DrowsiSense: A Real-Time Driver Drowsiness Detection System

(20XD68 - Deep Learning Lab)

Submitted by:
22PD10 - Chinnahyata Poorvika
22DP31 - Sarnika Sanjiv Kumar

Project Overview:

DrowsiSense is a real-time driver drowsiness detection system that combines classical computer vision with deep learning to monitor and alert drivers about signs of fatigue. Its main goal is to reduce accidents caused by prolonged driving and lapses in alertness by continuously assessing facial cues from a live video feed.

Core Components:

- **Video Capture & Preprocessing:**
  The system captures live video using a webcam (or uploaded video) and preprocesses the input by converting frames to grayscale for improved facial detection performance. This setup is integrated within a Streamlit-based web interface for user interaction and visualization.

- **Facial Landmark Detection:**
  Utilizing dlib model (`shape_predictor_68_face_landmarks.dat`), DrowsiSense accurately detects 68 key facial landmarks. This process isolates critical regions (eyes and mouth) used for calculating drowsiness indicators.

- **Metric Computation:**
  - **Eye Aspect Ratio (EAR):**
    EAR is computed from the relative distances between six eye landmarks. A drop in this ratio signals prolonged eye closure—a primary indicator of drowsiness.

  - **Mouth Aspect Ratio (MAR):**
    MAR is derived using distances between mouth landmarks to detect yawning. Consistently high MAR values across frames act as an additional warning sign.

- **Convolutional Neural Network (CNN) Verification:**
  In addition to heuristic thresholds, a CNN model, trained on a diverse driver dataset, validates the detected state. The model—built with TensorFlow/Keras—classifies facial expressions into multiple categories (e.g., alert, drowsy, yawning), further reducing false alarms.

- **Alarm & Alerts System:**
  When thresholds for EAR/MAR or CNN predictions indicate drowsiness, the application triggers:

    - **Visual Warnings:** Overlaid text annotations (e.g., “DROWSY”, “YAWN DETECTED”) and graphical markers are displayed on the video.

    - **Audio Alerts:** A continuous alarm sound (using pygame) is played after a set cooldown period to immediately warn the driver.

- **Real-Time Data Visualization:**
  Performance metrics—including plots of EAR, MAR, and detection events—are generated using matplotlib and updated in real-time, offering insights into the system’s operation and aiding in debugging.

User Interface & Configuration:
Users interact with DrowsiSense through a responsive Streamlit dashboard that allows them to:

- Select between live webcam input or video file upload.
- Dynamically adjust thresholds (e.g., for EAR, MAR, and CNN probability) via sidebar controls.
- View real-time status updates and historical detection plots.

Implementation & Results:
Developed in Python and leveraging libraries such as OpenCV, dlib, and TensorFlow/Keras, DrowsiSense demonstrates how a hybrid approach—merging traditional image processing with deep learning—can enhance robustness and reduce false positives. Experimental evaluations reveal its potential effectiveness, although performance may vary under different lighting conditions or hardware specifications.

Conclusion:
DrowsiSense represents a practical and adaptable system for monitoring driver drowsiness. Its integration of real-time video processing, advanced facial feature analysis, and deep learning-based verification positions it as a promising solution to improve road safety by delivering timely alerts to distracted or fatigued drivers.