Real-Time Driver Drowsiness Detection Using Facial Action Units

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PROBLEM STATEMENT

To develop a vision based method of detecting driver drowsiness using Facial Action Units with the following features -

→ Robust to illumination conditions and occlusions
→ Not intrusive
→ High inference accuracy
→ Real-time
→ Low training data requirement
FACIAL ACTION UNITS

What are Facial Action Units?

→ Movements of a particular muscle or a group of muscles in the face

Why use Facial Action Units to Detect Drowsiness?

→ High correlation with EEG signals - a reliable indicator of drowsiness

Fig. 1: Facial Action Units [1]

MOTIVATION

Challenges

- End-to-end models like CNNs do not necessarily perform well on unseen subjects
- Subject-specific training not practical

Two Stage Representation Learning based Pipeline

- **Subject Independent** - Generic feature extraction from subject, common across all subjects
- **Subject Specific** - Classify drowsiness based on computed features for each subject
METHODOLOGY

Fig. 2: Overview of the pipeline

PRE-PROCESSING

Landmark Detector

SUBJECT-INDEPENDENT

Face Detector

AU CNN

XGB Drowsiness Classifier

SUBJECT-SPECIFIC

Drowsiness Predictions

Landmark Coordinates

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DATASETS

**DISFA**
- **Denver Intensity of Spontaneous Facial Action Database [2]**
- Non-Posed Videos of 27 subjects exhibiting various FAUs
- 12 FAU Annotations for each frame
- Used for FAU detection

**NTHU-DDD**
- **NTHU Driver Drowsiness Detection Dataset [3]**
- Videos of 22 subjects performing a driving simulation
  - Drowsy/Non Drowsy Behaviour
  - Night/Day time illumination
  - Glasses/Sunglasses/No Glasses
- Used for Drowsiness detection


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RESULTS

Frame Rate

- 23.6fps

Training Data

- 9 minutes

Table 1: FAU Classifier Test Metrics

<table>
<thead>
<tr>
<th>Mean Accuracy (%)</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
<td>81.40</td>
<td>12.22</td>
</tr>
</tbody>
</table>

Table 2: Drowsiness Classifier Test Metrics

<table>
<thead>
<tr>
<th>Mean Accuracy (%)</th>
<th>Standard Deviation</th>
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<tbody>
<tr>
<td>99.43</td>
<td>0.36</td>
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Fig. 3: Timing diagram for pipeline

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CONCLUSION

- Two Stage Representation Learning Pipeline for Driver Drowsiness Detection based on Facial Action Units and Facial Landmarks
- Demonstrated high prediction accuracy from subject specific calibration
- Minimised data requirements for subject specific training
- Robust to varying illumination conditions
- Robust to occlusions of the eye
Thank You