Control Design of an Automated Highway System

This paper introduces us the multilayer control architecture of automated highway system (AHS), and particularly focuses on two major parts, the design and safety verification of the on-board vehicle control system and the design of the roadside control system. Specifically, in order to display a more detailed design of five individual layers, the author employed various techniques including mathematic modeling, control synthesis and analysis, vector fields/spatial functions and FSM model. A well-designed AHS control system can not only increase highway capacity, but also contribute to improve intervehicle safety as well as lower fuel consumption and gas emission. Despite it’s good performances in practical use, the design of such a system poses great challenges on technology development. While PATH AHS research program started in 1989, this paper emphasizes the progress since 1994.

ASH architecture mainly comprises five layers, namely network, link, coordination, regulation and physical layers. Their functions vary from traffic flow control and intervehicles communication to maneuvers arrangement and execution. The on-board control system is a hybrid control system, thus developing a design and verification methodology is desirable to ensure safety and efficiency. Specifically, the system is designed for the coordination, regulation and physical layers, aims at controlling vehicle safely and executing maneuvers efficiently. Since it has no access to the traffic-flow information, thus, the overall AHS capacity and traffic flow is not optimized here but in the roadside control system. The link-layer’s controller works complimentarily with on-board control system, it has access to traffic flow but not to individual vehicles. Vehicles are coordinated in this layer and the activity plans are modeled as spatial vector functions. By adjusting aggregated traffic densities and inlet flow, this hierarchical system can ultimately regulate AHS to a desired density profile and hence improve safety. Finally, the author emphasizes the AHS control is a magnificent project and only certain aspects are covered here. Also, the underdeveloped technologies and insufficient techniques are still the bottlenecks in designing an all-round AHS control system.