Analysis of Driver Behaviors During Common Tasks Using Frontal Video Camera and CAN-Bus Information

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Motivation

- Over 78% of crashes involved driver inattention [Neale et al., 2005].
- Drivers engage in potentially distracting secondary tasks 30% the car is moving [Ranney, 2008].
- Relevant problem since in-vehicle technologies are estimated to increase.
- Detection of distracted drivers is crucial for the prevention of accidents.

Our Goal

- Identify salient multimodal features to detect inattentive drivers.
  - Use data from real driving conditions.
  - Use various noninvasive sensors.
  - Study common secondary tasks.

Driver Distraction

- Diversion from primary driving task.
  - Not related to alcohol, fatigue and drugs.

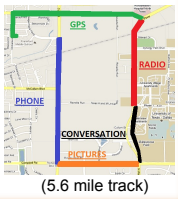
Database

UTDrive

- Frontal camera
- Microphone array
- CAN Bus
- Road camera

Data Collection

- 8 subjects.
  - First run - with 7 tasks.
  - Second run - normal driving (reference).
- Secondary tasks:
  - Radio
  - GPS - Operating
  - GPS - Following
  - Phone - Operating
  - Phone - Talking
  - Pictures
  - Conversation



(5.6 mile track)

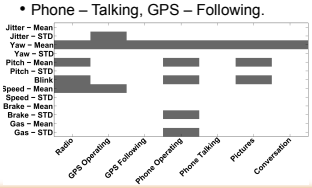
Multimodal features

- CAN-Bus Information:
  - Jitter of steering wheel angle.
  - Vehicle speed.
  - Brake and gas pedal pressures
- Frontal Facing video (AFECT [Barlett et al., 2008]):
  - Head pose (yaw and pitch).
  - Eye closure.

- Features: mean & std of 5sec windows

Hypothesis Testing

- Normal versus tasks conditions.
- Matched-pairs *t*-test (p-value = 0.05).
  - Head pose, blink and speed are salient.
  - Some tasks do not affect these features.
    - Phone – Talking, GPS – Following.

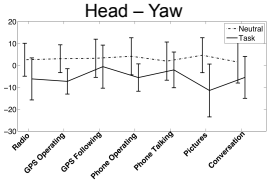


Analysis of Features

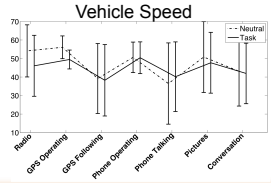
Error plots

- Driver patterns change during secondary tasks.
  - Drivers shift attention from the road.
  - Drivers reduce the car speed when engaged in secondary tasks.
- Characteristic of the route is an important variable.

Head – Yaw



Vehicle Speed

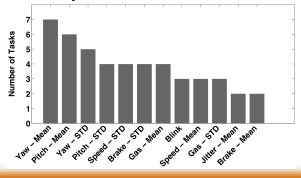


Discriminant analysis

- Task versus normal binary classification.
  - Forward feature selection.
  - K- Nearest Neighbor algorithm.
  - "Leave-one-out" cross validation.

	Video	CAN-Bus	Fusion
Radio	0.886	0.896	0.910
GPS - Operating	0.929	0.898	0.916
GPS - Following	0.628	0.629	0.635
Phone - Operating	0.740	0.740	0.813
Phone - Talking	0.636	0.570	0.591
Pictures	0.918	0.906	0.918
Conversation	0.632	0.719	0.742
Mean across tasks	**0.767**	**0.765**	**0.789**

- Frequency that the features were selected.
  - 7 binary classifiers.



Discussion

- Multimodal features can discriminate between task and normal conditions.
  - Frontal camera, 76.7%; CAN-Bus, 76.5%; and Fusion (78.9%).
  - Highest accuracies: Radio, GPS Operating, Phone Operating and Pictures.
  - Lowest accuracies: GPS - Following, Phone - Talking and Conversation.
  - CAN-Bus data is particularly useful for Phone - Operating and Conversation.

Future Directions

- Regression models to predict driver distraction.
- We are collecting more data.
  - We now have 20 subjects.
- We are studying other modalities.
  - Microphones, other CAN-bus signals.
- Looking at the driver emotional state.
- Study cognitive distractions.