Investigation of the effect of drivers' body motion on traffic safety

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Overview

- Introduction and Research Motivation
- Methodology
- Data Collection
- Preliminary Data Analysis
- Conclusions
- Next Steps

Introduction and Research Motivation

- Driver-assistance systems are typically focused on vehicle position rather than the driver

Motivation:

- Driver behavior is the key factor that affects safety
- Focus on driver may help improving safety

Introduction and Research Motivation

- Key questions:
  - What cues can the entire body posture provide us related to safety?
  - How can we classify safe or unsafe driving conditions?
  - How do these vary by driver type?
  - What can we do to help drivers be more alert of their surroundings?
    - Training?
    - Ergonomics?
    - Driver assistance system?

Low-cost infrared depth sensor

- Infrared projector
- and infrared camera
- 320 x 240 depth map

- Skeletal tracking

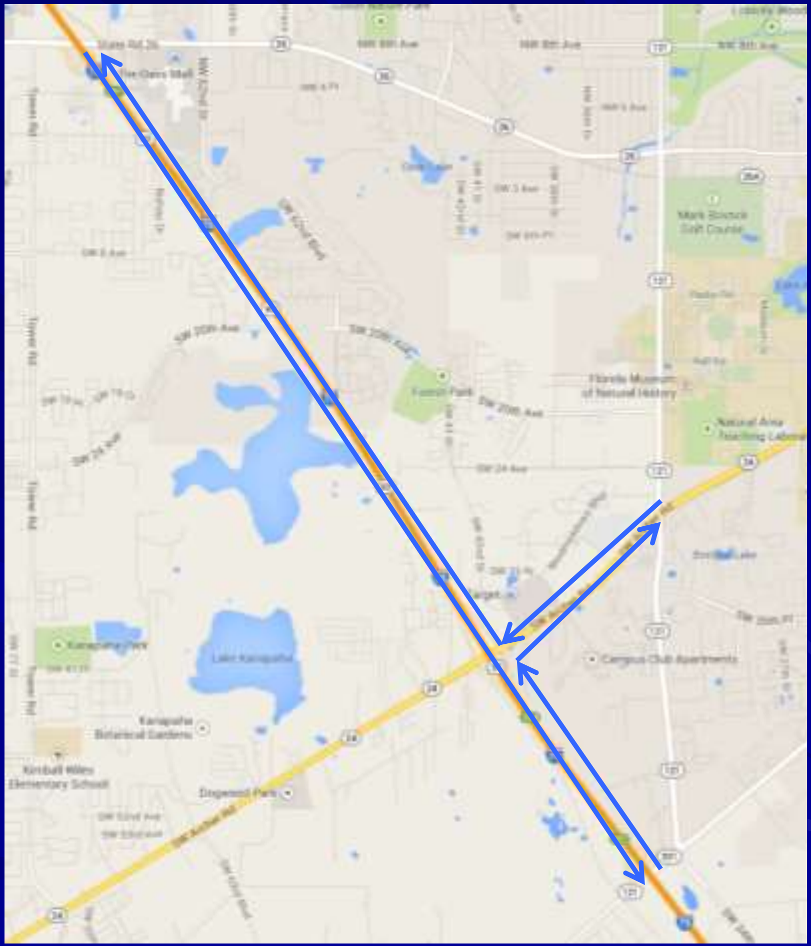
- (and RGB video camera)

Methodology Overview

- Identify patterns of body postures across drivers when:
  - merging
  - changing lanes
  - are involved in secondary tasks
- Correlate with eye gaze information and video information from the vehicle environment

Field Data Collection

- 40 participants (16 to 65 years old)
- 15 participants completed to date
- Observations of upper body posture and activity AND observations of eye gaze
- Merging, exiting and lane changing maneuvers
- Parking maneuver and texting (parking lot)
- Total duration = 2 hours each

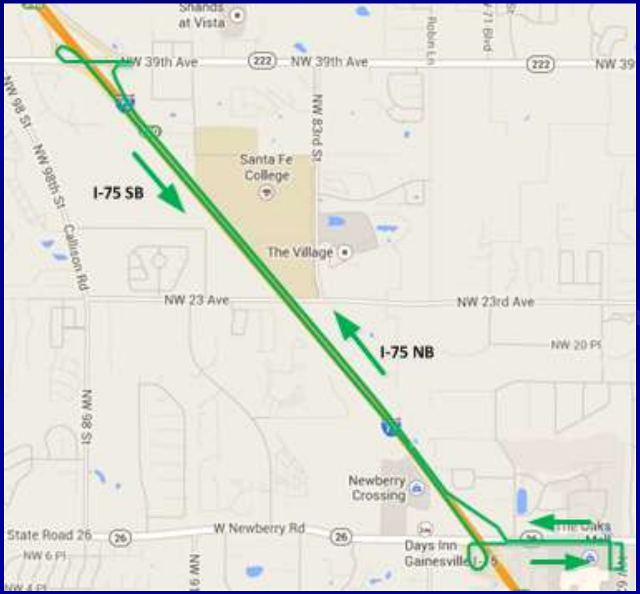


Field Data Collection

- Instrumented vehicle.
- Real-time driver behavior data through PrimeSense™ depth sensor within Kinect™ device.
- Device is connected to a laptop.
- ASL eye tracking glasses and laptop.

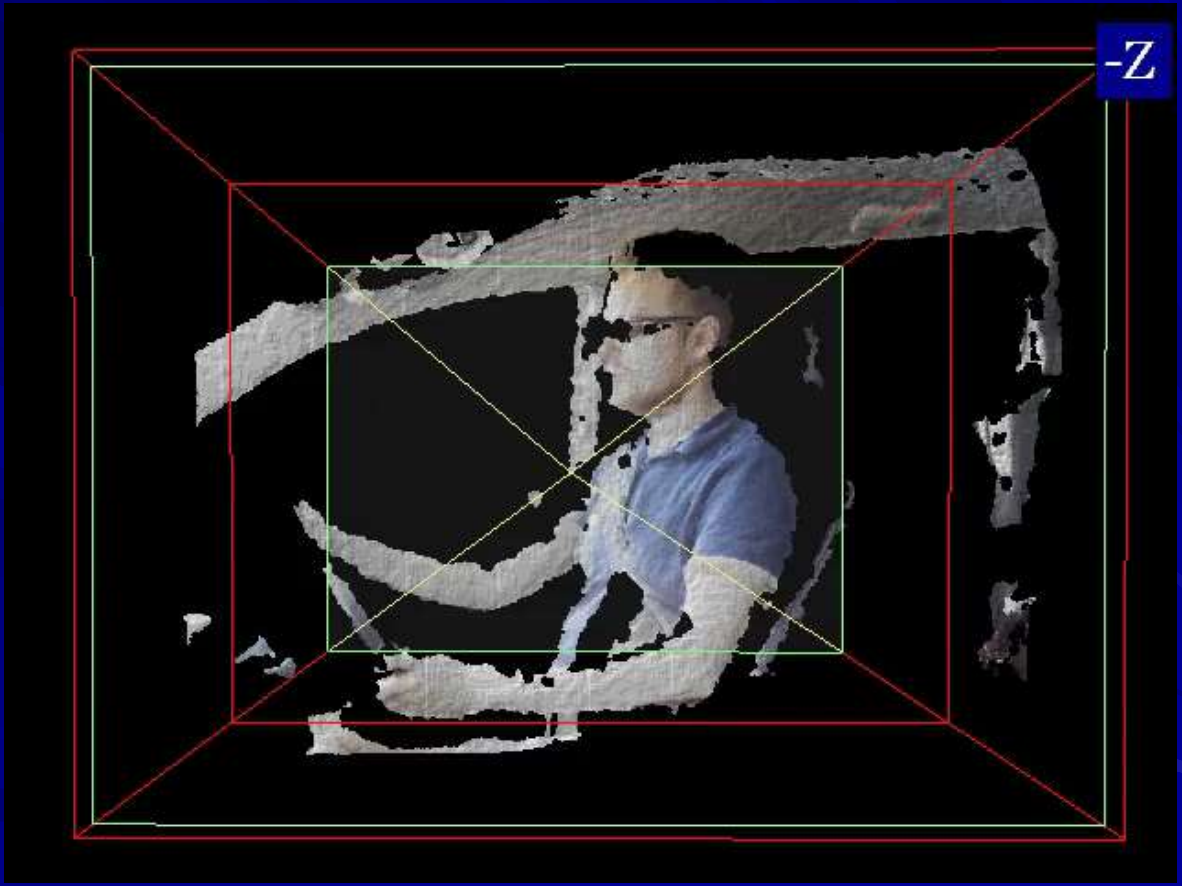
Pilot Study

- 4 participants: 2 male, 2 female
- Observations of upper body posture and activity
- Merging, exiting and lane changing maneuvers
- Total duration = 20 minutes each



Pilot Study Data Collection

- Camera was calibrated to record depth values in range or 0.5 to 3.0 m.
- Suitable for limited space within the cabin.

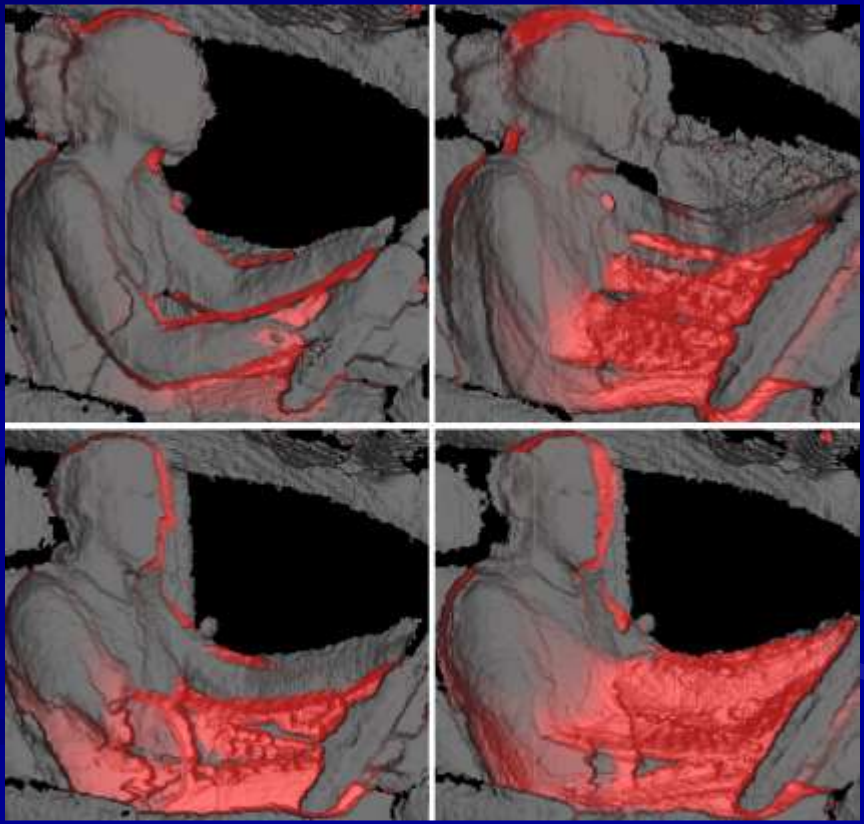


Data Analysis

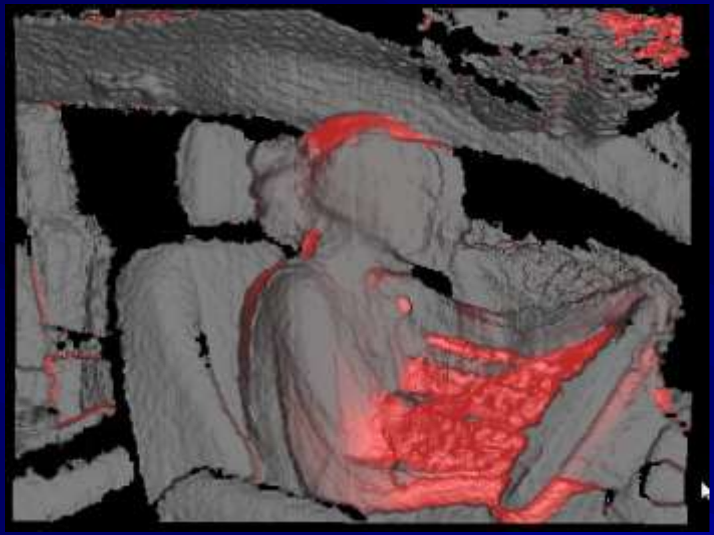
- Test quantitative measures to evaluate driver behavior and identify patterns of driver upper body posture/activity:
    1. Global statistics: mean and standard deviation of the depth value within each pixel across time
    2. Skeleton model – torso orientation
    3. Identification of direction of movement and associated magnitude

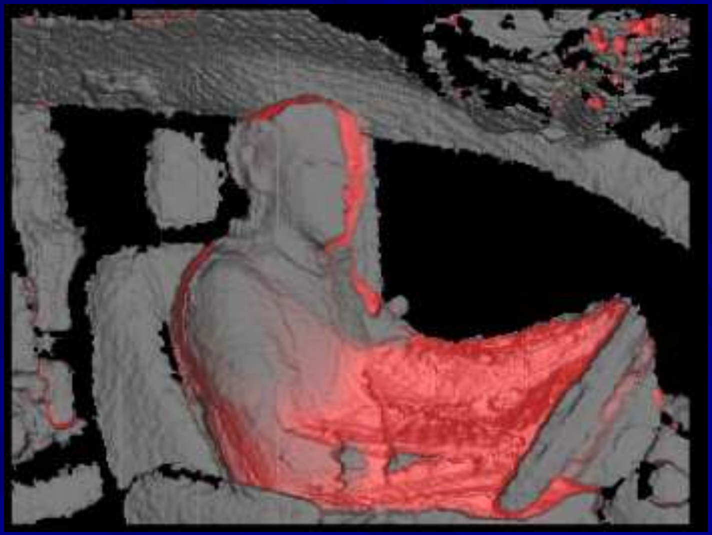
Data Analysis – Global Statistics

- Mean depth value: forms a surface which is plotted in 3D using shading
- St. deviation of depth values: color map/ intensity added to the mean surface
- Large st. deviation is associated with wide range of motion



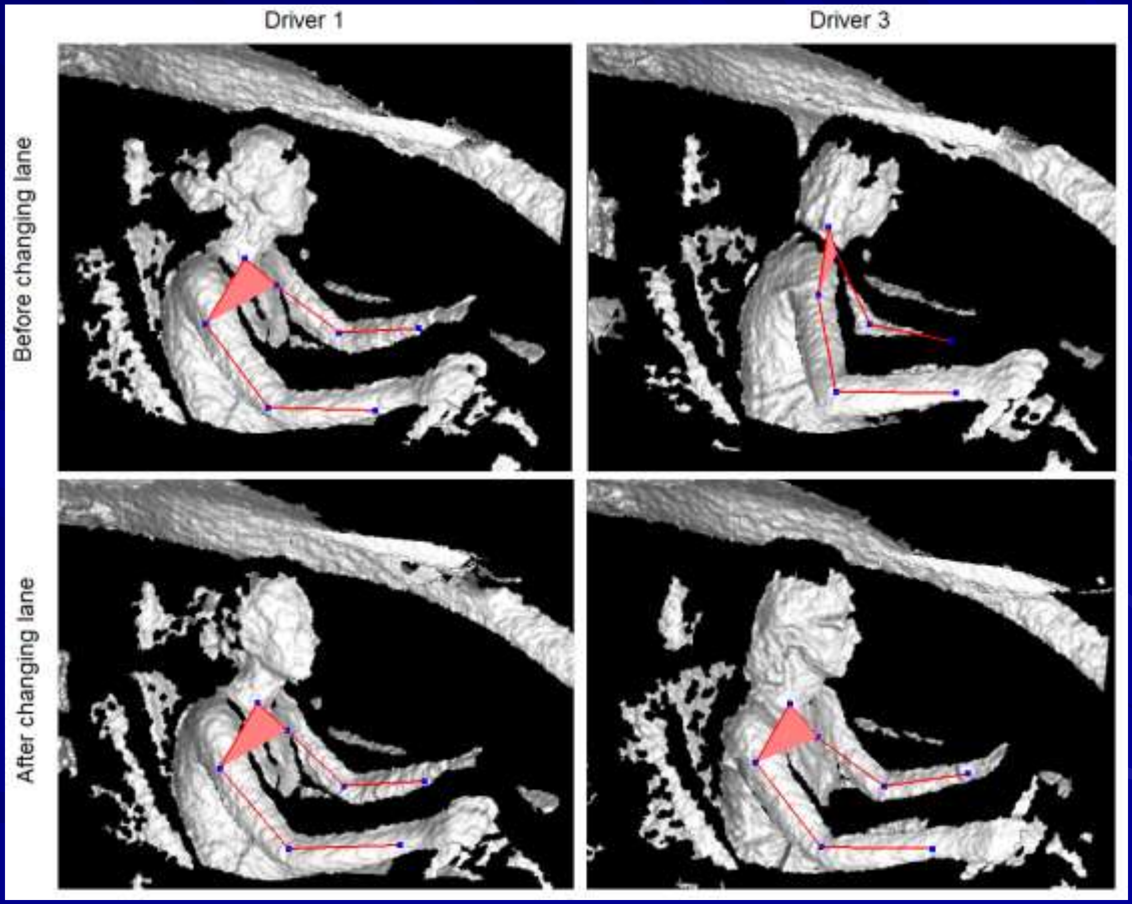
Data Analysis – Global Statistics





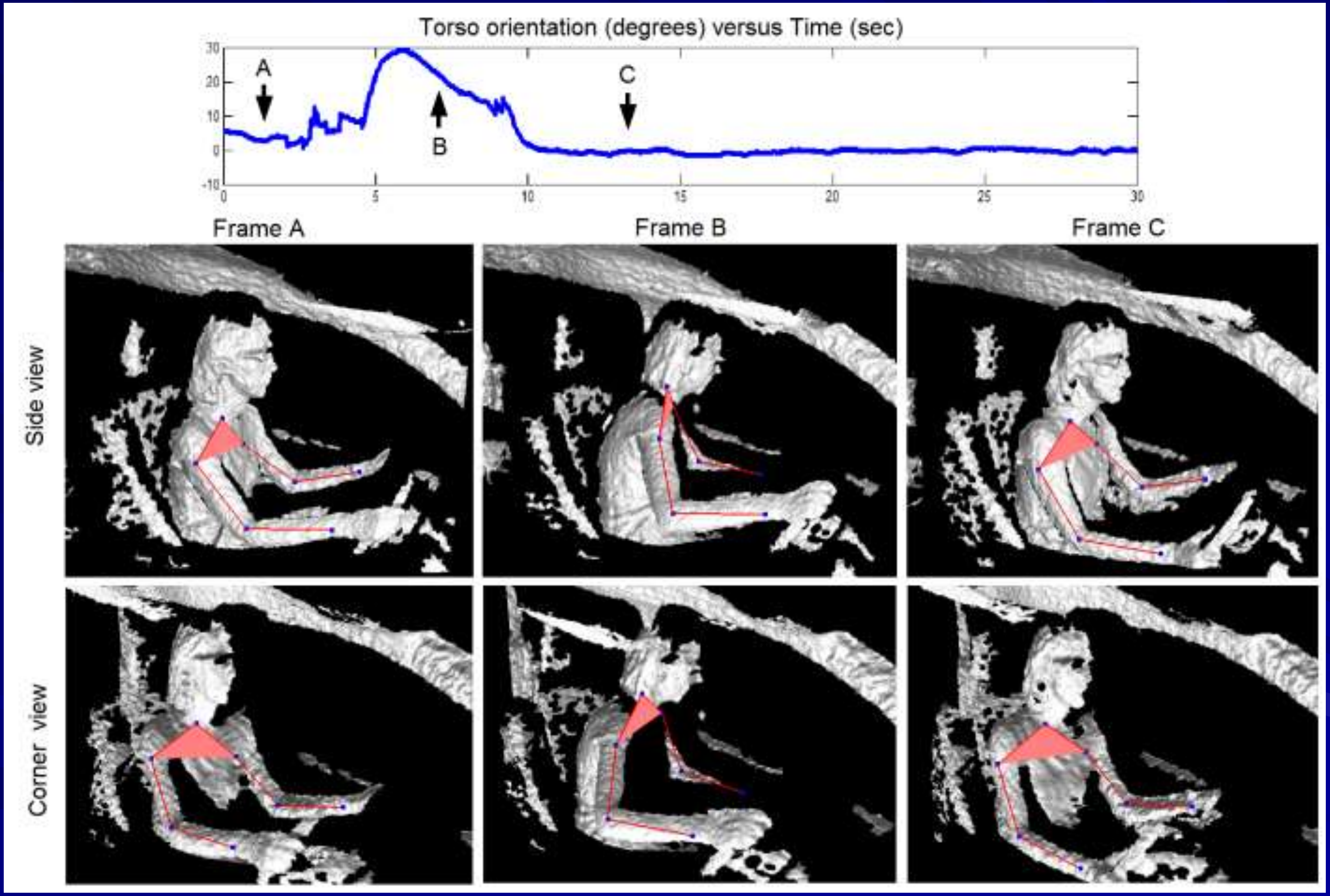
- Slight head and back activity indicate the use of side mirrors
- Different drivers keep different body postures and angles while performing the maneuvers
- Variations of mean and st. deviation by driver and by task/maneuver

Data Analysis – Skeleton/Torso Model

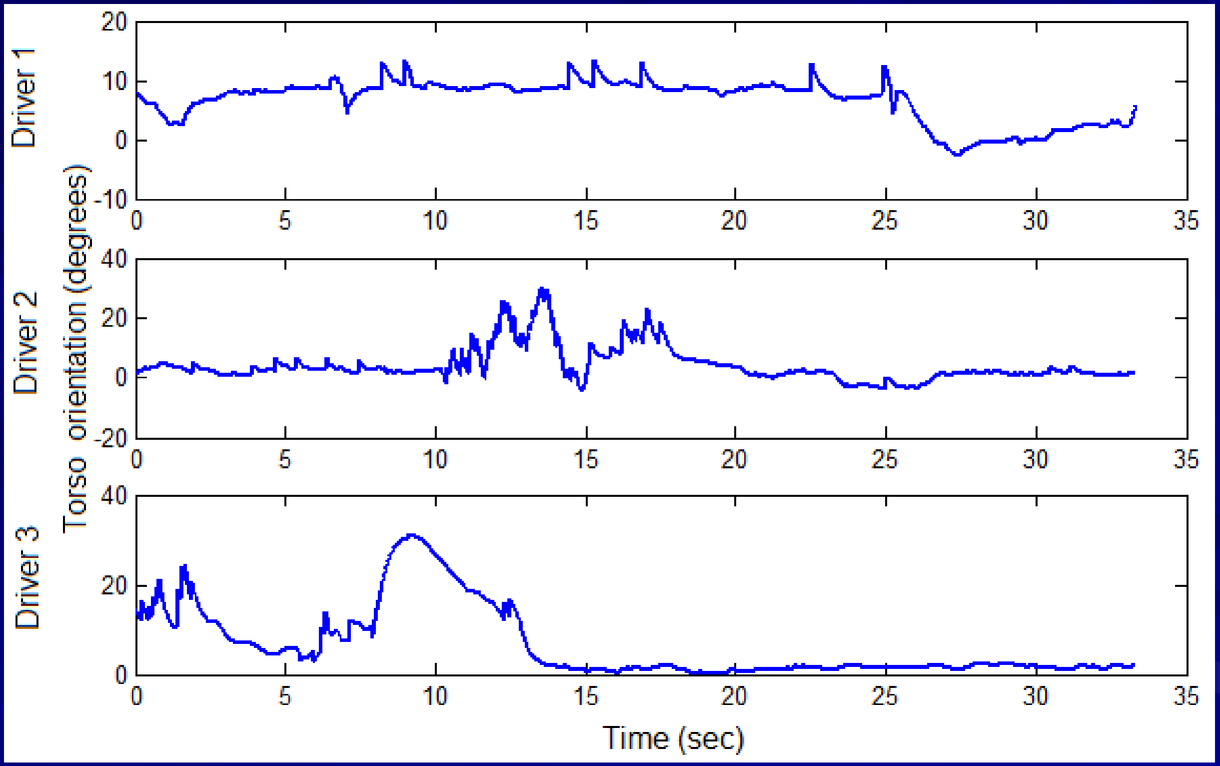


- 3D coordinates of shoulders, neck, head for real-time segmentation of upper body activity

Data Analysis – Torso Orientation



Data Analysis – Torso Orientation



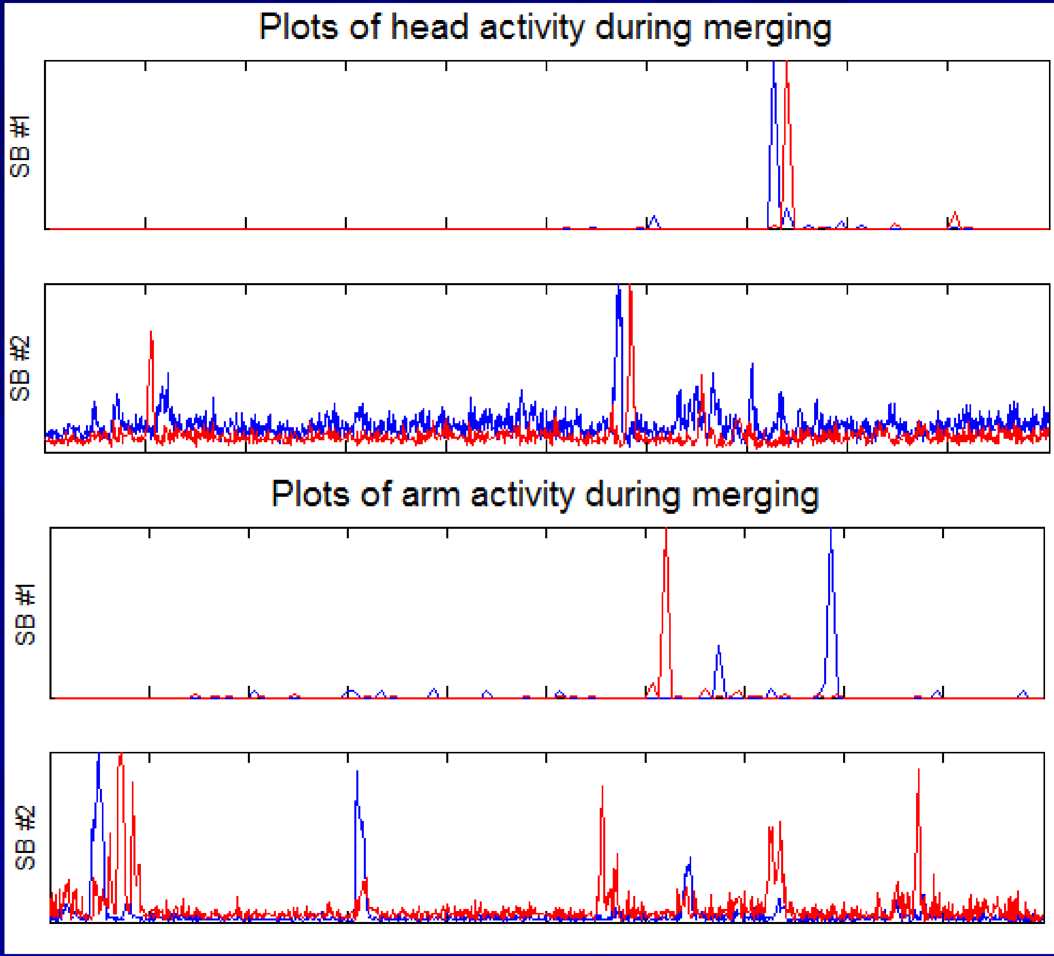
Torso orientation during a merging maneuver at the same ramp junction

Data Analysis – Direction of Movement

- Arm and head movement

Data Analysis – Direction of Movement

- Degree of coordination between head and arm activity
- Consider movements in combination rather that isolation
- Differences by drivers due to:
  - Driver behavior
  - Traffic conditions



Summary and Conclusions

- Novel approach for assessing driver activity
- Develop tools for investigating how different drivers perform various maneuvers and which movements lead to unsafe conditions
- Identify various quantitative measures of driver body posture activity

Next Steps

- Complete naturalistic type driver behavior data collection
- Apply developed methodologies for analyzing observations from different drivers under different maneuvers
- Derive potentially unsafe situations specific to driver body activity
- Provide guidelines for driver training purposes
- Establish framework for an in-vehicle driver-assistance system

THANK YOU!

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