Digital Signal processing

End Semester Project

Drowsiness Detection: A Digital Signal Processing Approach

CHITTESH.S [CB.EN.U4ECE23212]
G.ROHITH [CB.EN.U4ECE23217]
HAYNISH.K [CB.EN.U4ECE23221]

Abstract

This project develops a real-time drowsiness detection system using Eye Aspect Ratio (EAR) analysis to monitor driver fatigue. Utilizing computer vision, the system detects facial landmarks, computes EAR, and triggers an audible alert when eye closure suggests drowsiness. Fast Fourier Transform (FFT) analysis of EAR values provides frequency-based insights into fatigue patterns. The setup includes dynamic plots for real-time EAR and FFT visualization, offering a non-intrusive approach suitable for driver assistance and safety applications.

Overview

Introduction

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This project focuses on developing a real-time drowsiness detection system to enhance driver safety by monitoring eye behavior. Using Eye Aspect Ratio (EAR) analysis from live video, the system identifies signs of fatigue and issues an alert if drowsiness is detected. Additionally, Fast Fourier Transform (FFT) is utilized to analyze frequency patterns in EAR data, providing deeper insights into fatigue dynamics.

Importing Essential Libraries

- Computer Vision

The project uses OpenCV (cv2) to capture and process video from the camera.

- Facial Analysis

dlib is used to detect faces and locate key facial features like the eyes.

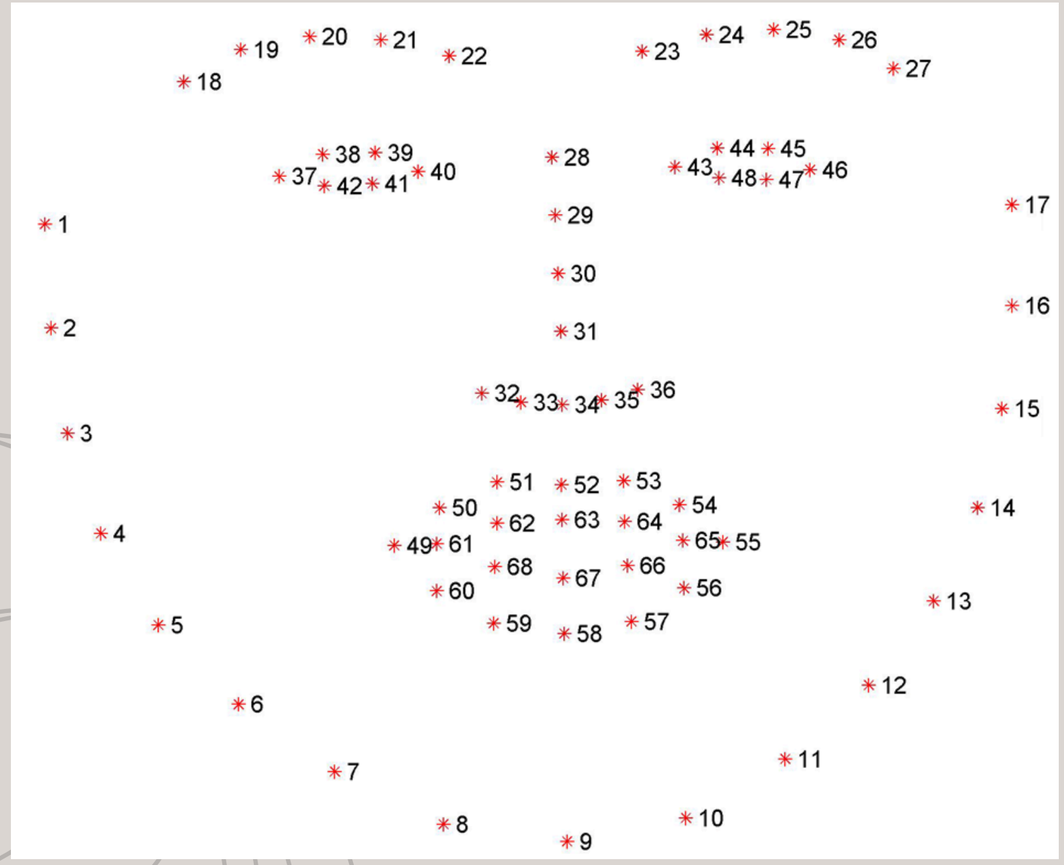
- Mathematical Tools

scipy and numpy provide the necessary mathematical functions for analyzing eye movement patterns.

- Audio Alerts

The winsound library is used to play a beep sound when drowsiness is detected.

Dlib’s Facial Landmark Detector



•The pre-trained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face.

•Facial landmarks are used for localizing and representing salient regions or facial parts of the person’s face, such as:

•Nose
•Jaws
•Left eye
•Right eye
•Left eyebrow
•Mouth
•Right eyebrow

Calculating Eye Aspect Ratio (EAR)

- Eye Landmarks

  The program uses dlib to detect 6 key points around the eye, which are used to calculate the Eye Aspect Ratio (EAR).

- EAR Calculation

  The EAR is a ratio that represents how open or closed the eye is. A higher EAR indicates the eye is more open, while a lower EAR means the eye is more closed.

- Drowsiness Detection

  By monitoring changes in the EAR over time, the program can detect signs of drowsiness, such as prolonged eye closure or slow blinking.

How it works ?

INITIALIASING THE VARIABLES

• eardata : This keeps a record of how much your eyes are open (calculated by the EAR)

.• framecount : This counts how many frames (individual pictures taken from the camera feed) have been analyzed

.•samplingrate: The program doesn't check every frame but takes a snapshot every 10th frame

•fftWindowSize: This limits the number of snapshots (120 frames in this case) used for detecting patterns in your eye movements.

Capturing and Processing Video

Video Capture
The program uses the computer's camera to capture a live video feed.

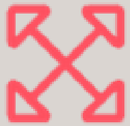


Image Resizing

The video frames are resized to a smaller size for faster processing.

Grayscale Conversion

The video frames are converted to grayscale to simplify face and eye detection.

Face and Eye Detection

The program uses dlib to detect faces and locate the user's eyes in the video feed.

Visualizing Eye Movements

Eye Tracking
The program draws outlines around the user's eyes to visually indicate that it is tracking their movements.

EAR Visualization
The current EAR value is displayed on the screen, providing a real-time indication of the user's eye openness.

Drowsiness Alert
If the program detects signs of drowsiness, it displays a warning message on the screen.

Collecting and Analyzing Eye Movement Data

EAR Data Collection

The program records the EAR values every 10 frames, storing the most recent 120 values in a list called earData.

FFT Analysis

Once there are 120 EAR values, the program uses the Fast Fourier Transform (FFT) to analyze the patterns in the eye movements, focusing on low-frequency patterns that indicate drowsiness.

Drowsiness Detection

If the low-frequency patterns in the EAR data are strong enough, the program determines that the user is becoming drowsy and triggers an alert.

CONCEPTS OF DIGITAL SIGNAL PROCESSING

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EAR Data Collection

*Sampling refers to capturing data at specific intervals, transforming a continuous signal (like eye openness) into discrete values.

*The project doesn’t analyze every single video frame but instead takes a snapshot every 10th frame (controlled by the sampling Rate variable). This is a form of down sampling, where only some data points are kept for processing to reduce computational load and make real-time analysis feasible.

WINDOWING

The program maintains a buffer (window) of the last 120 EAR values. As each new sample is added, the oldest one is removed. This windowed data is used for pattern analysis with FFT. The concept ensures that the system is continuously analyzing the most recent eye movement data.

FFT (Fast Fourier Transform) for Drowsiness Detection

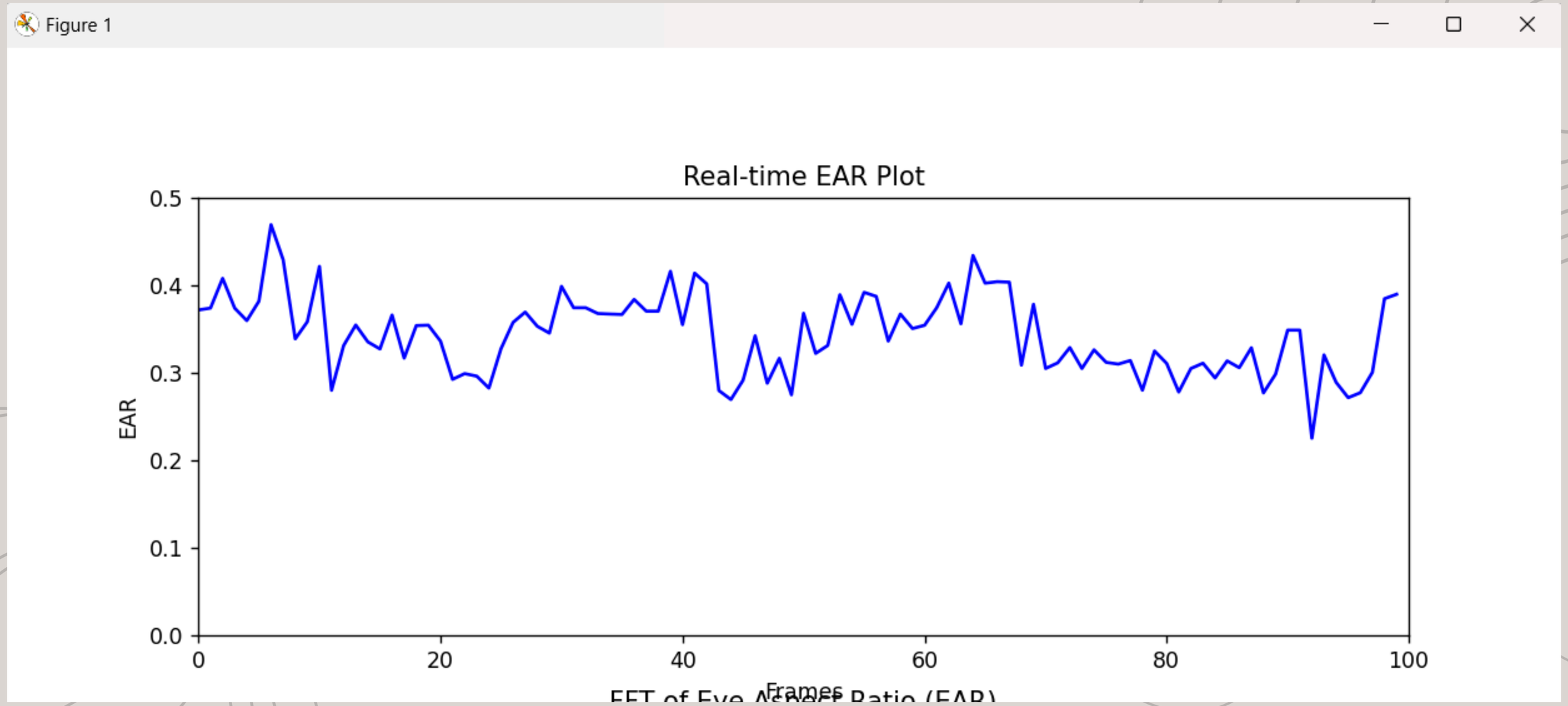
- Once there are 120 EAR values (frames) stored:
  The FFT tool is used to analyze how your eye openness has changed over time.

- ·FFT turns these 120 EAR values into frequencies (patterns of how fast or slow your eyes are opening and closing).

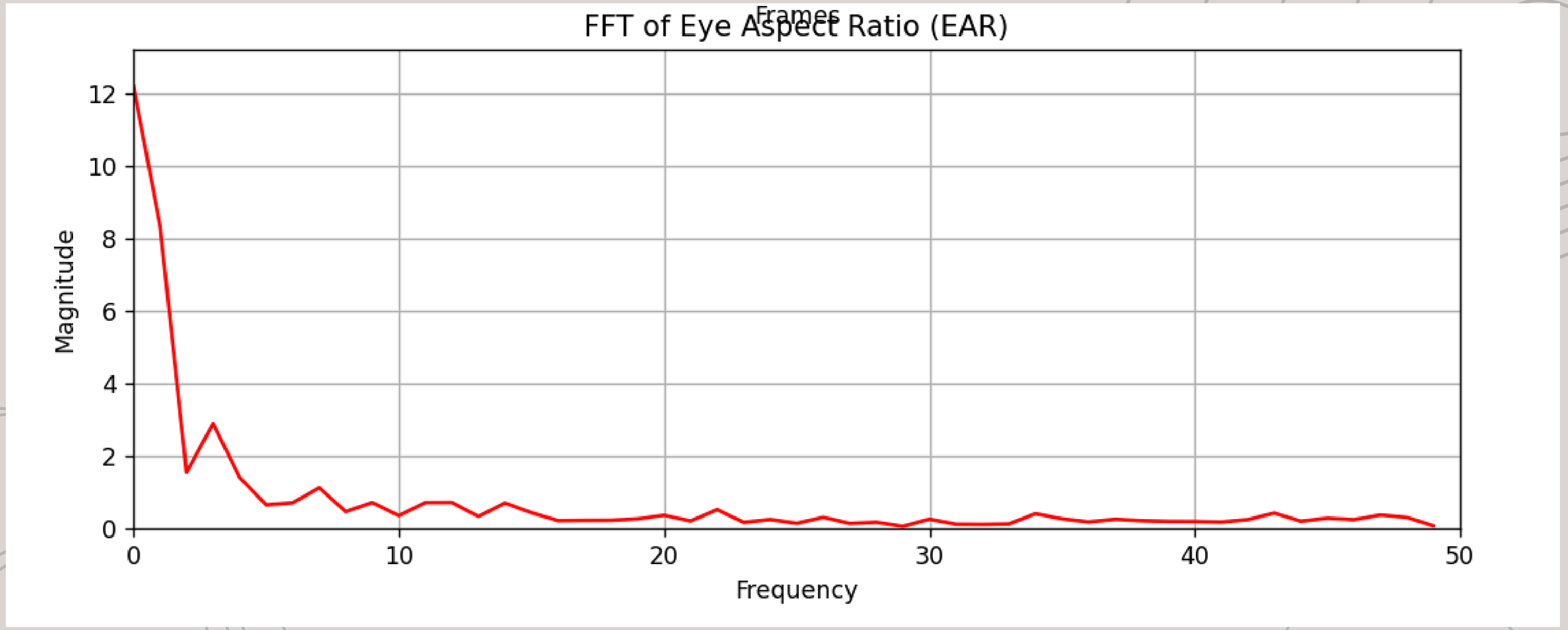
- ·The program focuses on low frequencies (slow movements), which often indicate prolonged eye closure or slow blinking, both signs of drowsiness.

Output

Real Time EAR plot



FFT Magnitude spectrum



Alerting the User

Visual Warning
When drowsiness is detected, the program displays a warning message on the screen to alert the user.

Audio Alarm
The program also plays a beeping sound to further grab the user's attention and help them stay awake.

Customizable Settings
The frequency and duration of the beep can be adjusted to suit the user's preferences and needs.

Conclusion

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The drowsiness detection system presented in this project effectively combines real-time Eye Aspect Ratio (EAR) monitoring with Fast Fourier Transform (FFT) analysis to identify and respond to signs of driver fatigue. By leveraging computer vision and signal processing, the system provides a robust and non-intrusive method to enhance road safety through timely alerts. The integration of dynamic visualizations further aids in understanding drowsiness patterns, paving the way for future advancements and practical applications in driver assistance technology.

Recommendation

Recommendation

1

Explore advanced facial landmark detection alternatives for improved accuracy.

2

Integrate additional physiological signals, like heart rate, for comprehensive monitoring.

3

Optimize the system for low-light conditions to enhance usability at night.

Thank You