Opportunities and Challenges for the Interaction Between AVs and Vulnerable Road Users

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Our Mission:
Use human factors methods to improve road safety & outreach for people at higher risk of crash or injury than average drivers due to their mode of transportation, intrinsic, or extrinsic factors.
CVRUS Leadership Team

Jon Antin, Ph.D.
• Center Director
• Senior driver safety, NDR

Charlie Klauer, Ph.D.
• Teen driver safety, driver distraction

Ryan Smith, Ph.D.
• Impairment - alcohol, drugs, OTC, marijuana

Justin Owens, Ph.D.
• Ped/bike safety, child safety, PWD, driver distraction & fatigue
What are “Automated Vehicles”?

SAE/NHTSA Automation Level

- **LEVEL 0**: No automation
- **LEVEL 1**: Automated systems can sometimes assist the human in some parts of the driving task
- **LEVEL 2**: Partially automated systems can conduct some driving tasks while human monitors and performs other driving tasks
- **LEVEL 3**: Conditionally automated systems can perform all driving tasks in specific conditions, but the human driver must be ready to take back control
- **LEVEL 4**: Moderately automated systems can perform all driving tasks in some conditions without human control
- **LEVEL 5**: Fully automated systems can perform all driving tasks, in all conditions in which humans could drive without human control

NHTSA: “Automated Driving Systems (ADS)”
NHTSA/USDOT Guidelines

Automated Driving Systems 2.0: A Vision for Safety

- Published 2017; DOT’s current guiding document for ADS
- Provides voluntary guidance for manufacturers & technical assistance to states
- Pedestrians & cyclists only touched upon:
  - “[HMI] Considerations should be made for the human driver...and external actors with whom the ADS may have interactions, including...bicyclists and pedestrians.”

Hypothetical AV Penetration Rate

- Market readiness rate still unclear, but...
- Mixed fleet for decades to come
Automated Driving Systems: Pedestrian Safety Potential

- Improved Perception
  - ...potentially at night (?)

- No Distraction/Fatigue/Emotion
  - ...or with occlusion

- Better Affordances for People w/Disabilities

- Faster Reaction Time
- Improvements in Efficiency
Challenges for AV/VRU Interactions

• Wide variety of challenges all levels of AV control
  – Some apply in different ways across levels
  – Compounded by operator takeover in L2/3
• Further discussion available in:
Detecting Pedestrians & Bicyclists

- How does an ADS detect vulnerable road users (VRUs)?
- **Challenges:**
  - Multiple technologies (machine vision, Lidar, etc)
  - All have $$ and/or tech limitations
  - How can ADSs parse & track crowds of VRUs?
How do Pedestrians Identify AVs?

Level 2
www.tesla.com
www.cadillac.com

Level 4
www.easymile.com
www.navya.tech

Level 4/5*
newsroom.uber.com
www.waymo.com
Communication & Negotiation of Intent

• How do vehicles and pedestrians communicate *control & intent*?
• Shift from bidirectional human-to-human to user-machine interface
Determining Right of Way

- Legal, social & cultural issues
- Interpretation & respect for local customs and norms?
- Replicate or replace personal communication?
Vehicle Behavior Around Peds & Bikes

• How does an ADS determine when to pass a cyclist/pedestrian in the road?
  • vs. hanging back given roadway parameters
• How does it weigh giving lateral passing distance vs. crossing lane line?
Driver Engagement

• L2/3 – How do interfaces successfully maintain/obtain driver engagement?
  – Especially in unexpected or complex scenarios involving VRUs?
  – Some calls (e.g. NACTO) for restricting use of midlevel automation in city centers.
HF Considerations for VRUs w/Disabilities

• What accommodations can be developed to assist or improve safety?
  – Benefits of connectivity?
  – Extra crossing time
  – Advanced communication
  – Onboarding/offboarding
Equity Considerations

• Universal Design: inclusive of people with disabilities
• Fair distribution of benefits/risk across states, SES, race & gender
• Deployment of new & upgraded infrastructure
  – Connectivity, separated walking areas, etc.
Infrastructure Development

• Designing for *now* vs. *future*
• Predicting future travel patterns
  – Increased/decreased pedestrian traffic
  – Parking vs. return trips
• Separated travel lanes/paths
• What is the *interaction* between design & HF?
Legal/Ethical Questions

• Who to harm?
  – Trolley problem
• Who is liable?
• When can AVs break the law?
  – Major/minor
• Limitations on operational domain?

moralmachine.mit.edu
Summary: A Call for Research

• Even (especially!) with automation, questions about interaction between humans & machines
• Opportunities for improvements over current (fallible) human perception & performance
• Many issues, need engagement from all sides
Thank you!

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