CURRENT NEWS
SOCIAL MEDIA
IN THE NEWS
IN THE NEWS ARCHIVE
MEDIA CONTACT INFORMATION
CALENDAR

Experiments show that a few self-driving cars can dramatically improve traffic flow

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The presence of just a few autonomous vehicles can eliminate the stop-and-go driving of the human drivers in traffic, along with the accident risk and fuel inefficiency it causes, according to new research. The finding indicates that self-driving cars and related technology may be even closer to revolutionizing traffic control than previously thought.

"Our experiments show that with as few as 5 percent of vehicles being automated and carefully controlled, we can eliminate stop-and-go waves caused by human driving behavior," said Daniel B. Work, assistant professor at the University of Illinois at Urbana-Champaign, a lead researcher in the study.

The use of autonomous vehicles to regulate traffic flow is the next innovation in the rapidly evolving

world in ways we can only imagine.

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this innovation is a deeper understanding of the dynamic between these autonomous vehicles and the human drivers on the road.

Funded by the National Science Foundation's Cyber-Physical Systems program, the research was led by a multi-disciplinary team of researchers with expertise in traffic flow theory, control theory, robotics, cyber-physical systems, and transportation engineering. Principal investigators (PIs) were: Benedetto Piccoli, the Joseph and Loretta Lopez Chair Professor of Mathematics at Rutgers University, Camden; Benjamin Seibold, associate professor of Mathematics at Temple University; Jonathan Sprinkle, the Litton Industries John M. Leonis Distinguished Associate Professor in Electrical and Computer Engineering at the University of Arizona, Tucson; and Daniel B. Work, assistant professor in Civil and Environmental Engineering and the Coordinated Science Laboratory at the University of Illinois at Urbana-Champaign.


Daniel Work

The team conducted field experiments in Tucson, Arizona, in which a single autonomous vehicle circled a track continuously with at least 20 other human-driven cars. Under normal circumstances, human drivers naturally create stop-and-go traffic, even in the absence of bottlenecks, lane changes, merges or other disruptions, Work said. This phenomenon is called the "phantom traffic jam." Researchers found that by controlling the pace of the autonomous car in the study, they were able to smooth out the traffic flow for all the cars. For the first time, researchers demonstrated experimentally that even a small percentage of such vehicles can have a significant impact on the road, eliminating waves and reducing the total fuel consumption by up to 40 percent. Moreover, the researchers found that conceptually simple and easy to implement control strategies can achieve the goal.

"Before we carried out these experiments, I did not know how straightforward it could be to positively affect the flow of traffic," Sprinkle said. "I assumed we would need sophisticated control techniques, but what we showed was that controllers which are staples of undergraduate control theory will do the trick."

vehicles on the road.

"Fully autonomous vehicles in common traffic may be still far away in the future due to many technological, market and policy constraints," Piccoli said. "However, increased communication among vehicles and increased levels of autonomy in human-driven vehicles is in the near future."

The near future with only a few autonomous vehicles on the road is more challenging than the far future in which all vehicles are connected, Seibold said.

"The proper design of autonomous vehicles requires a profound understanding of the reaction of humans to them," Seibold said, "and traffic experiments play a crucial role in understanding this interplay of human and robotic agents."

The researchers say the next step will be to study the impact of autonomous vehicles in denser traffic with more freedom granted to the human drivers, such as the ability to change lanes.

The paper describing this work, "Dissipation of stop-and-go waves via control of autonomous vehicles: Field experiments," is available here: https://arxiv.org/abs/1705.01693. A video of the research is available here: https://youtu.be/2mBjYZTeaTc.

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