COOPERATIVE ADAPTIVE CRUISE CONTROL: CRITICAL HUMAN FACTORS ISSUES AND RESEARCH QUESTIONS

Stephen Jones[1] & Brian H. Philips[2]

[1]SAIC, McLean, Virginia, USA

[2]Federal Highway Administration, McLean, Virginia, USA

Email: brian.philips@dot.gov

Problem: Travel Congestion

- Over $100B in lost time/fuel due to travel delays in urban areas in 2010[1]
- Average annual commuter delay in 1982, 14 hours; by 2020, 41 hours[1]
- New roads/lanes cannot match ever-increasing travel demand

Solution: Technology

Cooperative Adaptive Cruise Control (CACC), uses dedicated short-range communications to permit vehicle-to-vehicle and vehicle-to-infrastructure coordination.

- ✓ Faster, automated vehicle longitudinal control
- ✓ Shorter following distances
- ✓ Increased throughput
- ✓ Improved string stability[2]
- ✓ Reduced fuel usage and emissions

CACC uses DSRC*, allowing vehicles and infrastructure to communicate directly.

Potential Issues

CACC has been demonstrated to be technically feasible but faces several human factors-related issues that may impact its acceptance, utilization, effectiveness, and safety.

* Dedicated Short-Range Communications

1. Automation

- Successful use of automation relies on appropriate understanding of its purpose, operation, and performance[3]
- Incorrect trust in automation leads to misuse, disuse, and abuse[4]
- Automation changes human role, becomes monitor
- Misuse or over-reliance places driver at higher risk

Key Research Questions

- *How does traffic density affect choice to utilize CACC?*
- *Does the number of travel lanes affect choice to utilize CACC?*
- *Does available preset time gap options affect CACC utilization?*
- *How does a driver enter/exit a CACC platoon?*

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2. Workload, Distraction, and Situation Awareness

- Reduced workload provides spare mental capacity
  - Could improve driving-related tasks
  …or…
  - Could invite engagement in non-driving-related secondary tasks[5]

Reduced workload may invite non-driving-related tasks.

- Secondary task engagement can distract and negatively affect a driver's situation awareness (SA)
- Studies have shown drivers' tendency to over-rely on automation rather than maintaining necessary SA[6]

Key Research Questions

- *How does use of CACC affect workload and SA levels?*
- *Are drivers more likely to engage in secondary tasks while utilizing CACC?*
- *Does driving behavior or performance change during CACC driving? During secondary task engagement?*

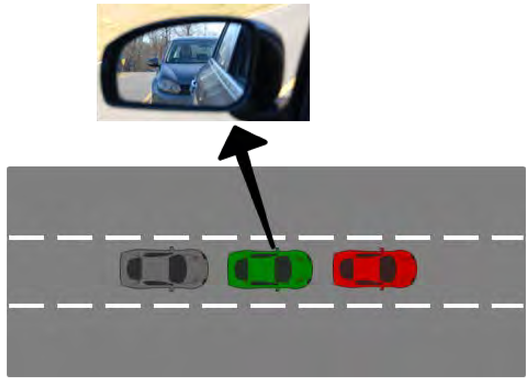
3. Driving Behavior

Inaccurate human perception may have major effects on general driving behavior, such as lane-changing and car-following.

- Humans not good at assessing relative speeds in adjacent lanes;[7,8] frequent lane-changes disrupt CACC platoons and reduce string stability benefits
- Drivers follow larger vehicles at shorter gaps though visibility is reduced[9]
- Humans overestimate their own capabilities and underestimate those of others[10]

Key Research Questions

- *How willing are CACC drivers to remain in platoon as nearby lane conditions vary?*
- *Does comfort level change with CACC experience, vehicle position in platoon, or varying traffic density?*
- *How comfortable is a driver with a following vehicle at a short time gap?*



CACC drivers may not be comfortable with cars following behind closely.

SUMMARY

CACC has the potential to dramatically improve highway throughput and relieve traffic congestion. It is technically feasible, but its success depends highly upon addressing the numerous human factors-related issues identified that could affect its acceptance, efficacy, and safety[11].

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