Virtual and Augmented Reality in Transportation: Examples from Academia

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http://psychology.uiowa.edu/hank-virtual-environments-lab
Overview of Presentation

• Review of Academic Research Labs
  • Real-time interactive simulation
  • Virtual environments

• Critical Issues
  • Stereoscopic display (Does it matter?)
  • Display type (HMD vs. Large Screen)
  • Interaction modality and motion
  • Scenario design and development
  • Validation
Driving Simulators: VR, AR, or not?

• Immersive
• Interactive
• 3D
• Multi-Sensory

• Separate communities
  • Separate conferences
  • Separate publication venues
    TRB.org search
      virtual reality 11 hits
      driving simulation 237 hits
    IEEE VR search
      virtual reality 1651 hits
      driving simulation 20 hits
National Advanced Driving Simulator (NADS)

University of Iowa

- Driver Assistance Systems
- Driver distraction
- Night Vision Enhancement
- Safety warning systems for older drivers
- Young drivers
University of Massachusetts - Amherst

- Advanced Yield Marking (shark teeth)
- Boston Central Artery (big dig)
- Roadside Vegetation and Clear Zone
- Toll Lane Configurations
- Deflection Angle on Roundabouts
- Infrastructure Strategies for Safer Cycling
University of Wisconsin TOPS Lab

Holographic Traffic Controls

Mini-sims

low cost, fixed based driving simulators

Umass - Amherst
University of Alabama Youth Safety Lab

Teaching children how to safely cross a road

Semi-immersive virtual environment
Three screens show a simulated roadway
Participants take one step off a curb
Triggers third-person view of an avatar crossing traffic

Pedestrian Simulator

10 screens (2.55 m high and 1.88 m wide) allowing a pedestrian to walk up to 7 m across two lanes of simulated traffic.

The Transport Systems Catapult (TSC)
Innovate UK Centre for Intelligent Mobility

Pedestrian Simulator
  Omnidirectional Treadmill
  Oculus Rift

Pedestrians interactions with driverless cars

Way finding in new public spaces

The Hank Virtual Environments Lab

Creating realistic, immersive virtual environments that allow full-body movement

• Bicycling simulator
• Pedestrian simulator

Studying human behavior in virtual environments

• How do child cyclists cross roads with traffic?
• How do texting pedestrians cross roads with traffic?
• How do children and adults cross roads with peers?
The Bicycling Simulator
Bicycling Studies

One-way and two-way traffic

High density traffic

Interception of gaps on the run

Peer influence
ADHD riders
A Typical Response Curve Showing Gap Choice in High Density Traffic

What do we find?

Gap Choice
• Children choose the same size traffic gaps as adults
• Aggressive boys take tight gaps
• Virtual Peer influence gap choice

Movement Timing
• Children have less time to spare than adults when they cross through traffic gaps
• Children with ADHD time their movement less precisely
The Pedestrian Simulator
Pedestrian Studies

Influence of Stereoscopic Viewing

Children’s road crossing

Two-people crossing

Crossing while texting with and without alerts
Child Pedestrian Road Crossing

Developmental changes from ages 6 to 12

Gap selection

Movement timing

Pedestrian Texting Awareness Campaigns

New Haven, CT, “Look Up” stencils on sidewalks
http://www.newhavenindependent.org/index.php/archives/entry/i_got_caught/

NYC Look! Campaign

Improv Everywhere: Seeing Eye People
http://improveverywhere.com/2013/04/30/seeing-eye-people/

Eyes down, minds elsewhere, ‘deadwalkers’ are among us
Washington Post, September 27

National Geographic
Cell Phone Lanes on Sidewalks

Vehicle-to-Pedestrian (V2P) Technology

Alerts using Dedicated Short-Range Communications Technology

*Permissive Alerts*

When it is safe to cross

*Prohibitive Alerts*

When it is unsafe to cross
Don’t walk signal
Collision warning

*Connected Vehicles: Vehicle-to-Pedestrian Communications USDOT factsheet*

Permissive Alert Study

Interface:
- Count down to next safe gap + signal when gap opens

Results:

Gaze
- Focused on the cell phone ~80% of the time
- Glance at traffic immediately before crossing

Gap selection
- High likelihood of crossing identified gaps

Timing
- Fewer close calls and hits as compared to texting only
- Time left to spare similar to non-texting control
Joint Road Crossing

Pairs crossed together 75% of the time

Pairs tightly synchronized their movements

*Road entry within .19 seconds of one another*

Pairs selected larger gaps and timed crossing to accommodate joint crossing
What’s next?

What are the most effective ways to communicate information to texting pedestrians?

How does the avatar fidelity influence joint action?

Appearance
Motion
Pedestrian Avatar
Carl and Carly
Stereoscopic display (Does it matter?)

- Driving simulators are non-stereo (mostly)
- Cue strongest in near field (personal space)
  - Falls off as square of distance
  - Effective range in real world ~ 1 km
  - Effective range in VE ~ 44 m
- Possible contributions
  - Judging gap size
  - Time movements
- Natural experience
  - Close one eye
  - Drivers without stereo
Display type (HMD vs. Large Screen)

+ Large field of regard
+ Portable
+ Low cost, modest infrastructure
- Low field of view (typically)
- Encumbrance
- Sickness from tracking latency
Collaborators

• **Co-Director of the Hank Lab:**
  Jodie Plumert

• **Lab Manager:**
  Calvin Bryant

• **Students:**
  Katie Brown, Yuanyuan Jiang, Zhimao Liu, Elizabeth O’Neal, Pooya Rahimian, Paul Yon

• **A host of others:**
  Sab Babu, Ben Chihak, Jim Cremer, Luke Franzen, Tim Grechkin, Megan Mathews, Quinn Montgomery, Dat Nguyen, Geb Thomas, Christine Ziemer, Tyler Zeken
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