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Automated Driving Systems for Rural America

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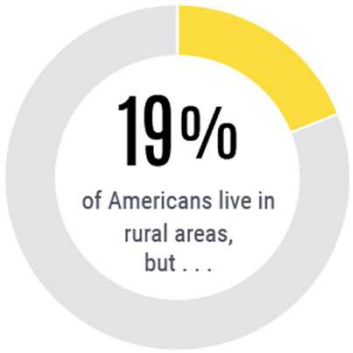
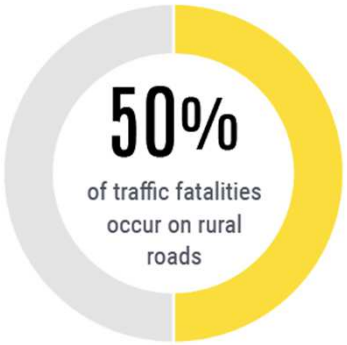
Rural Roadways are Under-Represented in AV Testing and Demonstrations

Urban-centric AV testing will lead to urban-centric solutions





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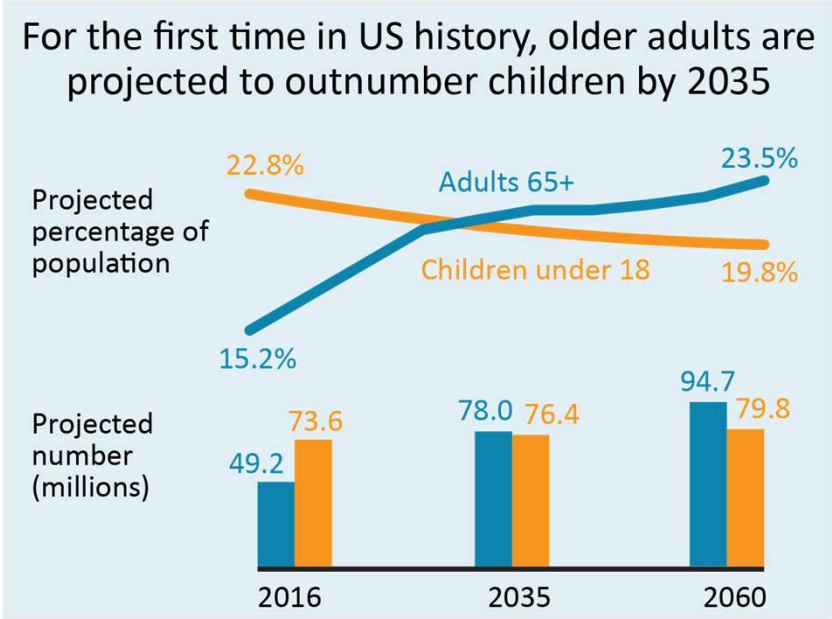
US Census Bureau and FHWA Statistics

Mobility-Impaired Populations Need More Options

- 1 in 5 adults over the age of 65 live in rural America
- Older adults are projected to outnumber children by 2035



https://www.census.gov/library/stories/2019/10/older-population-in-rural-america.html

ADS Vehicle

- 2020 Ford Transit 350 HD Chassis
- Buy American Act
- Mobility-friendly vehicle
- Always monitored by safety driver and co-pilot
- Built to support higher levels of automation
- ADA compliant

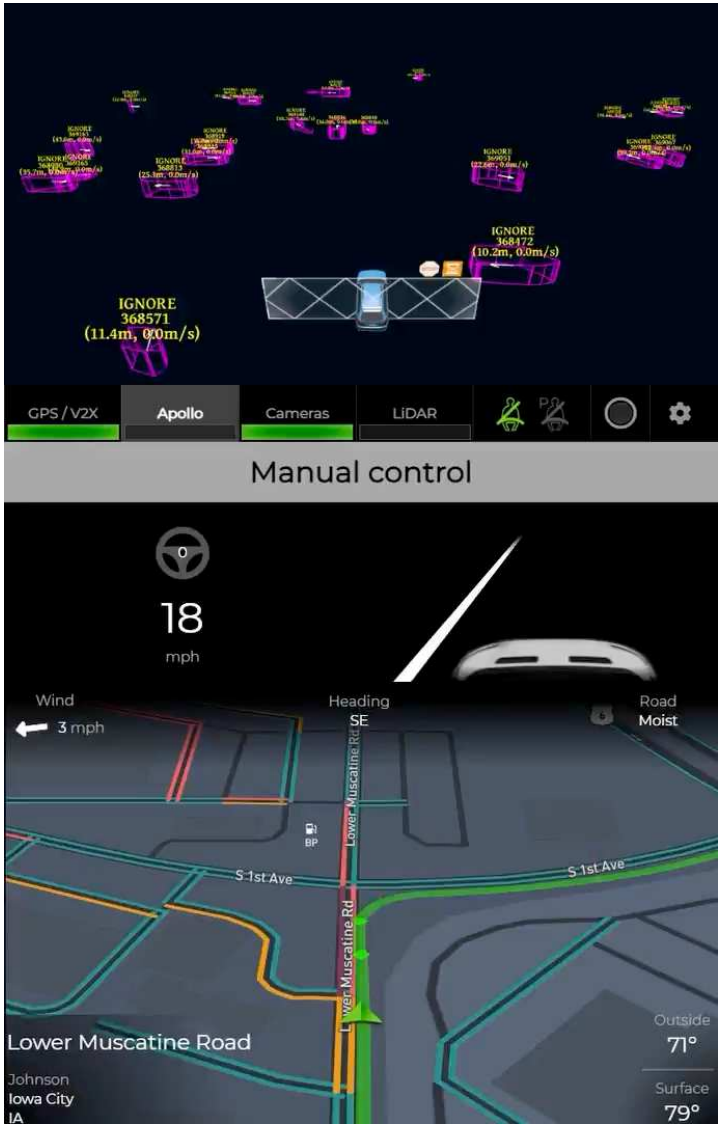
Accessibility

ADA compliant

Equipment

1. GPS antenna
2. DSRC antenna
3. High-definition cameras (2)
4. Velodyne Lidar (on front, sides, and rear of vehicle)
5. Webcam video camera (front and rear)
6. Mobileye collision avoidance system
7. Vaisala mobile detector: road, surface, and weather data
8. Long range radar (front and rear)

Video: Safety Driver Display



Route

- 47-mile loop, driven clockwise
- 4 stops
  - Iowa City Marketplace
  - Hills Community Center
  - Riverside Casino
  - Kalona Public Library
- Different road types
  - Marked, unmarked, unpaved
- Driven all 4 seasons
- Different times of day
- Mapped in high-definition
- Construction along route

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Riders from Local Communities

Older adults

- Age 65 and over
- May have a driver's license with or without restrictions

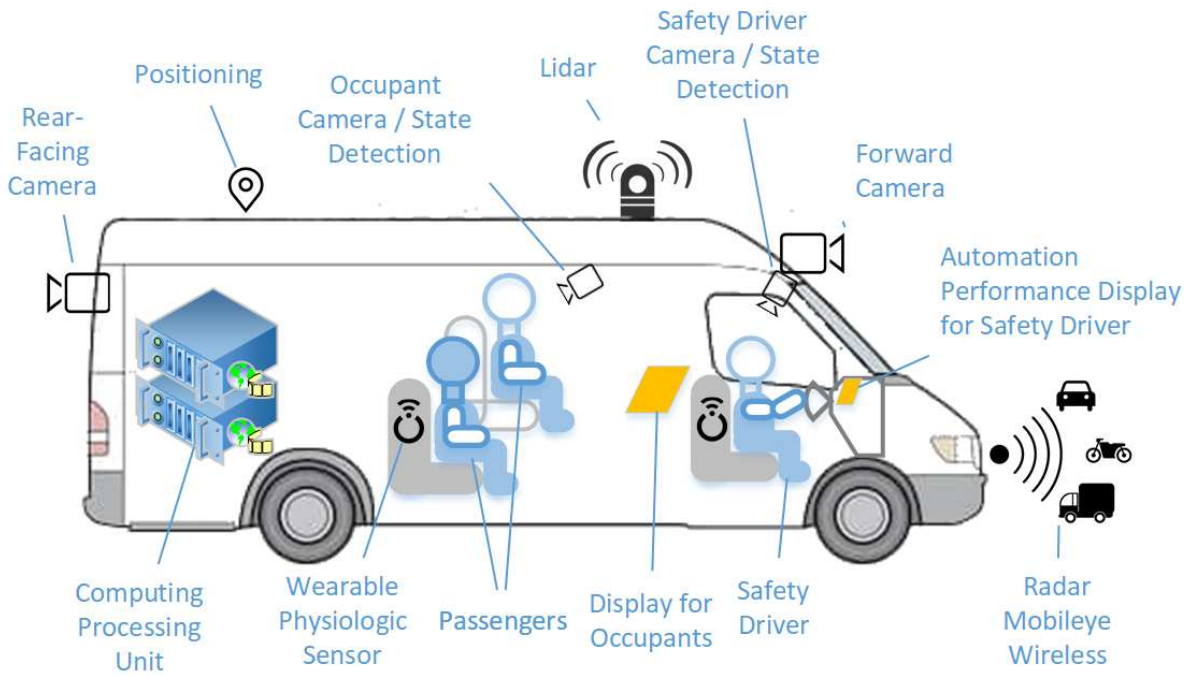
Mobility-impaired adults

- Age 25 and over
- Need the aid of a walker, cane, or wheelchair

Visually-impaired adults

- Age 25 and over
- Vision between 20/70 - 20/200

Data to be Collected



- Video data from driver and passengers
  - Driver performance/workload
  - Driver/passenger state detection
- Questionnaire data from the riders regarding trust and acceptance
- Physiological data from riders and safety driver regarding stress/anxiety
- Automation performance data
  - Impact of environment

Hypothesis: Trust and acceptance will be gained through experience with the AV

Questionnaire Data

Pre- and post-drive:

- Trust
- Reliability
- Anxiety
- Safety
- Intention to use
- Perceived usefulness

I would trust a highly automated vehicle to drive on gravel roads

How concerned are you about an automated vehicle's ability to interact with non-self-driving vehicles?

Biometric Data (Empatica)

Baseline data collected pre-drive (10 minutes)

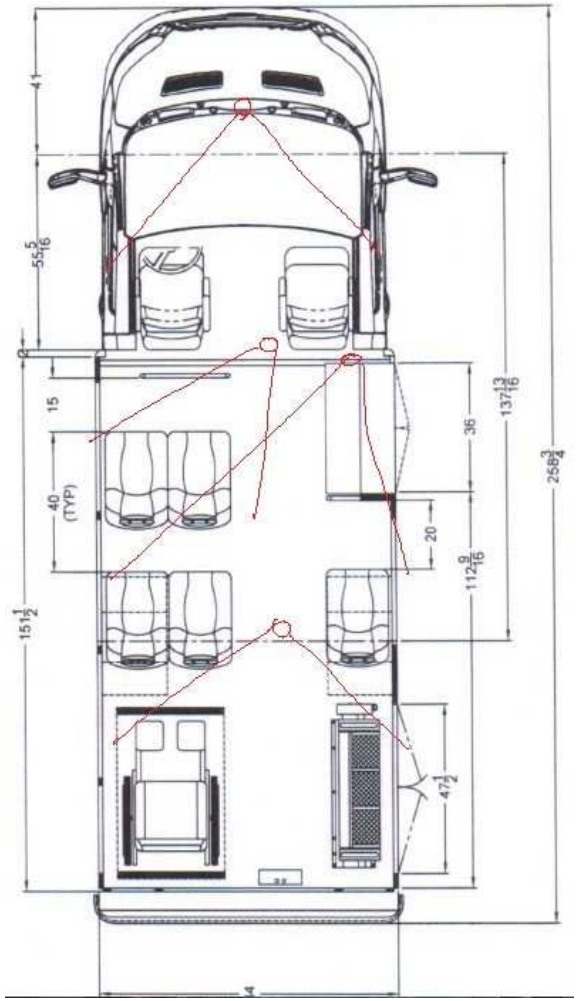
- Data from temperature sensor
- Data from the electrodermal activity sensor
- Blood Volume Pulse (BVP) data from photoplethysmograph
- Data from 3-axis accelerometer sensor
- Inter-beat interval extracted from the BVP signal
- Average heart rate extracted from the BVP signal

Ratings of Anxiety

- Asked at various points throughout the drive
- A monitor at front of shuttle will continuously display the status of the automation (i.e., manual or automated control)

Video Data

- Forward view
- Rear view
- 4 synced video streams
  - Driver and co-pilot face, hands, torso
  - Passenger's face/torso
- Time-stamped
- HD resolution (1080P)



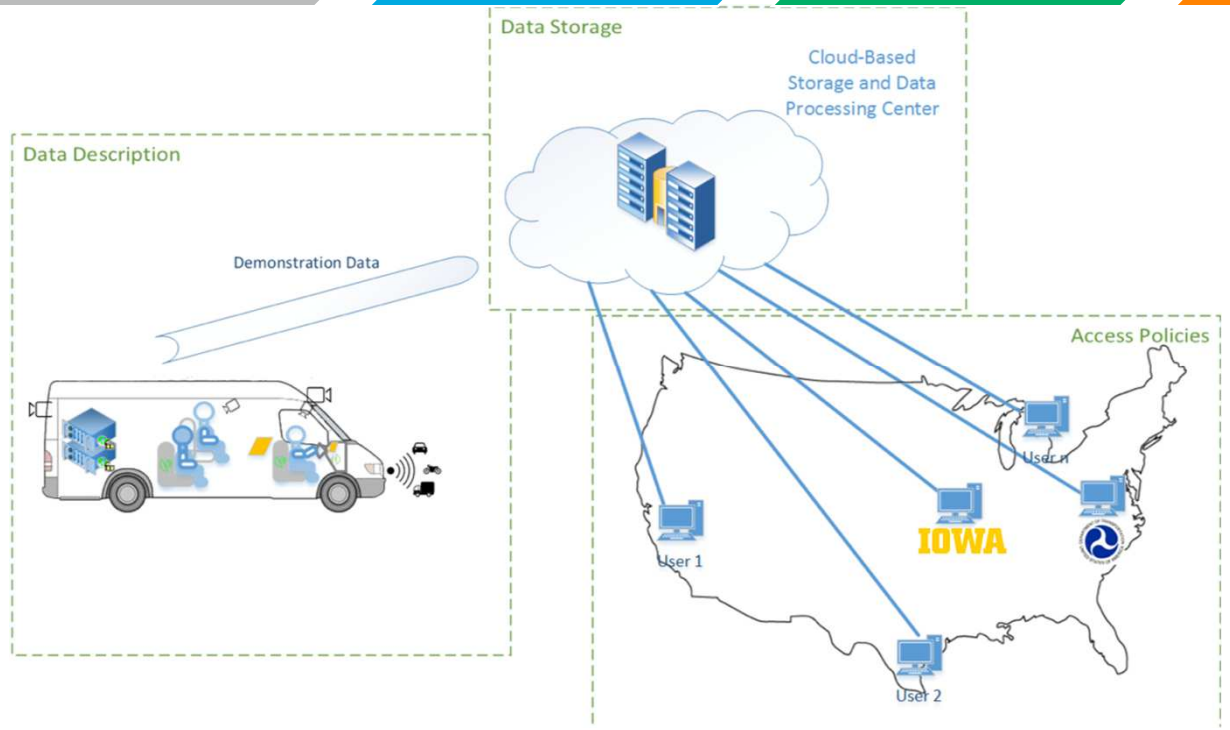
Access to raw video data requires data usage agreement

Phase and Automation Focus

Phase	Name / Focus on Automation
1	Controlled Access Divided Highways/Interstate
2	Two-Lane Undivided Highway
3	Connected Vehicles
4	Roads Through Cities and Towns
5	On and Off-Ramps / Wet Weather
6	Unmarked and Snowy Roads
7	Navigating Parking Areas
8	Full Route Under Automation

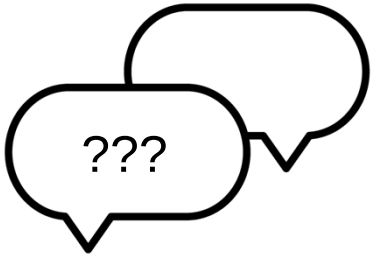
Data Sharing Approach

Vehicle / ROS Bag Data → Indexed Relational Database Data → Cloud → Access Portal → Data To Users



Lessons Learned & Issues for Consideration

- AVs are complicated, expensive, and fickle
- Sometimes perceived as “too safe”



- Marketing hype and buzzwords cloud understanding
- Public fear of the unknown

Funding for solutions targeted to solving critical use-cases

Questions from Kitazakisan:

1. What is the most important research question/challenge?

- Managing the public's expectations about what automation means
  - Automation is greatly overmarketed
  - ODD is critical to discuss in any public forum
  - Give examples and be clear that home to work or play automation is decades away

Questions from Kitazakisan:

2. What aspects should/can be internationally standardized?

- Automated driving is largely not an OEM process as before
- Computer and start-up don't play by the same rules as the OEMs
- Their work is too proprietary and dynamic (e.g., over air updates) to wait for consensus standards

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