

Project Title: AV4EV - Open-source Autonomous Vehicle software for Open-standard Electric Vehicle platforms

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Center Name: Safety21 National University Transportation Center for Promoting Safety

Research Priority: Promoting Safety

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Project Partners:

- The Autoware Foundation
- Wharton School Mack Institute

Research Project Funding: \$100,000.00

Project Start and End Date: 07-01-2023 to 06-30-2024

Project Description:

Over the past decade, self-driving capability for all variants of on-street vehicles have promised safer and more efficient transportation. This remains “work in progress” with large unfilled gaps in addressing user-acceptance, safety, ethics, regulation, technology and the business model. Our goal is to develop the Open-source Autonomous Vehicle (AV) software for Open-standard Electric Vehicle (EV) platforms, ie. AV4EV paradigm, to help realize safe, reliable, and efficient autonomy for off-street use cases. In particular, we focus on developing the AV4EV Autonomy Essentials Kit (AV4EV-Kit) for known controlled application domains: logistics (in-warehouse mobile robots), material handling (autonomous forklifts) and airside cargo (autonomous ground support equipment). The AV4EV business model addresses these many smaller domains through simplification and modularity. The EV “skateboard” chassis is orders of magnitude simpler than on-street vehicles (~20 moving parts compared to nearly 2,000 in contemporary vehicle architectures) - supporting standardization of interfaces for autonomous driving. Modularity allows AV4EV to address autonomous vehicle market sizes of 50K-250K vehicles/year for each use case by enabling component re-use and efficient customizability to meet specific segment needs. If successful, the AV4EV Kit will create a new business category for Autonomy-as-a-Service with plug-n-play hardware and software for rapid prototyping and deployment. Autonomous machines have a serviceable market of \$2.9B with a 15.5% growth rate. The AV4EV Autonomy Essentials Kit enables logistics customers to kickstart their journey of autonomous machines for safe and efficient movement of people and goods, even if their companies have little prior autonomous system development experience. Using the AV4EV-Kit, customers can rapidly prototype EV platforms into autonomous machines in 10 days for brownfield deployments. The AV4EV Autonomy Essentials Kit is dedicated to lowering the entry barrier of autonomous driving development and deployment. AV4EV-Kit consists of (1) a plug-in-play hardware platform with sensors and compute, (2) an autonomy software stack to achieve essential autonomous driving functions of perception, sensor fusion, mapping, localization, path planning, obstacle avoidance, traffic light recognition and safe control; and (3) a new Software Defined Vehicle approach for autonomous machine software development and testing in the cloud to lower cost of mixed-criticality software and over-the-air upgrades to enhance safety across the vehicle lifecycle and customize for different deployment scenarios. The AV4EV-Kit conforms to the open-source Autoware autonomous vehicle software standard to interface with the EV’s drive-by-wire system for users to easily integrate navigation functions with vehicle control. The AV4EV-Kit incorporates energy-efficient machine learning-based perception, planning and control algorithms developed by the PI’s and Co-PI’s labs and will be tested by commercialization partners on a variety of EV platforms.

Outputs:

AV4EV will create research prototype reference platforms for academic research in developing autonomous

vehicle software and systems for open-standards electric vehicle platforms. The AV4EV Autonomy Essentials Kit is dedicated to lowering the entry barrier of autonomous driving development and deployment. AV4EV-Kit consists of (1) a plug-in-play hardware platform with sensors and compute, (2) an autonomy software stack to achieve essential autonomous driving functions of perception, sensor fusion, mapping, localization, path planning, obstacle avoidance, traffic light recognition and safe control; and (3) a new Software Defined Vehicle approach for autonomous machine software development and testing in the cloud to lower cost of mixed-criticality software and over-the-air upgrades to enhance safety across the vehicle lifecycle and customize for different deployment scenarios. The AV4EV-Kit conforms to the open-source Autoware autonomous vehicle software standard to interface with the EV's drive-by-wire system for users to easily integrate navigation functions with vehicle control. The AV4EV-Kit incorporates energy-efficient machine learning-based perception, planning and control algorithms developed by the PI's and Co-PI's labs and will be tested by commercialization partners on a variety of EV platforms.

Outcomes/Impacts:

1. Demonstrate Cargo ODD with AV4EV Platform-0 Go-Kart
2. Update AV4EV stack from prototype version to pre-production version that is designed for manufacturability. The goal is to scale the production for the AV4EV-Kit. Develop Go-to-Market plan with Mack Institute.
3. Demonstrate fully operational system over multiple days of operations at Autoware Foundation sites. Accompany them on industry roadshows to capture pilot customers. Engage with Mack Institute to meet with investors and create customer contracts and CoE to complete purchase agreements.