mmWave Beamforming Using Multimodal Sensor Fusion and Machine Learning in Autonomous Vehicular Communications

Zhu, Ethan (School: Green Canyon High School)

Connected and automated vehicles (CAVs) have become a transformative technology that can change our daily lives. One of the many applications is to significantly reduce the more than 40,000 fatalities each year on U.S. highways, and 1.3 million worldwide. Efforts from all aspects are needed to reduce such a high fatality number. Among them, CAV is the only solution that has the potential to bring the number to near zero, hence has attracted increasing attention from industry, academia, and the government. Currently, millimeter-wave (mmWave) bands are identified as the promising CAV connectivity solution. While it can provide high data rate, its realization faces many challenges such as high attenuation. The existing solution has to initiate a pilot signal to measure channel information, then apply signal processing to calculate the best beamforming to guarantee sufficient signal power. This process takes significant overhead and time, hence not suitable for CAVs. On the other hand, it is envisaged that various sensors such as LiDAR, cameras, IMU which are readily deployed for the "Automated" side of the CAV function, can be leveraged to feed fused sensory data to a machine learning AI, in order to predict the optimal beamforming codebook, eliminating the iterative process via pilot signals. This multimodal data fusion, together with machine learning Artificial Intelligence (AI), can be expected to facilitate mmWave inter-vehicular communications, significantly advancing the "Connected" side of the CAV function. A case study was conducted to demonstrate the efficacy of this new beamforming method.