Driver Acceptance of Cooperative Adaptive Cruise Control

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Acknowledgement
This work was funded by the Federal Highway Administration ITS Joint Program Office under contract DTFH61-13-D-00024

Background
Adaptive Cruise Control (ACC) uses radar or LIDAR to maintain a gap between the driver’s vehicle and lead vehicle
• Effective when traveling on level, straight roadways
• Prone to losing forward vehicle on curves or hills
• Can cause abrupt acceleration
• May be interpreted as a system failure

Cooperative Adaptive Cruise Control (CACC) supplements ACC with direct communication between vehicles
• Allows rapid response to changes in lead vehicle speed
• Reduces chance of tracking loss and abrupt maneuvers

Goal
Examine driver acceptance of ACC and CACC
1. Compared driver trust when using ACC and CACC
2. Compared three ACC/CACC driver vehicle interfaces (DVI) with varying levels of information

Method
Participants
• 96 licensed drivers from Washington DC metro area

Highway Driving Simulator
• 200° horizontal x 40° vertical field of view
• Compact sedan
• 6 degrees of freedom motion base
• 3 dash-mounted eye tracking cameras

Simulated Roadway
• 17.8 mi simulated 4-lane road
• 20 horizontal curves

Vehicle Parameters
• Lead Vehicle Speed - 50 mph
• ACC/CACC set to 55 mph
• Gap Distance set at 2 s

Tracking Loss Behavior
• ACC responded quickly and aggressively
• CACC responded gradually to simulate a system with direct communication from lead vehicle

Trust Questionnaire
• 25 questions on trust in automation
• Adapted from Madsen and Gregor (2000)

Results
Trust
• CACC group consistently reported greater trust than ACC group
• DVI condition did not affect trust ratings

Eye Glance Behavior
• Driving situations:
  - Steady: Gap = 2 s
  - Closing: Gap = 1.95-1 s
  - Close: Gap < 1 s

 Figure 3. FHWA highway driving simulator

 Discussion
More gradual behavior of the CACC system relative to ACC resulted in higher trust
• Augmenting ACC with wireless vehicle communication could increase trust and use of ACC

Detailed DVI did not distract from roadway or increase trust
• More informative DVI associated with greater proportion of glance time
• Total percentage of glance time for any DVI < 2%
• Trust ratings were not affected by DVI

Figure 4. Glances per second to the cruise control display

Figure 1. Example of radar/LIDAR on curves

Figure 2. Driver vehicle interfaces

Figure 3. FHWA highway driving simulator

Figure 4. Glances per second to the cruise control display