## U-PASS Project Team Members Developed Agent-Based Modeling and Simulation for Shared Autonomous Electric Vehicles

Autonomous vehicle (AV) technologies have received extensive attention and investments in recent years and are expected to revolutionize urban transportation systems. Similarly, an environmentally friendly electric vehicle (EV) contributes to the development of green life and sustainable economic development. Facing the future transportation system, Shared Autonomous Electric Vehicle (SAEV) is a combination of on-demand ride services, AV, and EV, which can be expected to become the development direction of future urban mobility. It has many advantages such as environmental protection, safety, and efficiency, which will significantly facilitate urban mobility.

To study the operations scenario of SAEV, the Transportation Data & Simulation Optimization Laboratory (TDSO Lab) of Zhejiang University, led by Dr. Xiqun (Michael) Chen, has developed a future-oriented Agent-Based Modeling and Simulation (ABMS) for SAEV scenarios. It establishes an efficient matching and dispatching algorithm between vehicles and passengers, and real-time matching algorithm for vehicles and charging stations. The model simulates the complicated matching relationship and information interaction among the on-demand ride services platform, passengers, SAEVs, and charging stations.

The proposed ABMS framework for systematic operations of SAEV is implemented using real ride-sourcing order data and the large-scale road network of Hangzhou, China, as shown in the video. The simulation area is 23*19 km2, with a total of 84,097 passengers, 4,500 SAEV vehicles, and an average battery capacity of 172 km. There are 257 charging stations in the simulation road network. Each charging station contains one fast-charging pile and two slow-charging piles. In the ABMS virtualization interface of SAEV, dots of different colors represent SAEVs of different states, with white representing the vehicle relocating to where demand is high, yellow representing the car picking up the passenger, red representing the vehicle carrying passengers, and green representing the vehicle going to the charging station. Charging station usage reflects the charging demand of vehicles, which is usually higher at night. Passengers' waiting time demonstrates the level of service of SAEV. Passengers' waiting time is generally longer during peak hours in the morning and evening. Average mileage traveled and profit of SAEV are two important indicators, which accumulate over time. By testing different simulation scenarios, we find that fleet size, SAEV battery mileage, and charging speed are three essential factors that significantly affect the simulation results. At present, ongoing research based on this simulation platform is conducted in the TDSO Lab of Zhejiang University.

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