Self-Driving Technology and Trust
Can a Driving Simulator Help?

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March 17th 2022

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CEO Jitsik LLC
Drivers Ed for Self-driving

40,000 people die every year on US roads.

Helen Loeb, Ph.D.
Academic research

Spent last 10 years studying the cause of accidents.

Multimodal research: naturalistic studies, statistics, simulator studies

CChIPS | Center for Child Injury Prevention Studies

Naturalistic Driving @ Center for Injury Research and Prevention

Strategic Highway Research Program (SHRP2) - data mining
Bigdata NSF grant with Drexel University (Chris Yang)

- Authorized by US Congress in 2005
  - Impact of driver behavior and performance on traffic safety
  - 235 million dollars

- SHRP2 Naturalistic Driving Study: 3362 Vehicles, 3240 drivers (age 16 – 99)

- Data recorded continuously for over 2 years: 700 crashes, 7000 near crashes

Videos and driving variables available BEFORE, DURING and AFTER the crash/near crash.

- Academic research 2015 to present
- Teen crashes
- Driving behavior
- Automated Braking

Driving simulation @ Center for Injury Research and Prevention

Clinical study on simulator of 72 people

3 age groups:
- 16 to 19 years old
- 25 to 54 years old
- 65+ years old

2 scenarios:
- highway exit
- curve on 2 way road

2 frameworks:
- audio & visual warnings
- no warning

2 conditions:
- distraction
- no distraction

Results presented @ Automated Vehicle Symposium

Emergency Autonomous to Manual Takeover in a Driving Simulator: Teens vs. Adults, Males vs. Females

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Interacting with level 2 and 3 vehicles

Do drivers trust self-driving?
When can vehicle assume driver can resume control?:

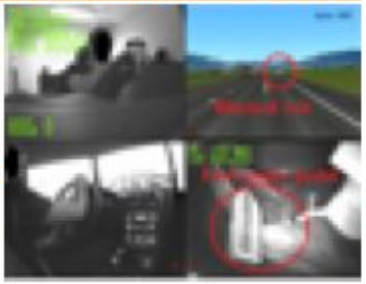
Driver focused? Hands on steering wheel? Foot on Pedal?

Driving simulator - Eye tracker - HOD (60 participants)

RTI HS Driving Simulator FOV 180 deg

ASL Eye Tracker

Age/Gender	Male	Female	Total
16 to 19	9	10	19
35 to 54	10	12	22
65 to 84	10	9	19
Total	29	31	60



60 participants were recruited and asked

- to share their opinion and knowledge about self-driving developments
- to ride a simulator in self-driving (acclimation – **blocked highway exit**)
- to assess the simulator experience

Results

Pre-drive survey	Male	Female	Teen	Adult	Older
Do you use Cruise Control*	44%	25%	31%	37%	35%
Should training be required?	86%	94%	84%	87%	100%

Simulator crash scenario	Male (25)	Female (22)	Teen (19)	Adults (17)	Older (11)
Hands on wheel	24%	5%	11%	29%	0%
Foot near pedal	76%	50%	63%	65%	64%
Crash	52%	50%	53%	47%	55%

Post-drive survey	Male	Female	Teen	Adult	Older
Are you *more* comfortable* with self-driving	42%	43%	42%	39%	50%
Are you *less* comfortable* with self-driving	26%	19%	26%	33%	30%

Need to train drivers

Driving simulator experience boosts drivers confidence in self-driving (despite crash scenario)

- Standardize nomenclature (Self-driving, Driverless, Autopilot, Active Lane keeping…)
- Set reasonable expectations on vehicle capability
- Train drivers to ADAS and automated features

Acknowledgements

The authors would like to acknowledge the National Science Foundation (NSF Grant Number EEC-1937908) Center for Child Injury Prevention Studies (CICRC at the Children's Hospital of Philadelphia (CHOP) and the Ohio State University (OSU) for sponsoring this study. The views presented here are solely those of the authors and not necessarily the views of CHOP, OSU, or NSF.

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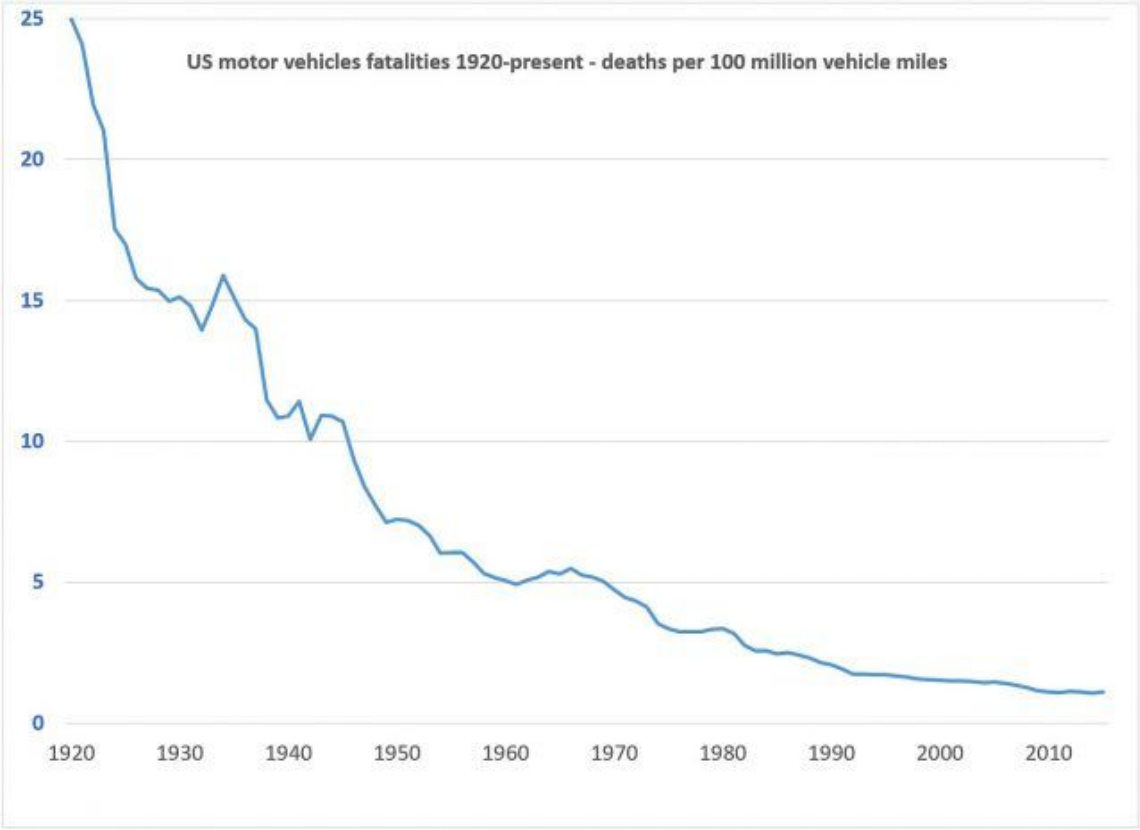
CENTER FOR INJURY RESEARCH AND PREVENTION

Mission: converge to Vision Zero for road fatalities



Fatalities divided by 25
in 100 years.

Drop of 96%
Great but **not enough!**

- Education can help
  - Better training
- Legislation can help
  - Alcohol regulation, Speed limit, GDL
- Technology can help
  - Seat belts, airbags, ADAS

Self-driving cars: a tool toward Vision Zero?

Self-driving cars: the Trust issue

Pittsburgh Post-Gazette

Image courtesy of Aurora Innovation

Safety first: Self-driving industry needs to earn trust

THE EDITORIAL BOARD
Pittsburgh Post-Gazette

JAN 10, 2022 5:52 AM

Research Question:

How can we build people's confidence in car automation?

Self-driving cars: the Trust issue

JITSIK startup (Penn/Drexel University)

Jitsik

First company to focus
on human side
of self-driving.

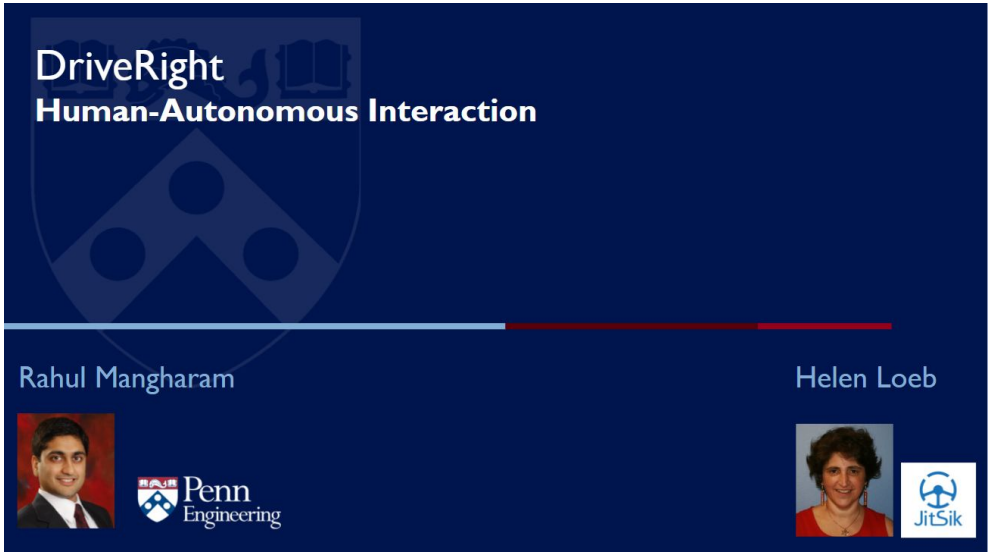
Inform,
Train,
Build trust.

The DriveRight Project: Hyperrealistic simulator for training

Supported by a grant from Mobility21 @ CMU

Mobility21
A USDOT NATIONAL UNIVERSITY TRANSPORTATION CENTER

July 2020 to present (second year)



12 students since 2020
5 papers on driving simulation

- Zhijie, G, Loeb H., Drive Right: Autonomous Vehicle Education Through an Integrated Simulation Platform, accepted, SAE Journal of Connected and Automated Vehicles
- Loeb, H, Mangharam, R. Mixed Reality Driving Simulator as a Training Tool for Autonomous Vehicles, accepted, WCX World Congress, Detroit, April 5-7 2022
- Seacrist, T., Maheshwari, J., Sarfare, S., Chingas, G., Thirkill, M., & Loeb, H. S. (2021). In-depth analysis of crash contributing factors and potential ADAS interventions among at-risk drivers using the SHRP 2 naturalistic driving study. Traffic Injury Prevention,
- Jazayeri, A., Martinez, J. R. B., Loeb, H. S., & Yang, C. C. (2021). The Impact of driver distraction and secondary tasks with and without other co-occurring driving behaviors on the level of road traffic crashes. Accident Analysis & Prevention, 153, 106010
- Loeb, H. S., Vo-Phamhi, E., Seacrist, T., Maheshwari, J., & Yang, C. (2021). Vehicle automation emergency scenario: using a driving simulator to assess the impact of hand and foot placement on reaction time (No. 2021-01-0861). SAE Technical Paper.

Goal = immersive, ubiquitous simulator

Step1: Integrate simulator with **Virtual Reality**

+

Step 2: Integrate technology in **actual vehicle**

Step3: Move to **Mixed Reality with Chroma Key Technology (green screen)** for immersion and comfort

Native car environment

Light **affordable sensors fit any car**

Maximum **immersion**

Manual and AV modes

Simulate any scenario

Original proof of concept

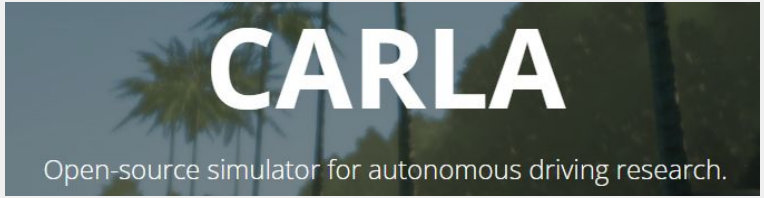
Step 1: Virtual Reality Simulator

Pilot Clinical study with Unity, SVL simulator completed in 2021 with University of Pennsylvania IRB

- 28 participants
- The study results indicate that a driving simulator effectively decreases the participants' perceived risk of autonomous vehicles and increases perceived usefulness.
- Zhijie, G, Loeb H., Drive Right: Autonomous Vehicle Education Through an Integrated Simulation Platform, accepted, SAE Journal of Connected and Automated Vehicles

Second clinical study planned for Spring/Summer 2022

1. Virtual Reality (VR) with **Oculus Quest 2** headset, **Unreal Engine**
2. **CARLA** rural map scenario for full self-driving demo
3. **Self-powered Logitech G29 steering wheel in the autonomous mode**
4. Free switch between the manual and automatic control
5. Server-Client running on separate laptops to share computation

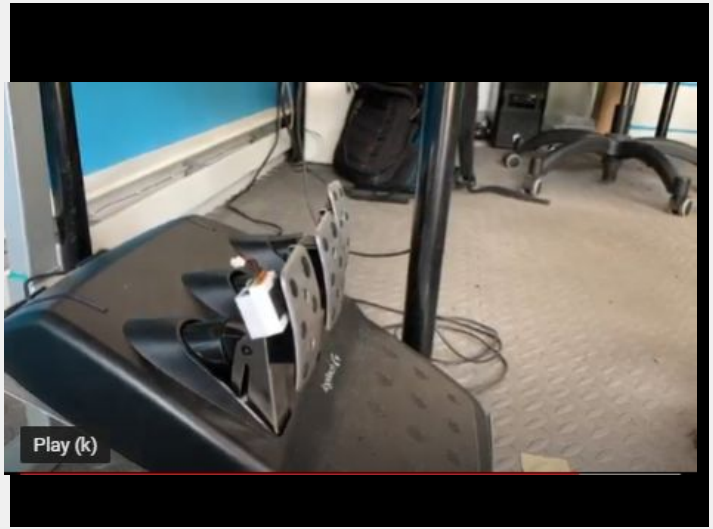


Carla Driving Simulator Scenarios

Step 2: Integrate technology in actual vehicle

Developed wireless IMU to equip vehicle for

- steering wheel
- both pedals.



Step 2: Integrate technology in actual vehicle

Car integration

- Battery lasts sufficiently long
- Very low latency, it feels real-time
- Fits well on most pedals/steering wheels
- Little to no drift

Step 3: Move to Mixed Reality

- Testing with a poster on the wall
- Using Oculus Quest and Zed mini for Mixed Reality

Step 3: Move to Mixed Reality

- We build a green screen enclosure

Step 3: Move to Mixed Reality

- Currently testing on Toyota Prius

Step 3: Move to Mixed Reality

- Mixed Reality can be obtained through
  - Video passthrough (HTC Vive Pro, Zed mini, Lynx)
  - Optical passthrough (Hololens, MagicLeap)

Currently evaluating options for our application (Xiatao Sun)

Varjo Headset

Lynx Headset

Oculus Quest 3

Potential deployment

- Driving school for teaching novice drivers

- Auto Dealerships to try ADAS/self-driving off road

- Community Centers for acclimation to technology

- Rehabilitation to driving after an injury

How you can help

Looking for **collaboration**

- For Virtual/Augmented/Mixed Reality integration
- For clinical study in on-road tests
- For Human Factors Study Design

Through SBIR, STTR, VC…

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Thank you!


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THE FUTURE . . .
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Acknowledgments

Thank you to Mobility21, Smart Mobility Connection or their support
Thank you to Lisa Kay Schweyer, Joy Mann, Stan Caldwell…

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