supervisor that takes account of general vehicle dynamics. Moreover, the assumption that the paths of vehicles are prescribed must be relaxed, and thus, all possible paths must be considered.

References

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