CRASH IMMINENT SAFETY:

A TIER 1 UNIVERSITY TRANSPORTATION CENTER

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IUPUI

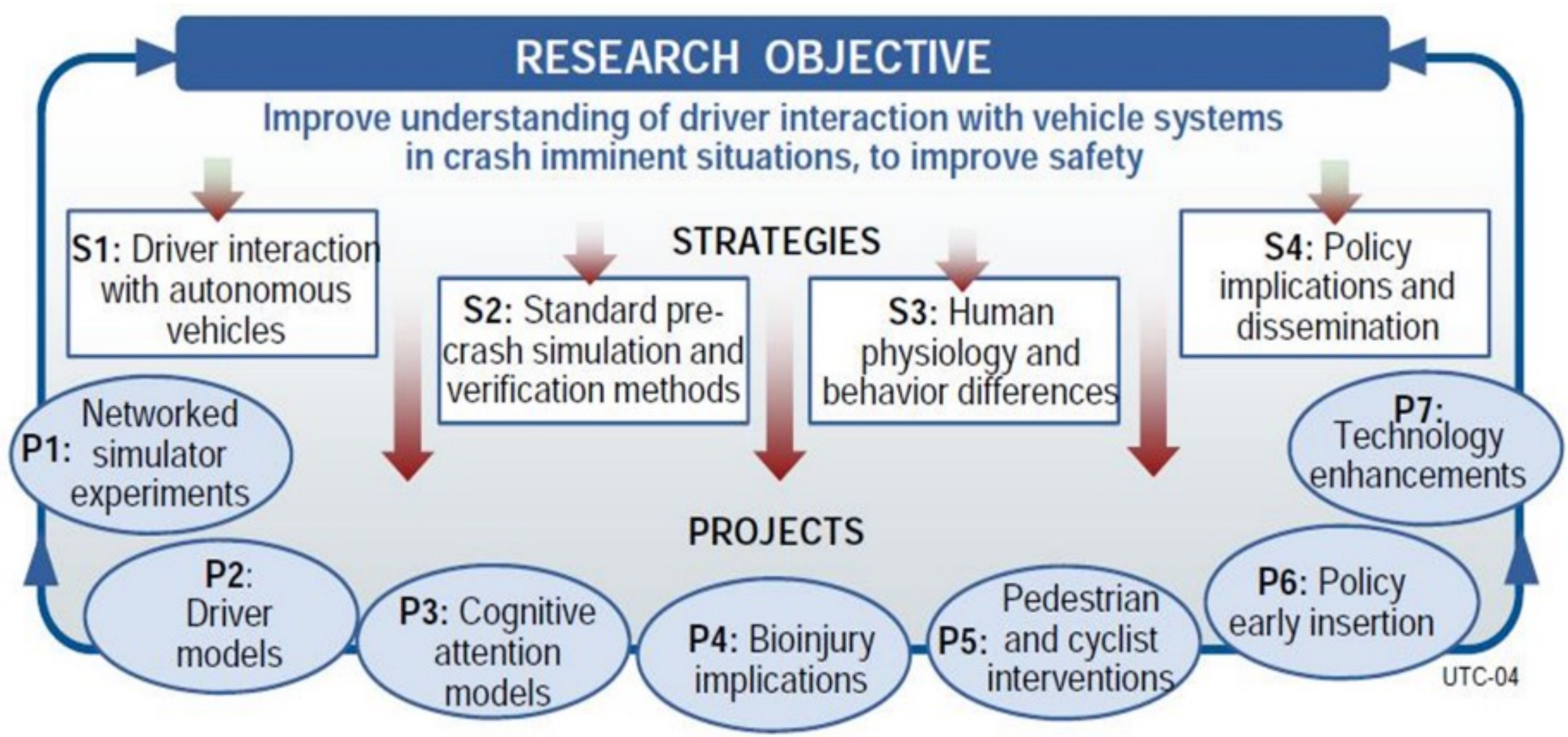
WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

UMASS
AMHERST

THE OHIO STATE UNIVERSITY

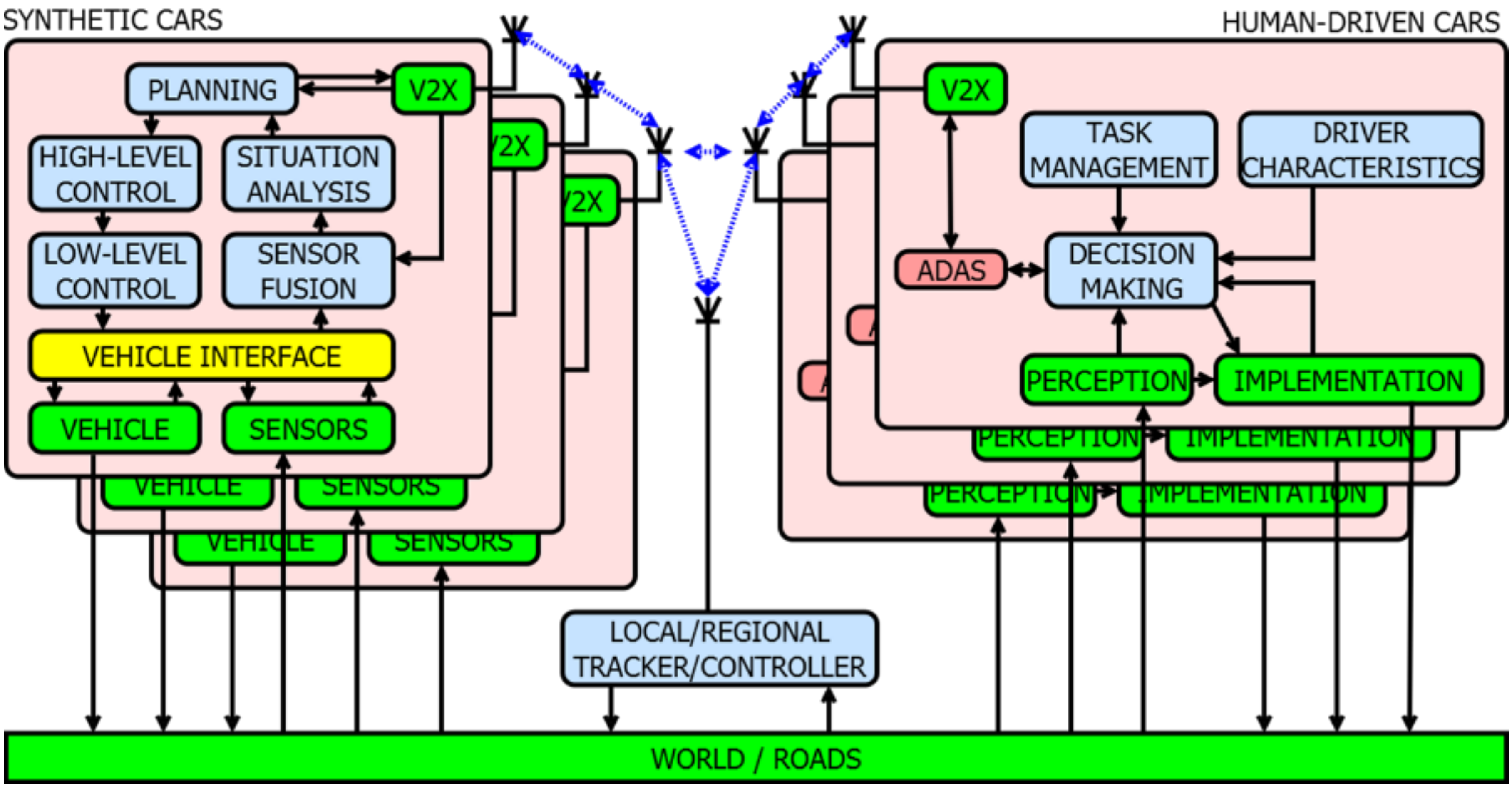
The full name of our Center:

"Human Factors for Crash Imminent Safety in Intelligent Vehicles"



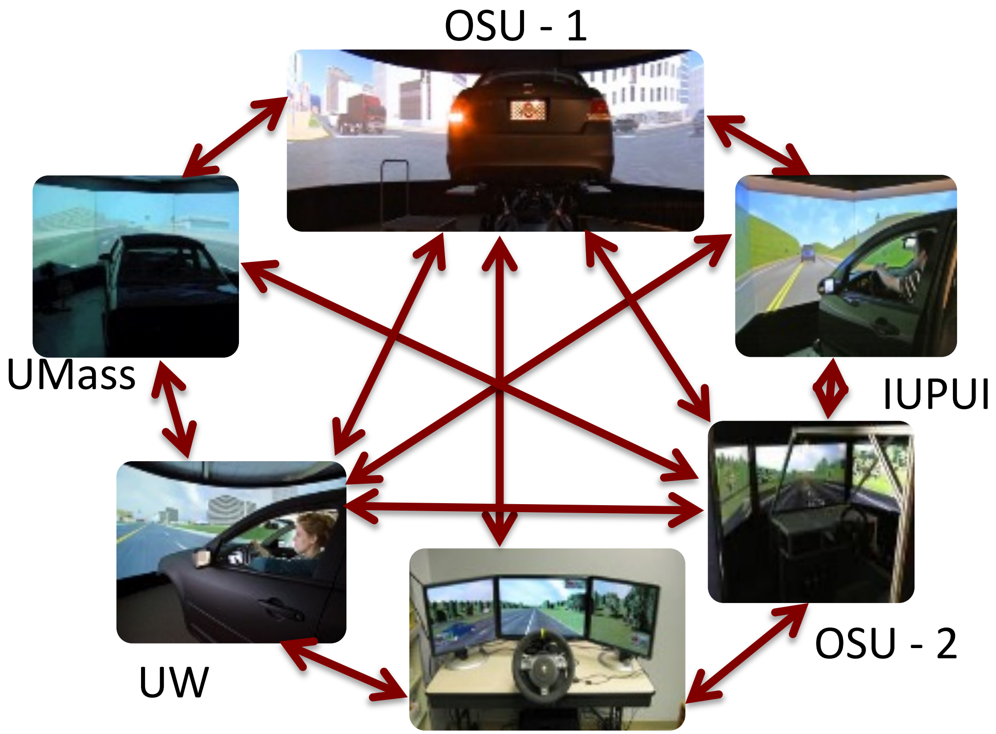
Each Project has a Lead Investigator and researchers from multiple Universities.

SYSTEM VISION & ARCHITECTURE



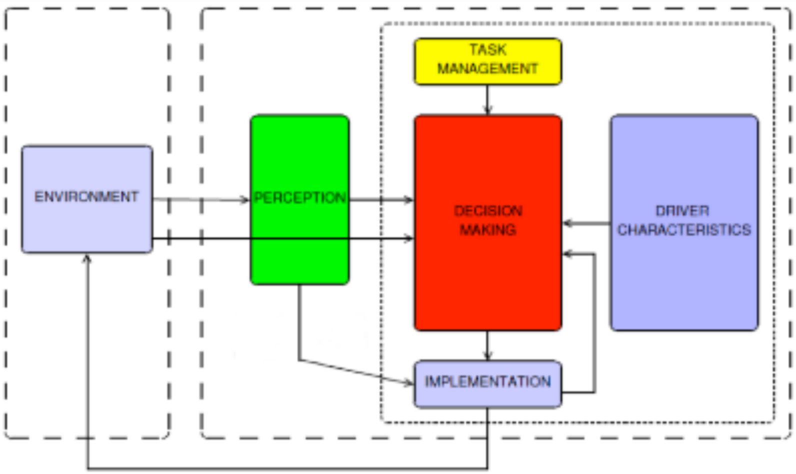
PROJECT #1: NETWORKED DRIVING SIMULATORS

- 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

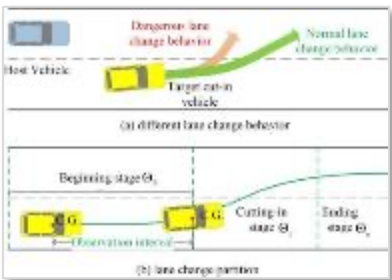
- Create computational models for human behavior in pre-crash scenarios.
- Utilize dynamic inputs about the changing situation and behavior of others.
- Use mathematical or symbolic processing to carry out the functions required to simulate the perception, attention, cognition, and control behavior of 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.

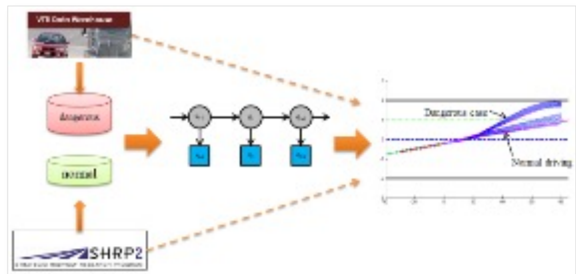


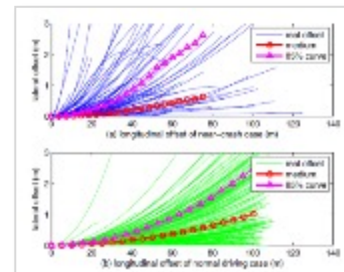
Accomplishments

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

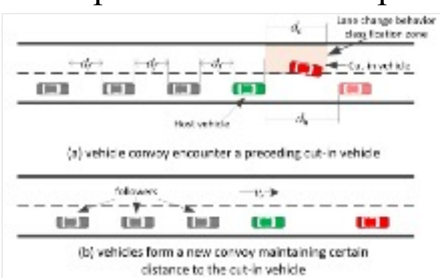


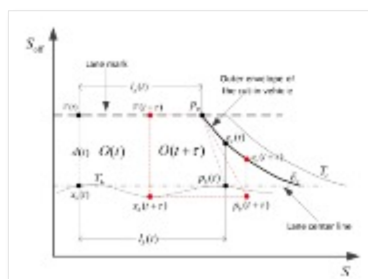


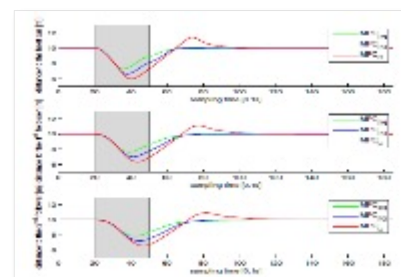


2. Predictive Control of a Vehicle Convoy Considering Behavior of Lane-Change Vehicles [2]

- 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



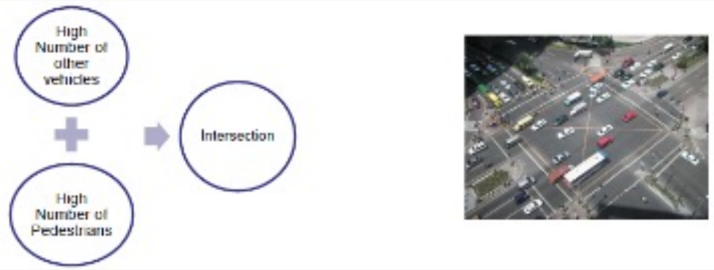


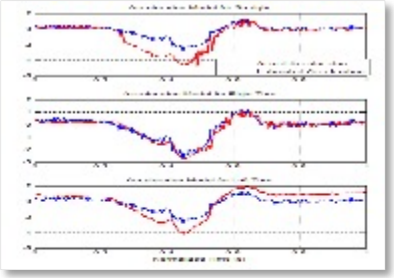


Accomplishments

3. Modeling Driver Behavior at Intersections with Takagi-Sugeno Fuzzy Models [3]

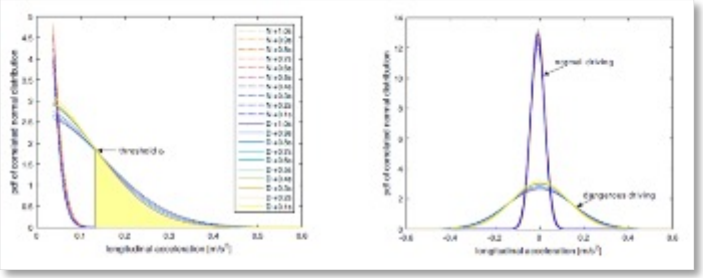
- Vehicle time series data extraction and collection from naturalistic driving data sets
- Driver behavior classification and dangerous behavior detection based on Hidden Markov Models
- Vehicle lane change trajectory prediction considering driver behavior





4. Other Ongoing Work

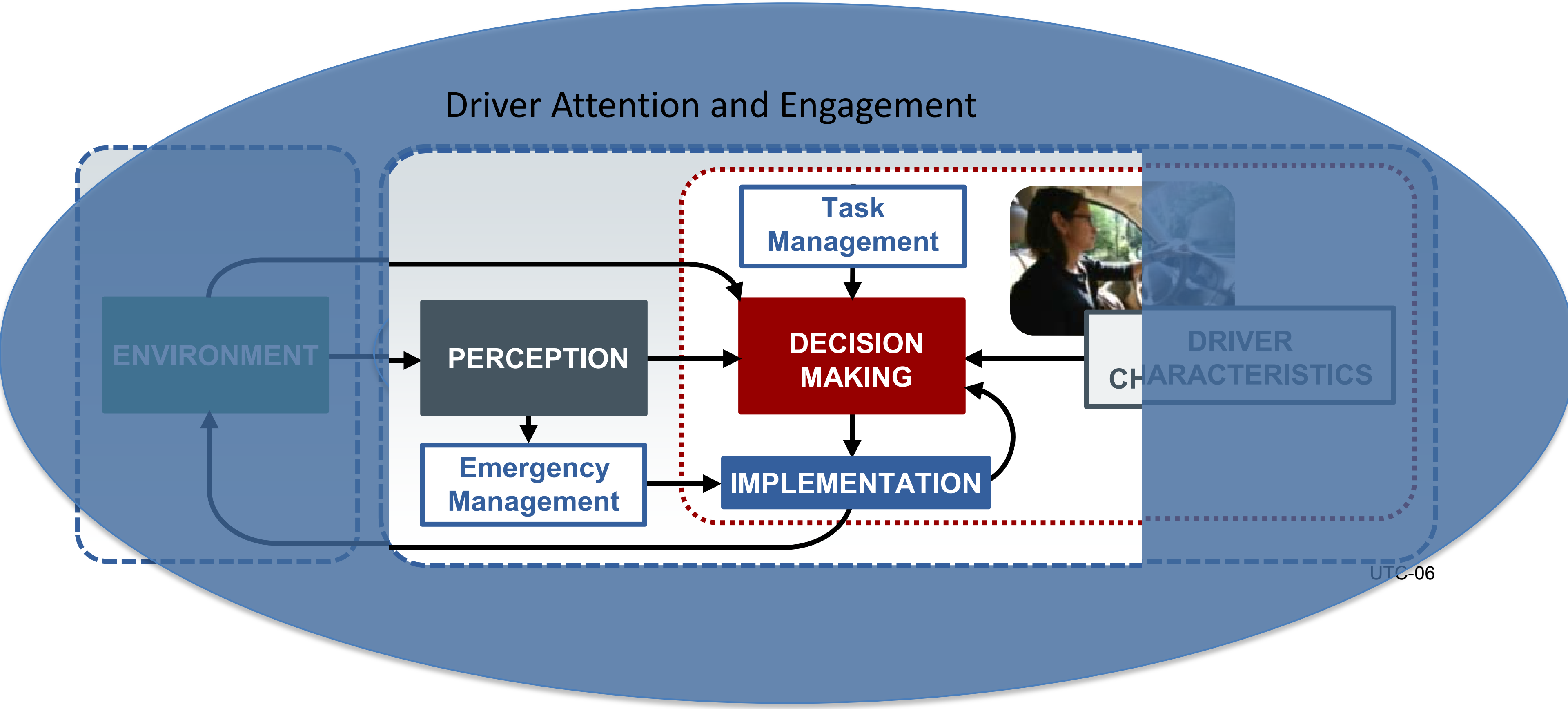
- Develop optimization methods that could improve the HMM training process[3]
- Analyze and extract decisive driving features for dangerous driving behavior detection
- Test and verify controller performance for crash imminent scenarios using simulator



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



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 demarking 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

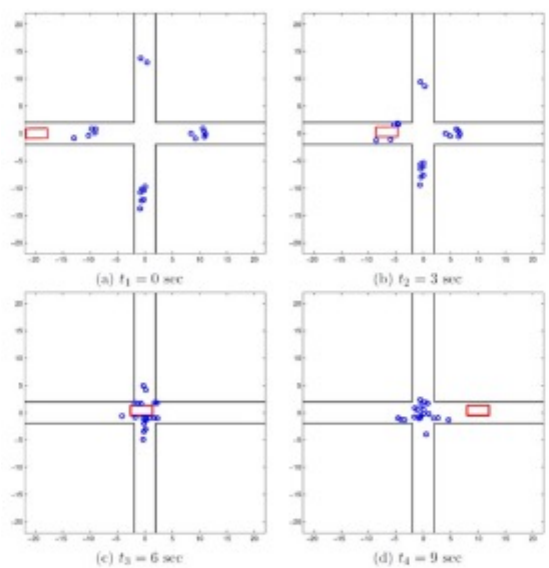
Case 2: Transfer of control

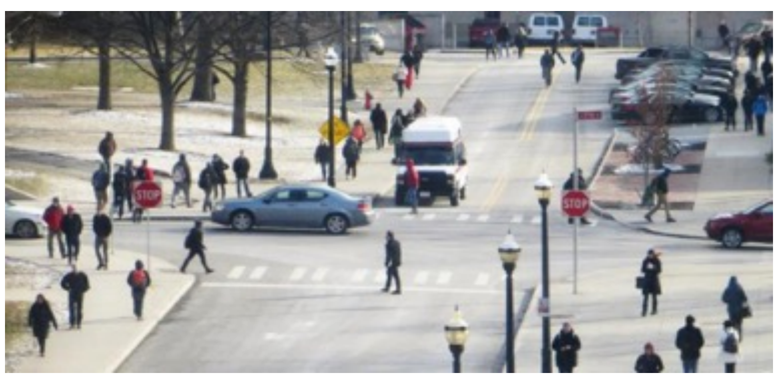
Minimum alerting time and next research questions

- 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





Commercially developed vehicle.

OSU-CAR vehicles

Different types of vehicles are being considered

Top vehicles can have "safety monitors" on board.

THE OHIO STATE UNIVERSITY
CENTER FOR AUTOMOTIVE RESEARCH

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