Situational awareness in connected and automated vehicle (CAV) systems becomes particularly challenging in the presence of non-line of sight objects and/or objects beyond the sensing range of local onboard sensors. Despite the fact that fully autonomous driving requires the use of multiple redundant sensor systems, the non-line of sight object detection problem still persists due to inherent limitations of those sensing techniques. To tackle this challenge, inter-vehicle communication is envisioned that allows vehicles to exchange self-status updates, in the form of basic safety message (BSM), aiming to extend their effective field of view and thus compensate for the limitations of sensor-based vehicle tracking subsystem. Tracking capability in such systems can be further improved through cooperative sharing of locally created map data instead of communicating only core BSM data. In cooperative sharing of safety messages, it is imperative to have a scalable communication protocol to ensure optimal use of the communication channel. This dissertation analyzes the scalability issue in vehicle-to-everything (V2X) communication, and then addresses the range issue of situational awareness in CAV systems by proposing a content adaptive V2X communication architecture. We present validation results of a scalable BSM scheduling protocol standardized in the SAE J2945/1 and examine the optimality of the default settings of its congestion control parameters. This dissertation also proposes a content adaptive V2X communication architecture aimed at map sharing and evaluates its safety benefits in terms of position tracking error. This dissertation determines that message content should be concentrated to mapped objects that are located farther away from the sender to the edge of local sensor range. This dissertation also finds that, optimized combination of message length and transmit rate ensures the optimal channel utilization for cooperative vehicle safety communication, which in turn improves the situational awareness of the whole system.

Major: Computer Engineering

Educational Career:
Bachelor’s of Computer Science & Engineering, BS, 2009, Bangladesh University of Engineering & Technology
Master’s of Computer Science, MS, 2015, West Virginia University

Committee in Charge:
Yaser Pourmohammadi Fallah, Chair, Electrical & Computer Engineering
Murat Yuksel, Electrical and Computer Engineering
Mainak Chatterjee, Computer Science
Samiul Hasan, Civil, Environmental, and Construction Engineering
Azadeh Vosoughi, Electrical & Computer Engineering

Approved for distribution by Yaser Pourmohammadi Fallah, Committee Chair, on April 16, 2019.

The public is welcome to attend.