Experimental Setup for Comfort Evaluation in Automated Vehicles: Design and Implementation Framework

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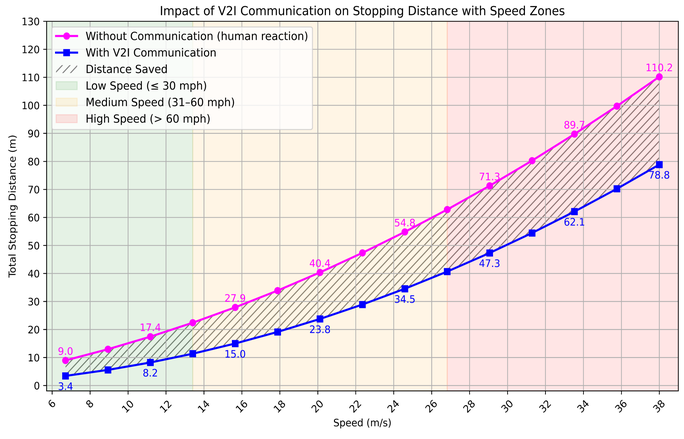
Background

Automated vehicles (AVs) promise improved safety and mobility, but passenger comfort remains critical for user acceptance. Braking behavior strongly influences ride comfort, particularly when deceleration occurs abruptly or unpredictably. Prior studies identify acceleration, jerk, and braking duration as key indicators of perceived comfort. In connected vehicle environments, Vehicle-to-Infrastructure (V2I) communication can extend the braking decision horizon by providing earlier awareness of road events. This work presents a controlled experimental framework to analyze how speed and stopping distance influence braking comfort and to support future connected-vehicle applications.

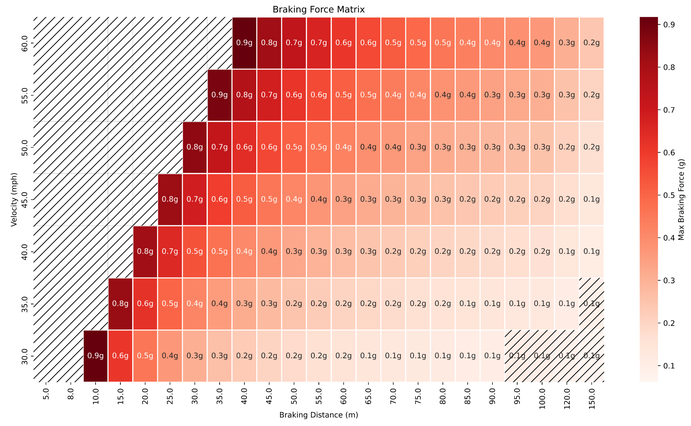


Comfort Metrics

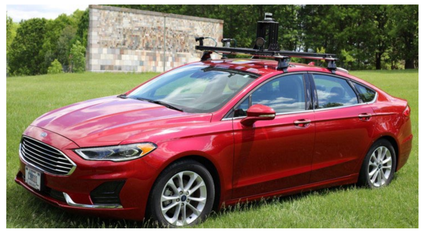
- **Acceleration** (m/s²): braking intensity $a = \Delta v/\Delta t$
- **Jerk** (m/s³): abruptness of motion $j = \Delta a/\Delta t$
- **Braking duration** (s): smoothness of stop - the elapsed time between the initiation of brake torque and the moment the vehicle reached a full stop.

Braking Force Heatmap

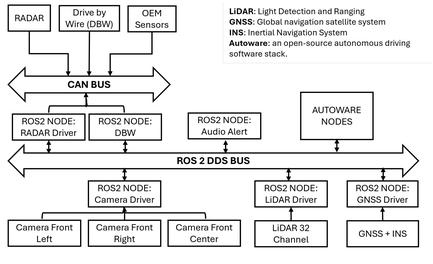
To systematically guide the selection of appropriate test scenarios, a comprehensive braking force heatmap was developed, mapping braking intensity across combinations of initial vehicle speed and stopping distance. This heatmap visually depicts the magnitudes of deceleration forces expected during braking maneuvers, providing an intuitive tool for identifying scenarios likely to affect passenger comfort.



NIST AV Testbed

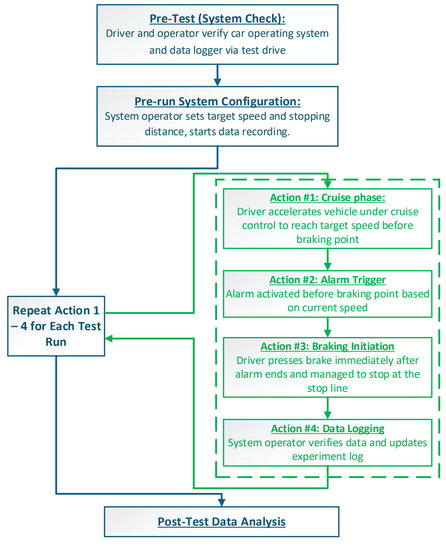


NAVT: NIST Automated Vehicle Testbed

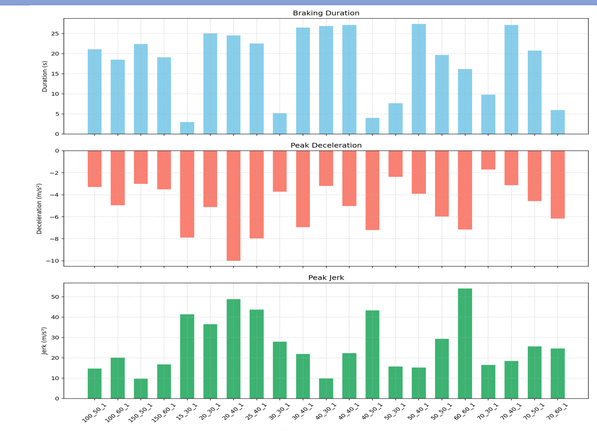


NAVT ROS2 System Architecture

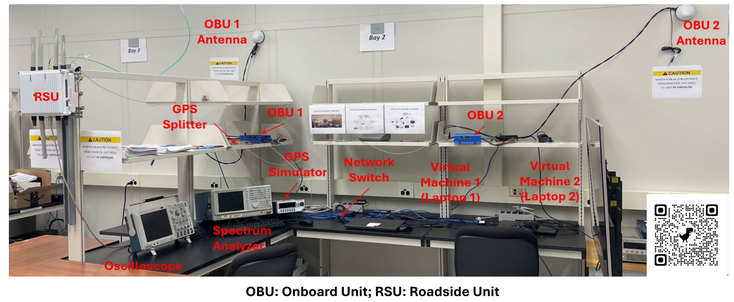
Comfort Testing Flowchart



Test Results



NIST C-V2X Testbed



OBU: Onboard Unit; RSU: Roadside Unit

Conclusions

- Developed a structured experimental framework to evaluate braking-related passenger comfort in AVs. The framework enables future integration with V2I communication and automated braking control to improve AV comfort.
- Increased stopping distance enables smoother, comfort-consistent braking by managing the relationship between speed and topping distance.
- Developed a C-V2X interoperability testbed and collected data for evaluating C-V2X communication network performance and interoperability testing.

References:
- Guo, W. , Kedia, S. , Roth, T. , Kootbally, Z. , Harishchandrakar, N. , Griffor, E. and Hajjaj, H. (2026), Experimental Setup for the Comfort Evaluation in Automated Vehicle: Design and Implementation Framework, NIST Interagency/Internal Report (NISTIR), National Institute of Standards and Technology, Gaithersburg, MD, [online], https://doi.org/10.6028/NIST.IR.8612.
- Dataset: Longitudinal and Lateral Motion Data for Ride Comfort Analysis Version 1.0.0. DOI: https://doi.org/10.18434/mds2-4113