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UT DALLAS

ASSESSMENT OF DRIVER'S DISTRACTION USING PERCEPTUAL EVALUATIONS, SELF ASSESSMENTS AND MULTIMODAL FEATURE ANALYSIS

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UTD

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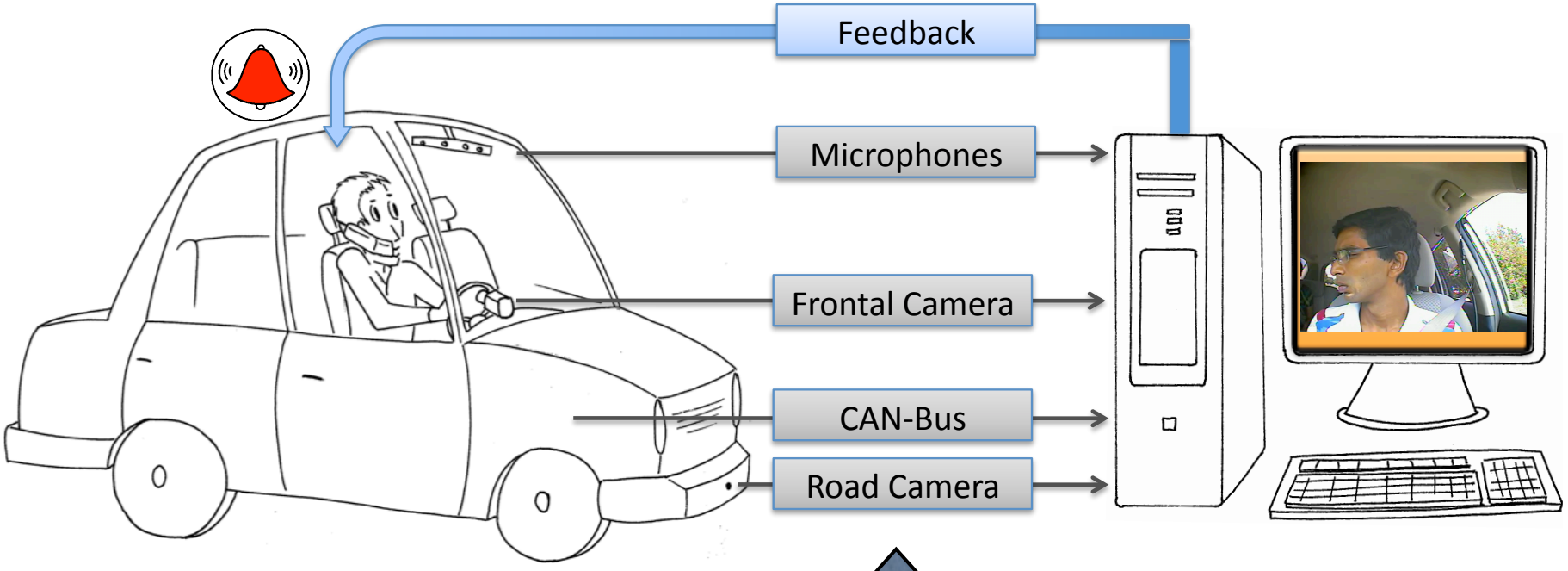
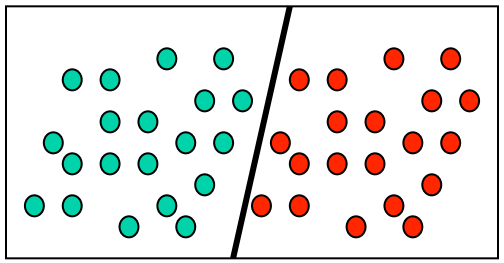
Long-Term Goal: Monitoring Driver Behavior





First step is to define metrics to characterize driver distraction

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Definitions

- Types of Distraction
  - Visual, cognitive, auditory and physical distractions
- Report by Australian Road Safety Board
  - Voluntary or Involuntary diversion from primary driving task
  - Not related to impairment due to alcohol, fatigue and drugs
  - While performing secondary task focusing on a different object, event or person
  - Reduces situational awareness, decision making abilities

Metrics for Distraction

- Secondary task performance
  - Complete artificial detection tasks (e.g., math problem)
  - Effectiveness (accuracy) and efficiency (required time)
- Surrogate schemes
  - The lane change test (LCT) [Mattes & Hallén, 2008]
  - Visual occlusion approach [Foley, 2008]
- Primary task performance metrics
  - Lateral control, longitudinal control, brake response

Metrics for Distraction

- Eye glance behavior
  - Detailed eye-control metrics (e.g., within-fixation metrics, eye closure pattern, eye-off-the-road duration)
  - Coarse visual behavior metric (e.g., head movement)
- Subjective assessments [Victor, 2008]
  - Subjective mental workload (NASA-TLX)

Not all these metrics can be directly used to define labels to train machine learning

Our Goal

- To define reference labels for distracted drivers
  - Facilitate the training of classifiers
  - Real driving conditions
- To explore and compare 3 different approaches:
  - Self evaluations (post driving questionnaires)
  - Perceptual evaluations (external raters)
  - Multimodal feature analysis (deviation from normal behaviors)

UTDrive

- Front facing camera
  - PBC-700
  - 320 x 240 at 30fps
- 4 - channel Microphone array
  - 25kHz
- CAN Bus for Steering wheel, Vehicle speed, Brake, Gas
- Road facing camera
  - 320 x 240 at 15fps

Protocol

- 2 runs of driving per subject
- First run – with 7 tasks
  - Operating a Radio
  - Operating Navigation System (GPS)
    - Operating and following
  - Cell phone
    - Operating and talking
  - Describing Pictures
  - Conversation with a Passenger
- Second run – neutral driving (without tasks)

20 drivers

Good Day light, dry weather conditions to reduce environmental factors

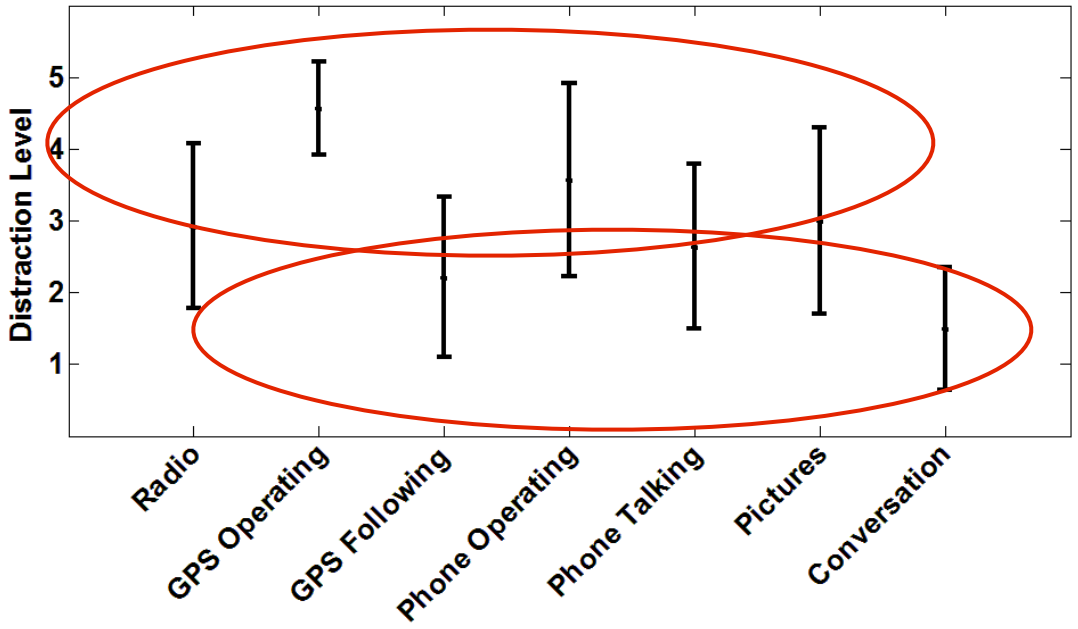
Self Assessments

Secondary tasks
- Radio
- GPS - Operating
- GPS - Following
- Phone - Operating
- Phone - Talking
- Pictures
- Conversation

- Assumption:
  - Drivers are aware of the distractions induced by common secondary tasks
- Questionnaires completed by drivers after the recording
  - They rate how distracted they felt while performing tasks
  - 1 – less distracted, 5 – more distracted

Self Assessments

- More Distracting
  - GPS - Operating
  - Phone - Operating
- Less Distracting
  - GPS - Following
  - Conversation



Visual intensive tasks are perceived more distracting

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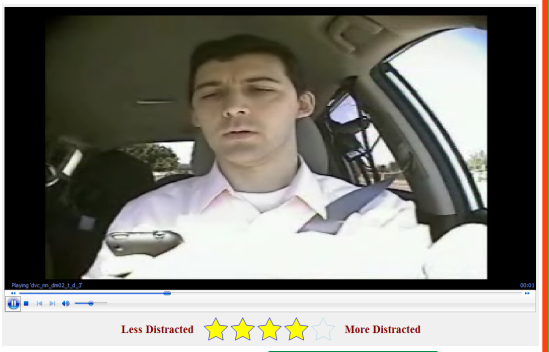
Perceptual Evaluations

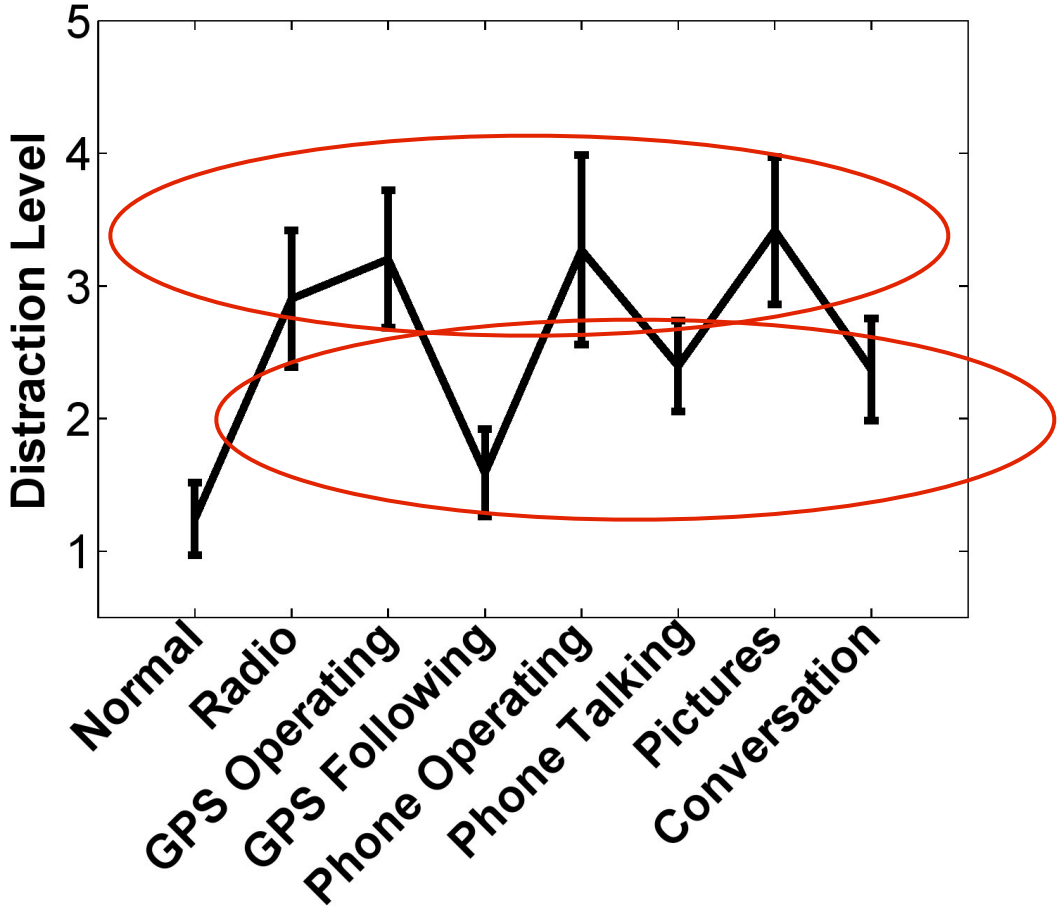
Secondary tasks
- Radio
- GPS - Operating
- GPS - Following
- Phone - Operating
- Phone - Talking
- Pictures
- Conversation

- Procedure:
  - Videos segmented into 5 sec videos
  - Subset of videos randomly chosen (480 videos)
    - 3 samples x 8 tasks x 20 drivers = 480
  - Twelve evaluators - UTD students ($\rho = 0.63$)
  - Three independent evaluations per video
- Advantages
  - Labels assigned to localized segments
  - Videos can be assessed by many raters



Perceptual Evaluations

- More Distracting
  - Radio
  - GPS - Operating
  - Phone - Operating
  - Pictures
- Less Distracting
  - GPS - Following
  - Phone - Talking
  - Conversation



Visual intensive tasks are perceived more distracting

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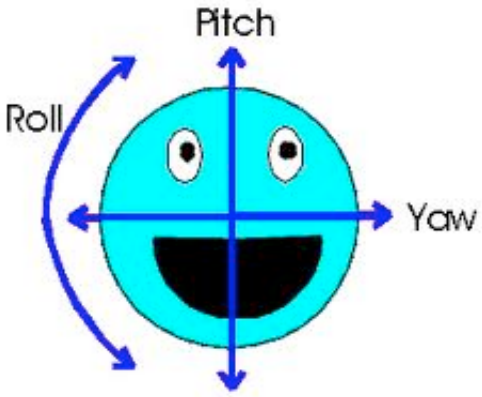
Multimodal Feature Analysis

Secondary tasks
- Radio
- GPS - Operating
- GPS - Following
- Phone - Operating
- Phone - Talking
- Pictures
- Conversation

- What features can be used to characterize distractions?
- Approach:
  - Contrasting features from task and normal conditions (for each route segment)
  - Hypothesis testing (matched pairs)

Multimodal Feature Analysis

- CAN-Bus Information
  - Steering wheel angle (Jitter), Vehicle Speed, Brake Value, Gas pedal pressures
- Frontal Facing video Information:
  - Head pose (yaw and pitch), eye closure
  - Extracted with AFECT



Courtesy: Machine Perception Laboratory, University of California, San Diego

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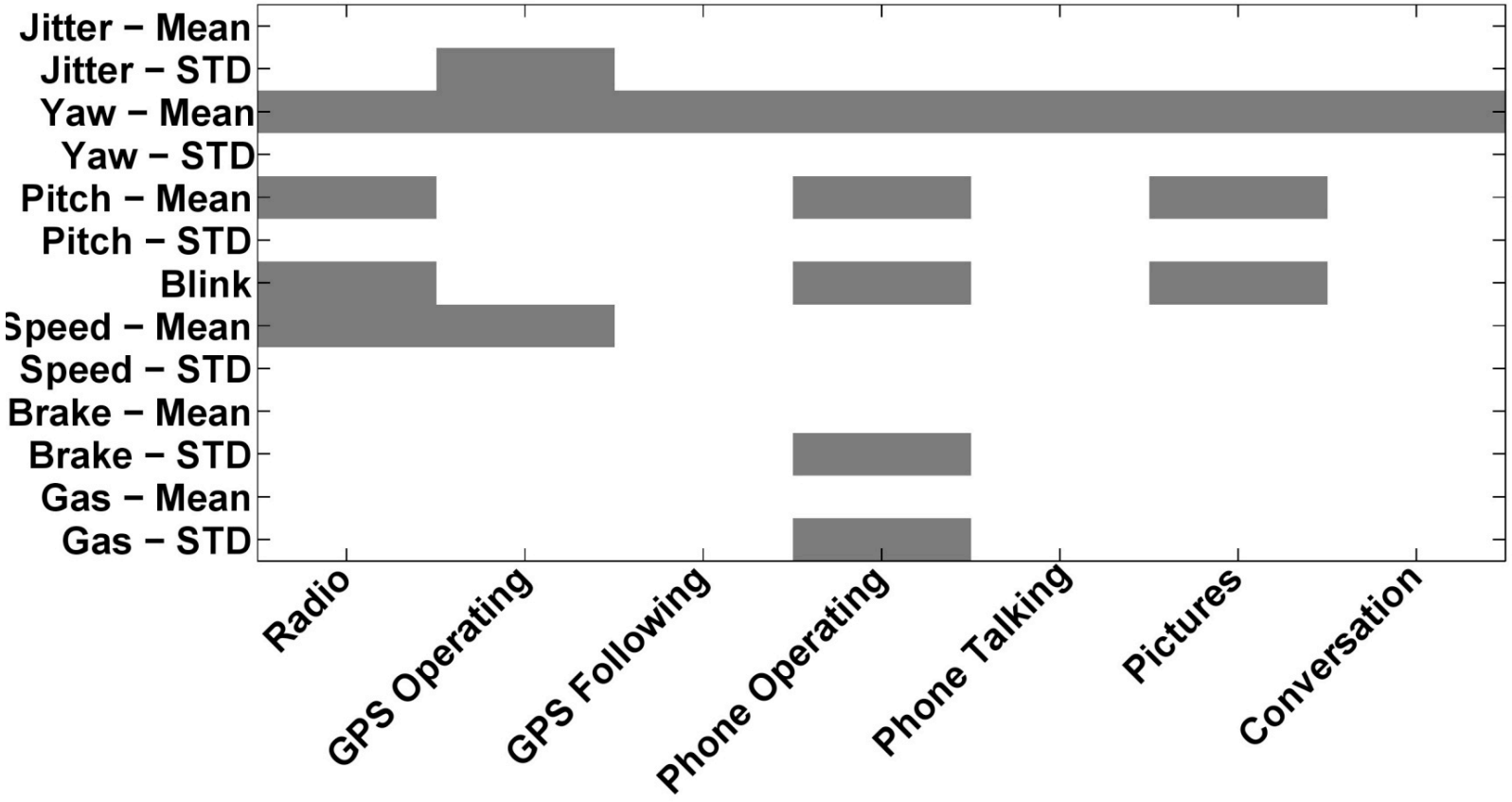
Multimodal Feature Analysis



- Matched pairs Hypothesis Testing (p = 0.05)

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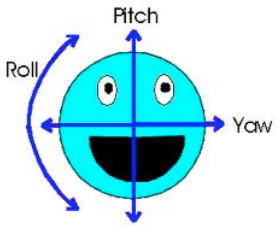
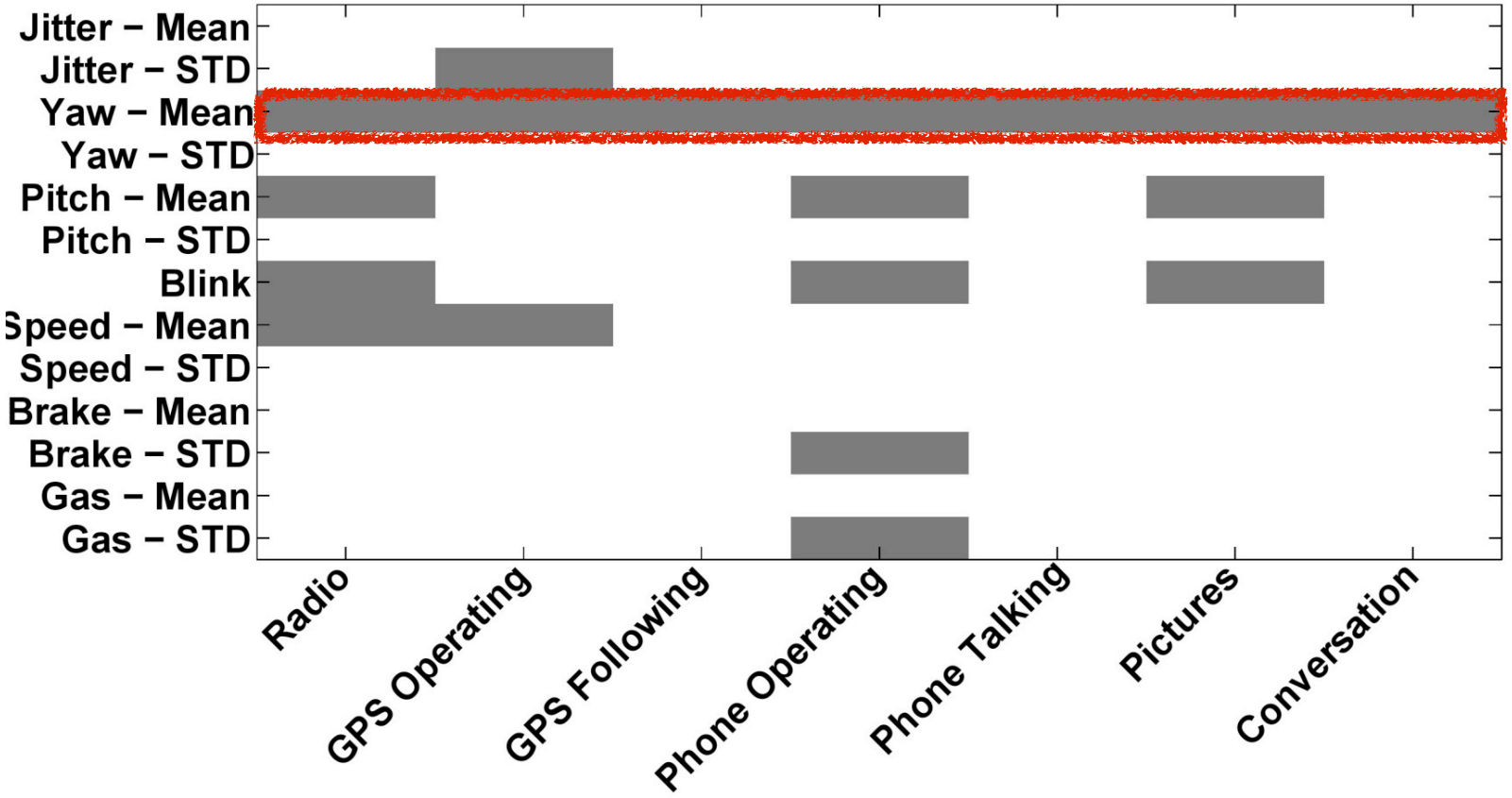
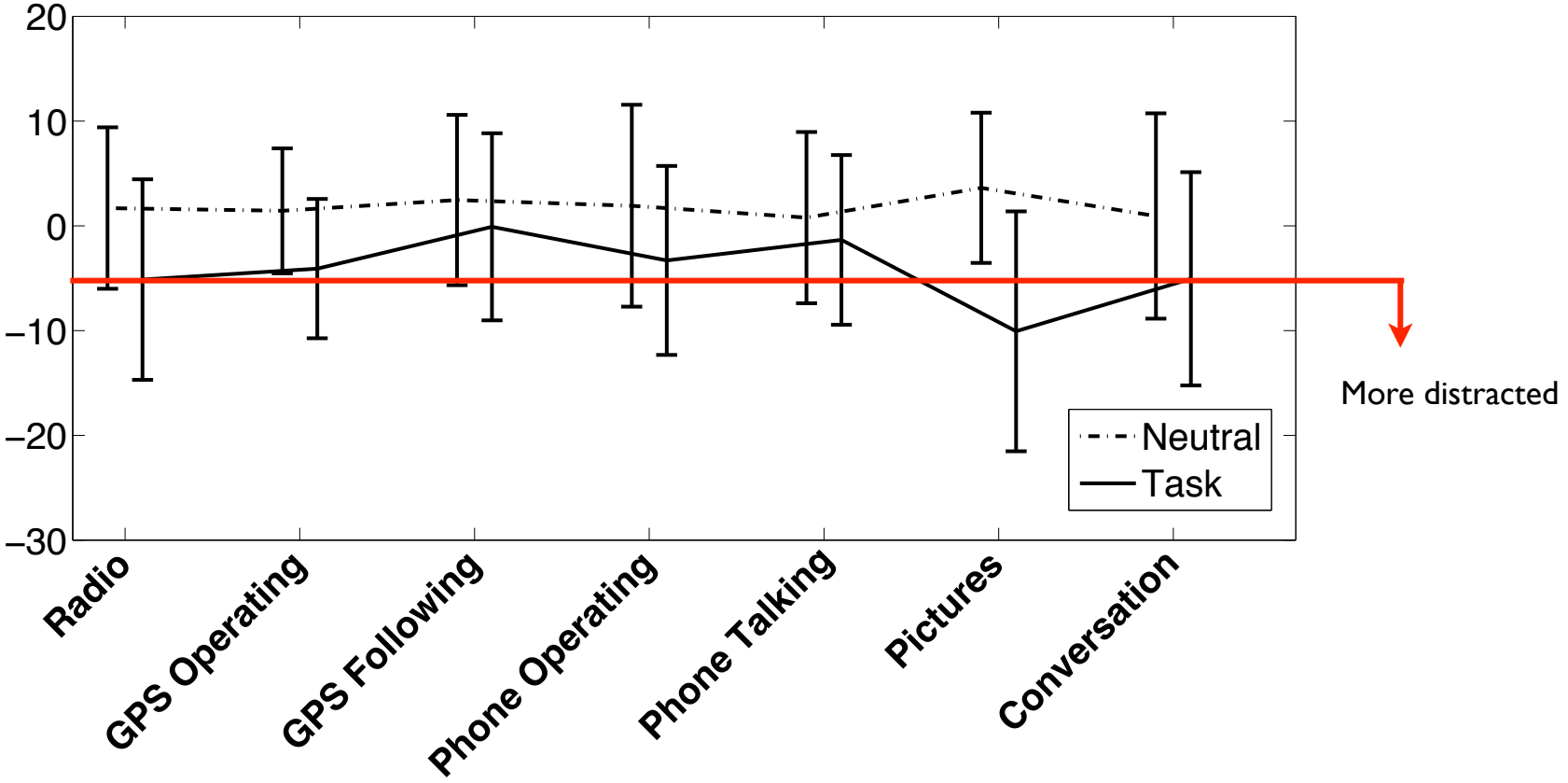
Multimodal Feature Analysis





- The mean of head - yaw is an important feature

Multimodal Feature Analysis



- Error plot for the mean of head - yaw

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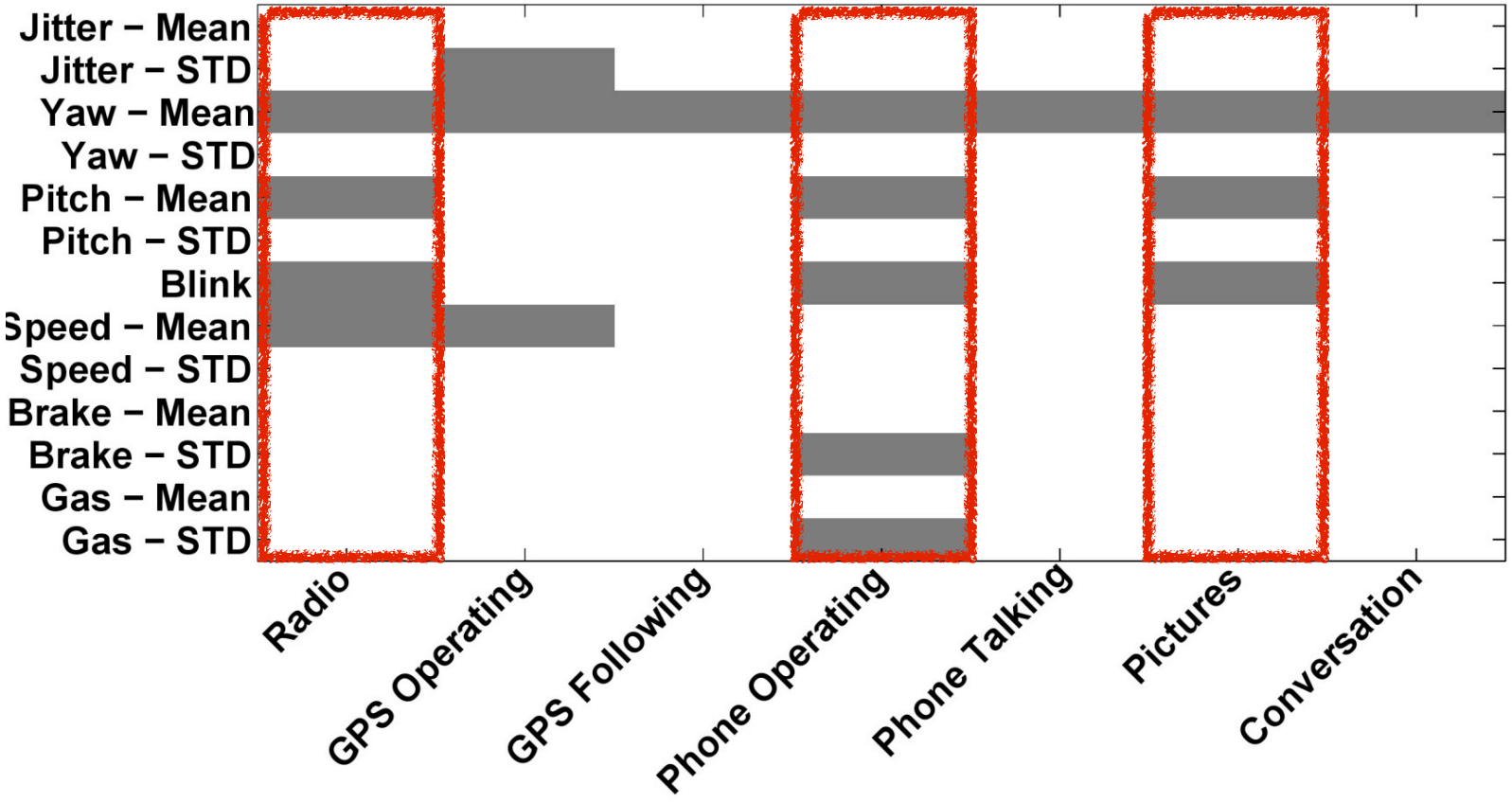
Multimodal Feature Analysis



- Some tasks produce higher deviation in the features from normal conditions

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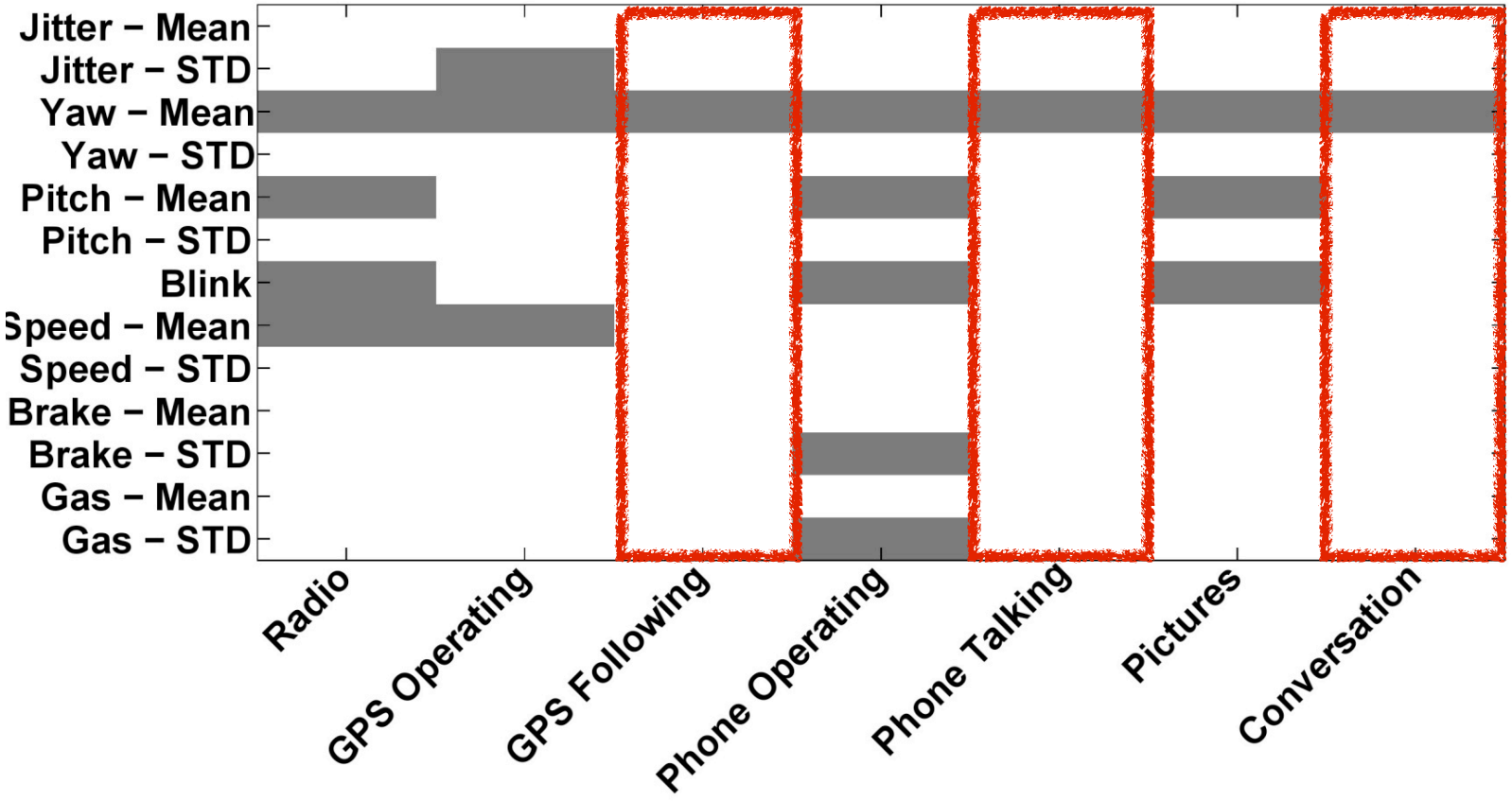
Multimodal Feature Analysis



- Other tasks produce small or no deviation in the features from normal conditions

Conclusions

- Three methodologies to describe drivers' distraction
  - Self evaluations
  - Perceptual evaluations
  - Multimodal feature analysis
- Consistent results are observed across approaches
  - Visual distractions are better described than cognitive distraction (e.g., Phone - Talking [Strayer et al., 2004])
- Current work: we are conducting subjective evaluations with mental workload scales

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Discussion & Questions

THANK YOU!