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Towards a Smart World: Hazard Levels for Monitoring of Autonomous Vehicles' Swarms

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Study Methods

This study explores an unconventional approach to solve the problem of safely integrating and coordinating the motion of a network of smart vehicles. Specifically, this work researches the creation of ad-hoc rules for monitoring the lateral and longitudinal movement of multiple autonomous vehicles (AVs) based on behavior that mimics swarm and flock movement in nature (or particle swarm motion). The goal is that of generalizing what systems like adaptive cruise control do currently by leveraging an entire family of vehicles, instead of a single master.

Specifically, the work investigates how particle swarm approaches can be augmented by setting safety thresholds and fail-safe mechanisms to avoid collisions in off-nominal situations. This concept leverages the integration of the notion of hazard and danger levels (i.e., measures of the "closeness" to a given accident scenario, typically used in robotics) with the concept of safety distance and collision avoidance for ground vehicles.

Findings

The analysis presented in this report shows that it is indeed possible to monitor both lateral and longitudinal motion within the same framework and concurrently ensure vehicles' separation by extending particle swarm rules. A draft implementation of four hazard level functions indicates that safety thresholds can be set up to autonomously trigger lateral and longitudinal motion control based on three main rules respectively based on speed, heading, and breaking distance to steer the vehicle and maintain separation/avoid collisions in families of autonomous vehicles.

Policy Recommendations

This work tackles the important issue of providing timely and actionable warnings for collision avoidance (between vehicles or other objects) to either remote operators/controllers for fully AV or drivers of semi-AV. Recent fatal accidents involving AVs have highlighted the need for novel regulations on warning systems. They also uncovered the striking absence of safety standards in some of the manufacturer's designs in relation to alerting vehicle's operators' of upcoming collisions. This work constitutes a first step towards overcoming such limitations.

About the Authors

Dr. Favaro is an Assistant Professor in the Department of Aviation and Technology in the College of Engineering at San Jose State University. Prior to joining SJSU she earned a PhD and MS in Aerospace Engineering at the Georgia Institute of Technology, and MS and BS in Space Engineering at Politecnico di Milano, Italy. Dr. Favaro research interests lie in the broad field of system safety and risk analysis, with an emphasis on system engineering concepts and the safe integration and embedding of new technologies and the consistent update of regulations and certification practices. In 2016 she founded the RiSA2S lab, which deals with Risk and Safety Assessment of Autonomous Systems such as drones and self-driving cars. In 2017 she became a research associate of MTI and started collaborating as expert in the realm of autonomous vehicles. Her interests are currently focused on the safe integration of autonomous systems within US public roads as well as the National Airspace. She particularly focuses on bridging the gap between the technology world and the current regulatory panorama. Dr. Favaro has authored several journal publications and conference proceedings on a variety of topics, and is currently working on a human-in-the-loop study to quantify response times and drivers' reactions to disengagements of the autonomous technology for advanced autonomous vehicles. She has been interviewed by multiple media outlets including the Wall Street Journal, Wired Magazine, and Verge Tech forum as a leading expert in the field of automation safety. Dr. Favaro is an FAA Aviation certified Advanced Instructor, a certified Remote Pilot for drone commercial operations, and a solo-endorsed pilot.

To Learn More

For more details about the study, download the full report at **transweb.sjsu.edu/project/1735.html**

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