Design and Experimental Validation of a Cooperative Driving System in the Grand Cooperative Driving Challenge.

In recent times there has been a great interest in Autonomous Vehicles, motivated by the possibility of improving current highways to meet future demands while still providing safety. This paper discusses in detail a model for a Cooperative Adaptive Cruise Control (CACC) architecture, which is broken down onto three main parts: Communication, Sensor Fusion, and Control. The communication is handled by a wireless network, which implements Vehicle-to-Vehicle (V2V) and Vehicle-to-infrastructure (V2I) methods. The V2I handles the information transmitted the Real-Time-Hardware (RTH) and the external node using the User Data Protocol (UDP). The states of the current Vehicle, the preceding one and the leading vehicles were synthesized in a Sensor Fusion Block, which received its data from the object sensing module; RTK GPS Module and the V2V information to provide filtered information required by the controllers and other parts of the architecture. The communication module is modified wireless card modified to implemented using the Communications Access for Land Mobiles (CALM)/FAST protocol on top of 802.11p for exchanging of messages between different blocks. The communication hardware interface with the RTH using a custom designed protocol over UDP. The data received from the RTH & the wireless link was decoded to extract information and transmit between each other’s and among other modules. The two main processes at the communication node of sending and receiving messages operate independently to ensure that in case of failure, the other process continued while the faulty process recovers. It was also observed that with the increase of line of sight distance and increase in frequency a packet loss was observed. The Sensor Fusion block, implementing filtering algorithms and analyzed the limitations of each sensor, generated reliable information based on the state of the vehicles for controller operations. Two types of controller were designed for the vehicle based on MPC (model predictive control) & a linear control. The former being based on the receding horizon control framework and requiring more parameters for operation was favored to implement a robust system.