Research
Report Summary

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SAFETY RESEARCH USING SIMULATION
UNIVERSITY TRANSPORTATION CENTER

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Agent-Based Simulation for Investigating the Safety Concerns of Electric Vehicles in the US

The occupied intersection taken from the traffic simulation

3D simulation window of the AnyLogic model

The growing popularity of electric vehicles (EVs) and hybrid electric vheicles (HEVs) in the U.S. has raised questions about whether or not they might pose a different crash risk than conventional vehicles. Many advocacy groups have asserted that the average EV/HEV silent engine is the primary risk factor for pedestrians and cyclists. On the other hand, many other groups claim that EV/HEV drivers tend to be more educated and therefore more likely to obey traffic rules, and that the risks caused by the aforementioned silent engines can be solved using relatively simple methods such as using an artificial sound system, resulting in an almost insignificant effect on overall traffic safety for EVs and HEVs. All of these positive and negative factors were investigated through an agent-based modeling approach in terms of their effects on pedestrian traffic safety. The factors affecting pedestrian safety were split into two model parameters: auditory vehicle detectability distance

and vehicle sight stopping distance. Through 9,000 subsequent traffic micro-simulations in AnyLogic, a sensitivity analysis was carried out to find the total number of near-crashes involving EVs and ICEVs throughout an entire year, after which the sensitivity results were compared with real statistical crash data for validation purposes. Based on the simulation results, the following conclusions were drawn:

- Although EVs have lower auditory vehicle detectability distance by pedestrians than ICEVs do (due to their low engine sound levels), EVs also have slightly lower stopping sight distance (SSD), meaning that they are more likely to stop in time when the driver sees a pedestrian crossing the road. However, the advantage of EVs in terms of SSD is not strong enough to compensate for their high near-crash risk due to their lower degree of auditory detectability.
- Higher ambient sound levels drastically increase the number of near-crashes for EVs. In rural areas where ambient sound levels are low, EVs pose significantly less safety risk than in urban areas where ambient sound levels are high. ICEVs also pose slightly higher pedestrian safety risks at higher ambient sound levels.
- Ambient illumination is another prominent factor that must be taken into account. Under low-light conditions, pedestrians become more dependent on hearing to detect oncoming vehicles, and therefore have a higher crash risk under such conditions.
- Overall, EVs pose a 25% higher risk to pedestrian traffic safety than ICEVs do. Although this safety risk is not as high as that observed in previous statistical reports, there is still a statistically significant difference between the near-crash risks of EVs and ICEVs. Therefore, certain solutions are advised to reduce the safety risk of EVs to pedestrians (artificial sound system, smart warning systems via mobile phones, etc.).

The agent-based model developed in this research indicates the necessity of modifications in the urban designs and highway systems. It is inevitable that EV adoption rate in the future will keep increasing exponentially and therefore will require specific highway design principles, codes, and regulations. The incompatibility of EVs with current highway design practice has the potential to cause traffic safety issues, especially for pedestrians. This research can be extended in the future in various ways. First, the simulation environment can be improved significantly by adding cyclist agents, more vehicle types (buses, trucks, emergency vehicles, etc.) and different near-crash mechanisms into the environment. Even the environment itself can be extended to a complete urban city with the help of increased computing power. Secondly, the simulation parameters can be studied further by considering the increased affordability of EVs in the future and by defining perception reaction time parameters more explicitly to include age and education factors in a clearer way; these parameters can be supported with statistical data. Lastly, the simulation can also be improved to touch on sustainability solutions such as the smart city concept, which entails EV communication with pedestrian agents using digital warning systems through cell phones

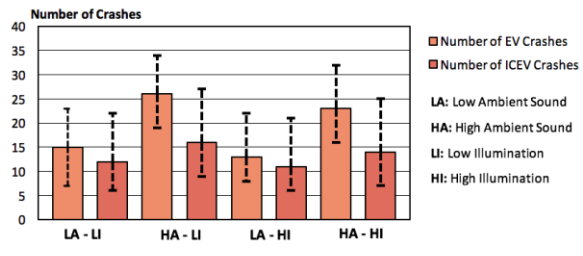

Figure: Sensitivity analysis results of the traffic micro simulation in terms of number of near-crashes