Novel Scalable Multiphase Autonomous Vehicle Systems for Emerging Markets

Ray Chaudhuri, Shounak (School: Francis Parker School)

Autonomous vehicle (AV) research has focused on structured, high-income Western environments, leaving dense, variable developing regions underexplored. This project develops three prototypes for emerging market AV technology, aiming to (i) interpret unstructured traffic patterns, multimodal communication, and diverse road users; (ii) demonstrate data interpretation and realistic powertrain commands via a scaled robot car; (iii) recreate representative unstructured traffic environments in a virtual simulation to train and test AV control software. First, four data collection modules captured synchronized video, audio, and inertial data from real vehicles, enabling large-scale multimodal sensing in complex urban environments. Second, an 18-inch autonomous robot car was designed in SolidWorks, machined from aluminum and 3D printed, and integrated with Raspberry Pis and DC motors to model a full-scale SUV. Third, a virtual simulation in BeamNG.tech replicated unstructured conditions, generated synthetic datasets, and evaluated autonomous algorithms. Each phase underwent iteration through calibration, deployment, and redesign. The data modules collected 114 hours (380 GB) of multimodal data in Kolkata, India, with reliable synchronization and post-processing, including distance prediction and object detection. The robot car achieved realistic movement, stable navigation across varied surfaces, and translation of perception outputs into steering commands. The virtual simulation generated synthetic datasets and demonstrated the efficacy of novel path-planning and perception models. Both datasets were published to expand global AV data availability. The system validates a pipeline for developing autonomous vehicles in emerging markets, contributing to global AV research.

Awards Won:
Second Award of $2,400
International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention, a 1-year free student membership to the INCOSE, and free virtual admission to the 2022 International Symposium of the INCOSE