Real-Time Drowsiness Detection with Deep Learning YOLO Model

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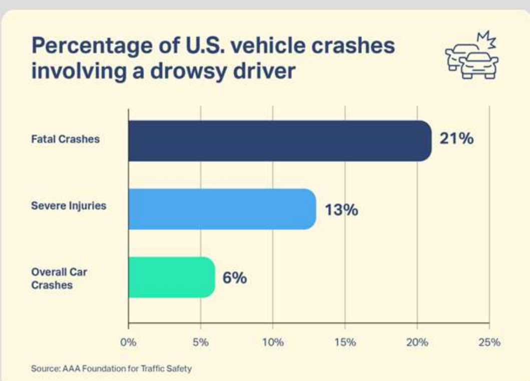
GOAL

Develop a robust deep learning model for real-time drowsiness detection from video streams to enhance road safety and prevent accidents.

MOTIVATION

- **Safety Enhancement:** Drowsy driving accounts for approximately 328,000 crashes annually, contributing to around 109,000 injuries and 6,400 fatalities every year, underscoring the need for improved detection systems. 96% of drivers recognize drowsy driving as dangerous but less than 30% believe that they will be pulled over.
- **Limitations of Traditional Methods:** Although traditional computer vision and sensor methods can be used, they can be intrusive and not effective.
- **Non-Intrusive Technology:** Deep learning offers a non-intrusive alternative, with technologies capable of detecting driver fatigue equated to a blood alcohol content of 0.08% after more than 20 hours of wakefulness.
- **Real-Time Detection:** Drivers are three times more likely to crash when fatigue, emphasizing the need for systems that can provide real-time alerts and prevent accidents.



METHODS

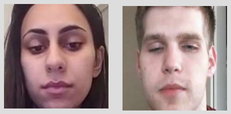
Data Preparation

Obtain dataset with drowsy and non-drowsy images (different lighting demographics, and angles)

Shuffle dataset to remove bias in training

Split data into 80% training and 20% testing

Data annotation/labeling in YOLO v8 format with classes 0 (drowsy) and 1 (nondrowsy)



Model training and evaluation with YOLO

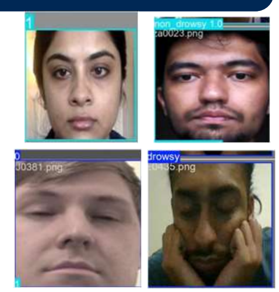
Interpret model performance

Test model

Visualize model's prediction

RESULTS

- **Precision** = 0.993 = 99.3% of the detections made by the model were correct
- **Recall** = 0.987 = 98.7% of all instances of "drowsy" and "non_drowsy" present in the test images were detected by the model.
- **mAP50** = 0.987 = model's accuracy in prediction for both classes



FUTURE WORK

- **Expand Model Capabilities:**
  - Use LSTM or GRU models to analyze temporal patterns like blink duration and frequency.
  - Integrate temporal data for detecting micro-sleeps and prolonged eye closures.
- **Multimodal Approach:**
  - Combine spatial detection (YOLO for eyes and face) with temporal analysis (LSTM for blink sequences).
  - Enable robust classification of drowsiness using both spatial and time-series data.

FACIAL LANDMARKS

Eyes
- Blink rate, eye closure duration, and pupil dilation.
- Detection of "micro-sleeps" or prolonged eye closures.

Mouth
- Yawning frequency and mouth openness.

Eyebrows
- Movement patterns, indicating alertness or fatigue.

Head Position
- Nodding or tilting, which may signal drowsiness..

Facial Expression
- Yawning frequency and mouth openness.

Other Factors to consider

Prolonged Eye Closure Duration (PERCLOS)
Measures the percentage of time the eyes are at least 80% closed over a given interval.
Higher PERCLOS values strongly correlate with drowsiness.

Reduced Blink Rate
A slower blinking rate can indicate fatigue as alertness decreases.

Irregular Blink Timing
Drowsy individuals may exhibit inconsistent intervals between blinks compared to regular, rhythmic blinking.

Incomplete Blinks
Blinks where the eyelids fail to fully close, often due to reduced muscle control during fatigue.

Micro-sleeps
Brief, involuntary eye closures (lasting 2–10 seconds) indicating extreme drowsiness.

Delayed Blink Reopening
Eyes take longer than usual to fully reopen after blinking

Frequent Blinking Bursts
An increased number of blinks in a short time as the body attempts to regain alertness.

Asymmetric Blinking
Uneven or uncoordinated movement of the eyelids, sometimes occurring during fatigue

Slow Eyelid Movement (SELM)
Sluggish motion of the eyelids during the blink process, often coupled with prolonged closure.

References

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