CRASH IMMINENT SAFETY:
A TIER 1 UNIVERSITY TRANSPORTATION CENTER

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March 19, 2015
The full name of our Center:

“Human Factors for Crash Imminent Safety in Intelligent Vehicles”
Each Project has a Lead Investigator and researchers from multiple Universities.
PROJECT #1: NETWORKED DRIVING SIMULATORS

- All are simulators from the same company, although some are “table-top” models. All are running the same software.
- OSU-1 has moveable base, back rear screen etc.
- Some connections established and still under test.
- Research also underway on synchronization issues
PROJECT #2: DRIVER MODELING

- Create computational models for human behavior in pre-crash scenarios.

- Utilize dynamic inputs about the changing situation and behavior of others.

- Use mathematical or symbolic processing to carry out the functions required to simulate the perception, attention, cognition, and control behavior of interest.

- Integrate different component models, including control theory models, decision and judgment models, learning classifier systems, joint human-automation system models, and attention models.

- Assist with making predictions in pre-crash situations and quantitative estimates of hypothesized safety improvements.
Accomplishments

1. Dangerous Lane-Change Behavior Detection and Trajectory Prediction [1]
   - Vehicle time series data extraction and collection from naturalistic driving data sets
   - Driver behavior classification and dangerous behavior detection based on Hidden Markov Models
   - Vehicle lane change trajectory prediction considering driver behavior

   - Vehicle convoy configuration and lane changing modeling with different driving behavior
   - Predictive controller design optimizing objective function based on vehicle headway set
   - Experiments and comparisons of the behavior-sensible controller with a conservative controller
Accomplishments


- Vehicle time series data extraction and collection from naturalistic driving data sets
- Driver behavior classification and dangerous behavior detection based on Hidden Markov Models
- Vehicle lane change trajectory prediction considering driver behavior

4. Other Ongoing Work

- Develop optimization methods that could improve the HMM training process [3]
- Analyze and extract decisive driving features for dangerous driving behavior detection
- Test and verify controller performance for crash imminent scenarios using simulator
Project 3: COGNITIVE ATTENTION MODELING

- Understand how drivers respond to vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) information cues in pre-crash scenarios.

- Understand driver engagement over a range of human physiological and behavioral factors, including age and drowsiness.

- Consider how to re-engage a driver who may be partially or completely disengaged from key attention elements while operating a semi-autonomous vehicle.
Cognitive Attention Models for Driver Engagement in Intelligent and Semi-autonomous Vehicles

Driver Attention and Engagement

ENVIRONMENT

PERCEPTION

Emergency Management

DECISION MAKING

Task Management

IMPLEMENTATION

CHARACTERISTICS

DRIVER

ENVIORNMENT

PERCEPTION

Emergency Management

DECISION MAKING

Task Management

IMPLEMENTATION

CHARACTERISTICS

DRIVER
Model-based re-engagement and control coordination

• Algorithms assess anomalies and risk at multiple temporal and spatial scales
• Re-engagement at multiple timescales
  – Alerting/warning
  – Redirecting driver attention to developing risk
  – Directing the driver to take charge of some control functions
  – Reconfiguring automated subsystems
  – Communicating authority and capacity—clearly demark ing intended use
• Concept development and evaluation in the simulator
• Driver model development in parallel to complement Project 2
Semi-autonomous Vehicles: Two cases

Case 1: Alternating glances inside and outside vehicle

Case 2: Transfer of control
Minimum alerting time and next research questions

• Minimum alerting time
  – Time spent and activities pursued inside the vehicle since the last glance up on the forward roadway
  – Situation awareness when driver is asked to take over control (John Lee)
  – Speed, traffic conditions, weather, and roadway conditions when drivers is asked to take over (David Woods)

• Next research questions
  – What is minimum alerting time
  – How does it vary as a function of different levels of situation awareness
  – How does it vary as a function of different factors in the environment.
ON DEMAND AUTOMATED SHUTTLES

• On demand automated shuttles can be used for the first or last mile of mobility or for mobility within a selected zone.

• Connected Vehicle technology (intersection safety, cooperative driving) has to be utilized for optimum results. Some Road-Side Units for communication may need to be installed.

• The shuttles are slow but move among dense pedestrian environments and present many “Crash Imminent” situations.
Different types of vehicles are being considered
Top vehicles can have “safety monitors” on board.
CONTACTS

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