**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

**Analysis of Features**

**Discriminant analysis**

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

<table>
<thead>
<tr>
<th>Feature</th>
<th>Video</th>
<th>CAN-Bus</th>
<th>Fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio</td>
<td>0.886</td>
<td>0.896</td>
<td>0.910</td>
</tr>
<tr>
<td>GPS - Operating</td>
<td>0.929</td>
<td>0.898</td>
<td>0.916</td>
</tr>
<tr>
<td>GPS - Following</td>
<td>0.628</td>
<td>0.629</td>
<td>0.635</td>
</tr>
<tr>
<td>Phone - Operating</td>
<td>0.740</td>
<td>0.740</td>
<td>0.813</td>
</tr>
<tr>
<td>Phone - Talking</td>
<td>0.636</td>
<td>0.570</td>
<td>0.591</td>
</tr>
<tr>
<td>Pictures</td>
<td>0.918</td>
<td>0.906</td>
<td>0.918</td>
</tr>
<tr>
<td>Conversation</td>
<td>0.632</td>
<td>0.719</td>
<td>0.742</td>
</tr>
<tr>
<td>Mean across tasks</td>
<td>0.767</td>
<td>0.765</td>
<td>0.789</td>
</tr>
</tbody>
</table>

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

**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.

**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.