CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6849: Implications of Automated Vehicles on Safety, Design and Operation of the Texas Highway System

Background

This project's intent was two-fold: 1) understand the implications of connected and autonomous vehicles (CAVs) on the safety, design, and operation of the Texas highway networks, and 2) develop best practices recommendations to cost-effectively support CAV adoption and implementation in Texas by TxDOT. Roadway crashes result in tremendous economic and other damages (averaging $1,000 per person every year in the U.S.). Advances in vehicle automation and communication are expected to reduce these losses dramatically. CAVs are expected to improve fuel consumption and help alleviate traffic congestion and delays, assuming that certain complementary policies and practices (such as intersection management controls) are in place.

What the Researchers Did

To determine the safety implications of emerging automation technologies, the project team conducted a national survey and a state-level survey. The national survey of over 1,000 Americans provided a wealth of data that the research team used to estimate parameters for a household-level annually-updated simulation of vehicle and technology choices over time. Eight different scenarios—based on time-variable technology prices, consumer willingness to pay, and government regulations—were used to forecast fleet evolution over time. The survey of Texas households emphasized perceptions and opinions, providing new perspectives on Texans' adoption of CAVs and allowing estimation of the Texas fleet mix over the next 25 years. Based upon the potential fleet mix indicated by the survey results, the research team completed these tasks:

- Estimated the safety benefits of certain CAV technologies for various incident types, paying specific attention to the impacts on vehicle crashes.
- Analyzed potential traffic impacts under a series of modelling scenarios at intersections in Austin, Texas.
- Conducted a benefit-cost analysis to identify design and management strategies that TxDOT could employ to transition to a safer and more efficient transportation future.
- Used these results to develop a series of policy recommendations, emphasizing safety, to assist TxDOT in optimally planning for and exploiting these new technologies in the short, medium, and long term.

Research Performed by:
Center for Transportation Research

Research Supervisor:
Kara Kockelman, CTR

Researchers:
Stephen D. Boyles
Prateek Bansal
Tianxin Li
Tejas Choudhary
Michael Levin
Dan Fagnant
Paul Avery
Lisa Loftus-Otway
Duncan Stewart

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What They Found

The U.S.-wide survey's fleet evolution results indicated that around 98% of the U.S. vehicle fleet is likely to have electronic stability control and DSRC connectivity by 2030. Long-term fleet evolution suggests that Level 4 AVs are likely to represent up to 87% of the U.S. light-duty vehicle fleet in year 2045; this forecast assumes technology cost reductions, increases in consumer willingness to pay, and policy changes implemented over time. (Per the National Highway Traffic Safety Administration's defined levels of automation, Level 4 is full self-driving automation, indicating that the vehicle is designed to perform all driving functions for the entire trip.) Survey results suggest that 41% of Texans are not yet ready or willing to use shared autonomous vehicles (SAVs), and only 7% hope to rely entirely on an SAV fleet, even at a user cost of just $1 per mile.

Additionally, results from the safety assessment suggested that advanced CAV technologies may reduce current U.S. crash costs by at least $126 billion per year (not including pain and suffering damages, and other non-economic costs) and functional human-years lost by nearly 1.5 million (per year). These results rely on three different effectiveness scenarios with a 100% market penetration rate for all CAV safety applications.

The benefit-cost analysis assessed potential benefits from 11 safety applications or combinations of safety applications. Of these, the one with the greatest potential to prevent or mitigate crashes is the forward collision warning associated with cooperative adaptive cruise control. The cooperative intersection collision avoidance system also offers substantial safety rewards, with total economic savings over $22 billion each year (and almost 1.24 million functional human-years saved). These two safety applications are estimated to represent over 55% of the total economic costs saved by all 11 combinations of CV and AV technologies, suggesting the most promising directions for government agencies and transportation system designers and planners. These two technologies may most merit priority deployment, incentive policies, and driver/traveller adoption.

The project recommended that in the short term (next 5 years), TxDOT should focus on updating infrastructure to encourage safe use of CAV technologies. TxDOT should also update legislative policy in a proactive manner to better address questions surrounding the future testing and adoption of developing CAV technologies. In the medium term (5–15 years), TxDOT should focus on strategies that will help increase CAV market penetration. Additionally, the agency should help form policies that regulate how CAVs operate in given conditions, such as nighttime darkness or near construction zones. Long-term strategies (15+ years) should center on the extensive use of CAVs.

What This Means

The transition from human-operated vehicles to CAVs will bring many safety and other benefits to Texans but also present challenges that need addressing. Several U.S. states have already taken steps to prepare for this paradigm change, and Texas will want to do the same.

For More Information

Project Manager:
Darrin Jensen, TxDOT, (512) 416-4728

Research Supervisor:
Kara Kockelman, CTR, (512) 232-4252

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Research and Technology Implementation Office
Texas Department of Transportation
125 E. 11th Street
Austin, TX 78701-2483

www.txdot.gov
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