

MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-447 (project 547) | December 2021

Infrastructure Safety
Support System for Smart
Cities with Autonomous
Vehicles



the ISSUE

Smart cities are home to a growing number of autonomous vehicles (AVs) that can sense their environment and navigate without human input. Studies suggest AVs will significantly improve transport efficiencies, reduce crashes, provide smoother rides, decrease congestion, and increase traffic flow through speed harmonization and reduced demand for roadway capacity. However, many expect that the full adoption of AVs will take 50 years or longer. Therefore, driverless vehicles will share the roads with human-operated vehicles for a long time. Subsequently, AVs of various levels of automation will continue to rely on human inputs. Thus, one of the biggest challenges facing smart cities is achieving fully harmonized vehicle operation in mixed-driver scenarios.

the RESEARCH

This research seeks to develop an infrastructure safety support system by embedding vehicle-to-infrastructure (V2I) enabled sensor networks into the transportation infrastructure to provide AVs and human drivers with inputs to improve their decision making when obvious decisions may not be possible. A new car-following algorithm is also developed to enable AVs to integrate the real-time traffic and road condition data from such an infrastructure safety support system to improve traffic safety and mobility with autonomous vehicles in mixed driver environments. The performed sensitivity study also optimizes such an infrastructure safety support system for combined considerations on effectiveness and affordability of the system.



A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

Colorado State University
North Dakota State University
South Dakota State University

University of Colorado Denver
University of Denver
University of Utah

Utah State University
University of Wyoming



Lead Investigator(s)

Dr. Ying Huang
North Dakota State University
ying.huang@ndsu.edu

Co-Investigator(s)

Dr. Pan Lu
Dr. Raj Bridgelall
North Dakota State University

Research Assistant(s)

Xinyi Yang, GRA, PhD
Yihao Ren, GRA, PhD

Project Title

Infrastructure Safety Support
System for Smart Cities with
Autonomous Vehicles

Sponsors | Partners

MnROAD, MnDOT
USDOT, Research and
Innovative Technology
Administration

the FINDINGS

This project developed an infrastructure support system based on infrastructure sensors and a new V2I algorithm for AVs to effectively use the infrastructure support system for enhanced safety and mobility. The infrastructure support system can monitor various vehicle and road condition data, including vehicle speed, wheelbase distances, the number of axles, vehicle classification, weigh in motion, road roughness, and in-pavement cracks. With the real-time information from the infrastructure support system, the new cumulative-adaptive, car-following model (CACF) can significantly improve the mobility and safety of the transportation system with different penetration rates of AVs.

the IMPACT

This research will contribute toward the existing knowledge of vehicle and highway automation using intelligent transportation system (ITS) applications. Effective communication between vehicles using the sensors embedded in the road infrastructure will ensure the safety of drivers by reducing the number of conflicts and crashes, improving travel times for different routes, and providing a tool for managing traffic congestion and traffic flows.

For more information on this project, download the Main report at <https://www.ugpti.org/resources/reports/details.php?id=1056>

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.



This publication was produced by the Mountain-Plains Consortium at North Dakota State University. The contents of this brief reflect the views of the authors, who are responsible for facts and the accuracy of the information presented herein. This document is disseminated under the program management of the USDOT, Office of Research and Innovative Technology Administration in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.



NDSU does not discriminate in its programs and activities on the basis of age, color, gender expression/identity, genetic information, marital status, national origin, participation in lawful off-campus activity, physical or mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, spousal relationship to current employee, or veteran status, as applicable. Direct inquiries to Vice Provost, Title IX/ADA Coordinator, Old Main 201, 701-231-7708, ndsu.eoaa@ndsu.edu.