Assessing the benefits and performance of technologies that automate the driving task

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Conditional automation is arriving and partial driving automation technology is already here
Safety benefits of automation will be limited to certain situations and by driver use for the foreseeable future

- Cadillac Super Cruise automates highway driving
  - 1/3 of vehicle miles travelled are on highways
    - 9% of police-reported crashes
    - 17% of crash deaths

- Audi’s Traffic Jam Pilot automates driving in heavy traffic
  - 17% of all police-reported crashes are front-to-rear or sideswipes during rush hour
    - 2% of crash deaths
Experiences with technology that automates driving
Are drivers willing to use driving automation technology and what influences their experience?

- 51 employees used one or more vehicles between August 2016 and July 2017
- Nearly 50,000 miles and 2 years of driving
- Vehicles used 104 times for 1 to 22 days and 6 days on average
- Drivers completed surveys each day and after use
I feel comfortable using adaptive cruise control when traveling on...

Percentage of drivers who agreed or strongly agreed

- free-flowing interstates
- major arterials with signalized intersections
- roads with moderate hills
- stop-and-go traffic
- low-speed, local roads
I feel comfortable using active lane keeping when traveling on…

Percentage of drivers who agreed or strongly agreed

- Free-flowing interstates: 60%
- Interstates with gentle to moderate curves: 50%
- Roads with moderate hills: 40%
- Winding, curvy roads: 30%
Overall, I felt this technology improved my driving experience

Percentage of drivers who agreed or strongly agreed

- **2016 Honda Civic**
- **2016 Infiniti QX60**
- **2016 Toyota Prius**
- **2017 Audi Q7**
- **2017 Audi A4**
- **2016 Honda Civic**
- **2017 Audi A4**
- **2017 Audi Q7**

**Graph:**
- **Adaptive cruise control**
- **Active lane keeping**
Drivers complained about Honda’s ACC system performance
Percentage of driver comments about adaptive cruise control by complaint type
Drivers complained about Honda’s ACC system performance
Percentage of driver comments about adaptive cruise control by complaint type

- **Participant 101CA**
  - “Lags and sudden acceleration/deceleration in more congested situations.”

- **Participant 116SA**
  - “It also seemed to brake very abruptly and hard.”

- **Participant 326SV**
  - “It did not gradually slow down, it would brake too hard when not necessary and then accelerate.”
Which attributes of adaptive cruise control improved the driving experience?

- Drivers reported their level of agreement with statements about adaptive cruise control:
  - Accelerated and decelerated the vehicle smoothly
  - Maintained a constant, desired distance to the vehicle ahead
  - Always knew whether the vehicle ahead was detected
  - Detected moving vehicles ahead
  - Detected stopped vehicles ahead
  - Continued to adjust vehicle speed after the vehicle ahead exited the lane
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Drivers complained about interactions with Audi’s lane keeping system
Percentage of driver comments about active lane keeping by complaint type

- **Honda Civic**
  - Functionality and performance: 40%
  - User interface: 30%
  - Circumstance: 10%
  - None: 20%

- **Audi Q7**
  - Functionality and performance: 50%
  - User interface: 40%
  - Circumstance: 10%
  - None: 10%
Drivers complained about interactions with Audi’s lane keeping system

Percentage of driver comments about active lane keeping by complaint type

- **Participant 101CA**
  - “Choosing the wrong lane at a lane split junction and the feeling that I was fighting the system when I was in the middle of my lane.”

- **Participant 302CV**
  - “I felt that this system was fighting me more than assisting me.”

- **Participant 302CV**
  - “It seemed very erratic and moved back and forth in the lane frequently.”
Which attributes of active lane keeping improved the driving experience?

Drivers reported their level of agreement with statements about active lane keeping:

- Always knew whether the lane markings were detected
- Consistently detected lane markings
- Made smooth, gentle steering corrections
- Kept vehicle in the center of the lane
- Made steering corrections infrequently
Which attributes of active lane keeping improved the driving experience?

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Evaluating the functionality of driving automation
Adaptive cruise control and active lane keeping performance measured on a test track and on-road

2017 BMW 5 series with “Driving Assistant Plus”

2017 Mercedes-Benz E-Class with “Drive Pilot”

2016 Tesla Model S with “Autopilot”

2017 Volvo XC90 with “Pilot Assist”
Adaptive cruise control with stopped lead vehicle
2016 Honda Civic

AEB only  ACC active
Adaptive cruise control with stopped lead vehicle
2016 Tesla Model S

AEB only

ACC active
Peak deceleration when approaching a stationary target
31 mph test speed

![Graph showing peak deceleration for different car models including Honda Civic, Audi Q7, Volvo XC90, BMW 5 series, Mercedes-Benz E-Class, and Tesla Model S. The graph compares automatic emergency braking and adaptive cruise control.]
Test-track performance was not necessarily replicated on-road

On-road testing – Mercedes-Benz E-Class
Lane keeping performance was inconsistent
Adding or dropping lanes created lane keeping issues
On-road testing – Mercedes-Benz E-Class
Lane keeping was problematic for some systems on hills

On-road testing – Tesla Model S
Lane keeping was problematic for some systems on hills

On-road testing – Volvo XC90
Lane keeping performance varied on curves
On-road testing – Tesla Model S and Volvo XC90
Conclusions

- Crash reduction benefits of driving automation systems hinges on the frequency and appropriateness of its use
- Drivers had mixed experiences with partial driving automation technology
  - Most comfortable using it in low demand situations
  - Restricting use will limit safety benefits
- Driving automation systems should not rely on users to limit use to the intended operational design domain
  - Manufacturers often do not recommend use in demanding situations
- Wide range of driving automation system performance
- It will take time to realize the full safety benefits of driving automation technology
- Must continue to promote countermeasures proven to reduce crashes
More information and links to our YouTube channel and Twitter feed at iihs.org

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