An Advanced Emergency Vehicle Control Strategy based on Automated Driving Technology

Master‘s Thesis of Liangyuan Tian

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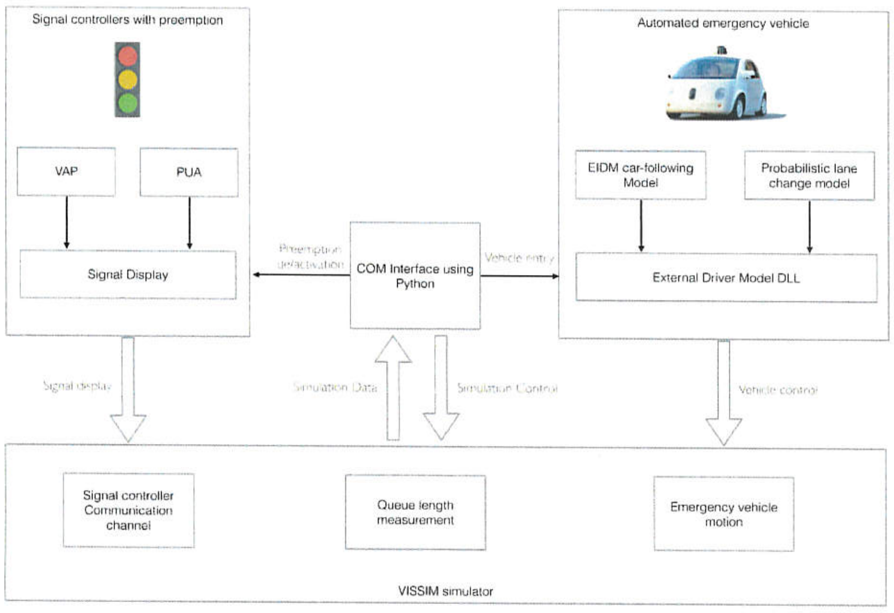

Figure 1 Sytem Overall Structure

Automated vehicles have seen an unprecedented growth in recent years. Most safety algorithms for controlling the automated vehicles are designed to slow down the vehicle against any projected danger regardless the exact situation. This improves vehicle safety while compromising mobility performance. This study has presented an integrated automated driving vehicle control strategy with preemption measures from both infrastructure and the vehicle itself. The system structure is shown in Figure 1.

For a more proactive driving strategy, new car-following model and lane change model are implemented to simulate automated vehicle driving behavior with several levels of aggressiveness. For car following model, the Enhanced Intelligent Driver Model controls vehicle longitudinal movement with zero reaction time and zero control variance, simulation results have shown the model exhibits higher maximum speeds and smoother acceleration control. For lane change model, a probabilistic model is applied with deciding lane change actions by simultaneously considering lane change possibility and benefit. Both of the longitudinal and lateral movement models are derived from real life automated vehicle control implementations.

For the preemption measures from the Infrastructure side, a real time emergency vehicle signal preemption system is proposed. The system activates preemption signal stage from the signal controllers based on waiting queue length at the intersection and the approaching speed of the incoming emergency vehicle, thus guarantees the smooth pass through of the vehicle and minimize the negative impact for traffic from other directions. The system concept is illustrated in Figure 2.

When the emergency vehicle is approaching an intersection, it is very likely that the next intersection along the vehicle route and is near to the approaching intersection and the distance in between are less than the required notification distance. Thus a coordinated signal control for the next approaching intersection assures the successful clearance in advance.

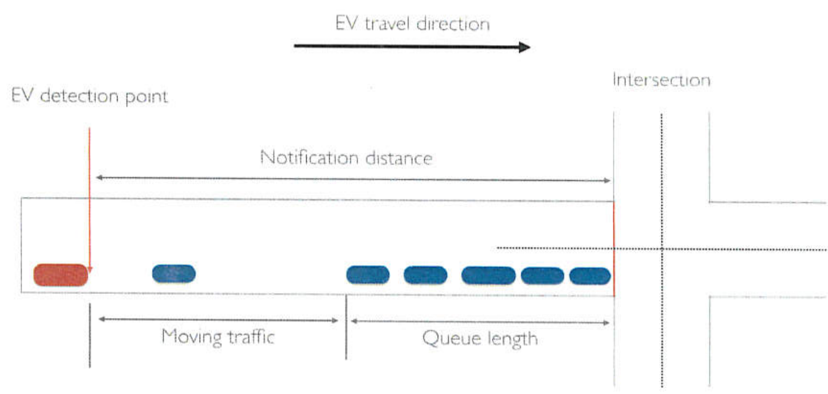

Figure 2 Signal Preemption Based On Queue Length

In order to evaluate the control strategy, a series of testing scenario are purposed to examine the impact of each preemption method with emergency vehicle entering the testing network through a range of entry times. The results have shown that signal preemption and automated driving reduce emergency vehicle travel time and delays and increase emergency vehicle operation speed. At the same time, the preemption measures do not create significant disturbance to other vehicles in the network. As the network delays do not appear observable changes.

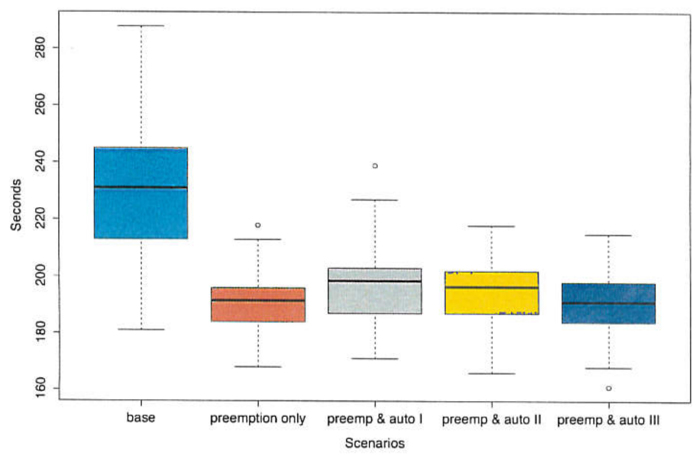

Figure 3 Emergency Travel Time Through the Network

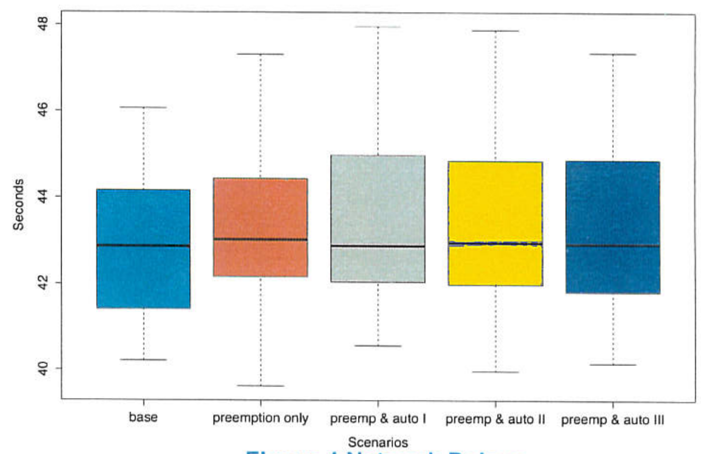

Figure 4 Network Delays