Driving Simulation for Driving Safety

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NATIONAL ADVANCED DRIVING SIMULATOR (NADS)
THE UNIVERSITY OF IOWA
Our Motivation

90% of motor vehicle crashes are attributed to human error

In 2006...

Estimated 6.2 million police-reported motor vehicle crashes

42,642 traffic fatalities; 4,810 involving motorcycles

2.6 million people injured

4.2 million crashes involving property damage only

Motor vehicle crashes are the leading cause of death for ages 2 through 34

The economic cost to society exceeds $230 billion

-NHTSA, Traffic Safety Facts, 2006 Data
NADS Facility

- Easy access to I-80/I-380
- Simulators at different levels of realism
- Safety training lab
Uniqueness of NADS-1

- The closest to driving an actual vehicle in a controlled, repeatable environment
- Simulate all ground vehicle types
- Driver can “feel” different types of roads
- Driver can experience different time of day and visibility conditions
- Drivers can experience sustained motion cues (braking, sliding, turning)
NADS MiniSim™

- Portable, small footprint
- Off-the shelf parts, easy to service
- Reliable
- Cost effective
- Multiple configurations
- Web-site provides connection to national network of researchers and practitioners
NADS MiniSim™ Partners

(Green=Vehicles, Blue=Heavy Trucks, Red=Both)
MiniSim Partnerships

Partners / Source of Funding
- Transportation Regulatory Agencies
- Automotive Industry
- Pharmaceutical Industry
- Universities
- NIH/NSF
- Defense Industry / DOD

Application
- Highway Design
- Driver’s Education
- Safety/Remedial Training
- Clinical Trials
- Vehicle Safety & New Technologies
- Clinical Assessment
- Military Training and Simulation
NADS Driver Safety Training Program

- Provide driver safety training for company fleets
  - Improve driving practices
- 2-hour training program consisting of training scenarios, safety presentations
- Developed in consultation with local company and safety committee
- Cost $125/trainee
NADS Driver Safety Training Program

**Situation Awareness**

- **Urban SA** – Urban driving often requires expecting the unexpected from other drivers
- **Rural SA** – Cues from the environment and other drivers may help them be more aware of situations and make better decisions.
- **Visibility** – Nighttime visibility is significantly shorter, even with high beam headlights, than daytime visibility
- **Road Conditions** – Stopping distance on wet or snow covered roads may be significantly longer than dry roads
Why Are Driving Simulators Important

- Provide a controlled and repeatable environment in which studies can safely be conducted

- Needed to assess how factors influence a person’s ability to drive safely; particularly in situations which are too dangerous to study on the real road

- Simulator trials allow observation of large groups of people and provides an arena for objective assessment of performance

- Physical and behavioral validity is proven to replicate the real world across different levels of driving simulators
NADS Areas of Research

- Active Safety: ESC, ACC, FCW
- Impairment Fatigue Drugs
- Driver Distraction
- Older Driver Mobility
- Highway Design and Visualization
- Novice Driver
- Training & Safety
- Clinical Assessment & Trials
- PC-Based Simulation
- Vehicle Dynamics & Motion
- Traffic Culture
- Augmented Reality
FOCUS AREA: ACTIVE SAFETY

Electronic Stability Control

• Problem
  – 8,565 vehicles involved in rollover crashes in 2004
  – 84% of these crashes were single-vehicle
  – Correlation between road departures and rollovers

• Goal
  – Assess effectiveness of ESC that keeps vehicle on road

• Method
  – OEM hardware/software in simulation loop
  – Collect data from 360 participants
  – Look at various age groups
  – Look at various types of vehicles
  – Look at dry and wet roads

• Results
  – Led to NHTSA-proposed regulation to make ESC mandatory for all vehicles sold in US by 2012
**FOCUS AREA: IMPAIRMENT**

Impairment Monitoring to Promote Avoidance of Crashes Using Technology (IMPACT)

- **Problem**
  - 25% of all fatalities involve drunk driving (12,998 deaths in 2007, NHTSA statistics)

- **Goal**
  - Identify behavior-based impairment signatures
  - Combine signatures into alcohol impairment detection algorithms—i.e. can your car detect that you’re driving impaired based on common sensors in vehicles

- **Method**
  - Build simulator scenarios sensitive to impairment (from alcohol) yet representative of real-world driving
    - 24 minute drive home from bar at night
    - Features urban, sub-urban, interstate, rural highway scenes
  - Collect data from 108 subjects across age groups and genders at varying BAC (0.00, 0.05, 0.10) on NADS-1
  - Develop predictive algorithm and characterize

Between midnight and 3am, 70% of speeding drivers involved in fatal crashes are alcohol-impaired (BAC=.08+)
**Focus Area: Impairment**

Impairment Monitoring to Promote Avoidance of Crashes Using Technology (IMPACT)

- **Results**
  - Algorithms able to detect 80% of impaired drivers while minimizing false-positive rate
  - Comparable to field sobriety tests
- **Future applications**
  - Collect comparative data on drugs, fatigue, distraction
  - Augment algorithms to detect impairment effects of fatigue, drugs, and distraction
Focus Area: Distraction

Driver Distraction & Mitigation

• Problem
  – 25-50% of crashes linked to driver distraction

• Goal
  – Develop a standard for categorizing distraction detection and mitigation systems
  – Provide NHTSA with guidelines on development of new systems
  – Provide NHTSA with a method for evaluating the effectiveness of new systems

Source: John Lee
Focus Area: Distraction

Driver Distraction & Mitigation

• Method
  – Document all commercial detection/mitigation systems using standardized templates
  – Conduct NADS-1 simulator data collection on human performance while driving distracted
    • Secondary tasks: (1) visual/manual task (simulates reading e-mail), (2) reaching task (simulates attending to something in the back seat), (3) complex cognitive (simulates navigating an interactive voice recognition menu akin to automated customer phone support), (4) visual/manual self-paced task (simulates adjusting volume on radio or searching for a radio station)
    • 32 subjects, within subject, baseline and distraction condition
  – Build algorithm to detect distraction based on data mining techniques
  – Conduct NADS-1 simulator data collection to test algorithm on detecting distraction in real-time and evaluate mitigation systems

• Results
  – Study under progress, nearing the start of the first data collection
Focus Area: Older Drivers

Enhancing the Effectiveness of Safety Systems for Older Drivers

• Problem
  – NHTSA crash statistics show older drivers more susceptible to get into accidents at intersections

• Goal
  – Determine range of driver responses to intersection violation warnings and the effect of the driver age group
  – Identify of in-vehicle intersection negotiation aids for older drivers

• Method
  – Develop a representative model of intersection warning system in simulator
  – Conduct data collection

• Results
  – Final report to sponsor being authored
Evaluation of Adaptive Cruise Control Interface Requirements

• Goal
  – To examine the relationship between ACC use and driving safety among experienced ACC users
  – Identify and analyze use and misuse patterns among experienced ACC users, if present
  – Recommend appropriate countermeasures to address potentially problematic use and misuse patterns, if detected

• Method
  – Develop a representative model of ACC in simulator
  – Recruit participants familiar with ACC in Iowa
  – Study drives representative of known system misuse

• Results
  – Study currently under progress
ROADWAY DESIGN AND SIMULATOR FIDELITY

- **Broad Goal**
  - Make simulators more useful for highway engineers

- **Method**
  - Define needs based on input from highway engineers
  - Collect comparison data (simulator and roadway)
    - Intersection/interchange design and optimization
    - Lane selection
    - Speed selection
    - Gap acceptance
    - Traffic control device comprehension
  - Develop transformations and matching

- **Outcomes**
  - Match design issues to simulator platforms
  - Document utility and limitations of simulator-to-roadway data transformation
  - Identify opportunities for using simulators to address roadway design issues

- **Status**: study in early phases
Virtual Iowa City
Virtual Iowa City
Upcoming Enhancements

- Photorealistic geo-specific graphical environments; virtual cities
- Validation against field data for road studies
- Physics-based graphics, 3D displays
Thank you

• Questions...

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