Dayananda Sagar College of Engineering

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(An Autonomous Institute affiliated to VTU, Approved by AICTE & ISO 9001:2008 Certified)

Accredited by National Assessment and Accreditation Council (NAAC) with 'A' grade

Assignment

Program: B.E.	Branch: ECE
Course: Machine Learning	Semester : 7
Course Code: 19EC7DEMAL	Date:05/12/2023

A Report on

Drowsiness Detection using CNN based approach with mathematical models to check the drowsiness condition

Submitted by

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INTRODUCTION

In an era dominated by technology, the integration of artificial intelligence and computer vision has paved the way for innovative solutions to real-world challenges. One such critical issue is the alarming rise in road accidents attributed to driver drowsiness. Drowsy driving poses a significant threat to road safety, as it impairs a driver's alertness and reaction time, leading to an increased risk of accidents. To address this pressing concern, researchers and engineers have turned to cutting-edge technologies, among which Convolutional Neural Networks (CNNs) stand out as a promising tool for drowsiness detection.

This project aims to harness the power of CNN-based approaches to develop an effective system for real-time drowsiness detection in drivers. CNNs, a class of deep neural networks, have demonstrated remarkable success in image and pattern recognition tasks. Leveraging their ability to automatically learn hierarchical features from visual data, we seek to create a robust model capable of accurately identifying signs of drowsiness from facial expressions and eye movements captured by in-car cameras.

However, the effectiveness of any drowsiness detection system does not solely rely on the prowess of CNNs. Complementing the deep learning approach, this project incorporates mathematical models to refine and enhance the accuracy of drowsiness condition assessment. Mathematical models bring a quantitative dimension to the analysis, enabling a more nuanced understanding of the driver's state. By integrating these models, we aim to establish a comprehensive framework that not only detects drowsiness but also provides insights into the severity of the condition.

This research is motivated by the potential to mitigate the adverse effects of drowsy driving and enhance road safety. As we delve into the intricacies of CNN-based approaches and mathematical modeling, this project seeks to contribute to the development of advanced driver monitoring systems. Through the fusion of artificial intelligence and mathematical precision, we aspire to create a sophisticated and reliable drowsiness detection system that can be seamlessly integrated into modern vehicles, ultimately reducing the risk of accidents and saving lives on our roads.

ALGORITHM USED

1. **Data Collection:**Gather diverse facial images and labels indicating drowsy or alert states

2. **Preprocessing:** Resize, normalize, and augment images.Extract relevant facial features.

3. **CNN Model:**Design a CNN for drowsiness detection.Train the model on labeled data.

4. **Mathematical Models:**Integrate mathematical models for severity assessment.Consider metrics like eye closure duration and blink frequency.

5. **Real-time Monitoring:**Interface CNN and mathematical models with in-car cameras.Analyze facial features for signs of drowsiness.

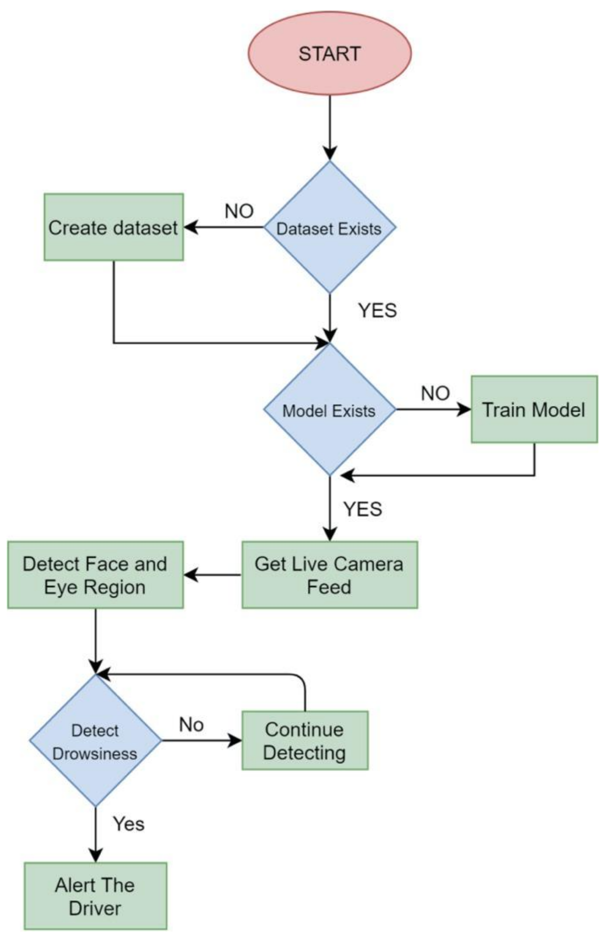
6. **Drowsiness Threshold**:Set a threshold based on CNN and mathematical model outputs.

7. **Alert Mechanism:**Trigger alerts (visual or auditory) when the threshold is exceeded.

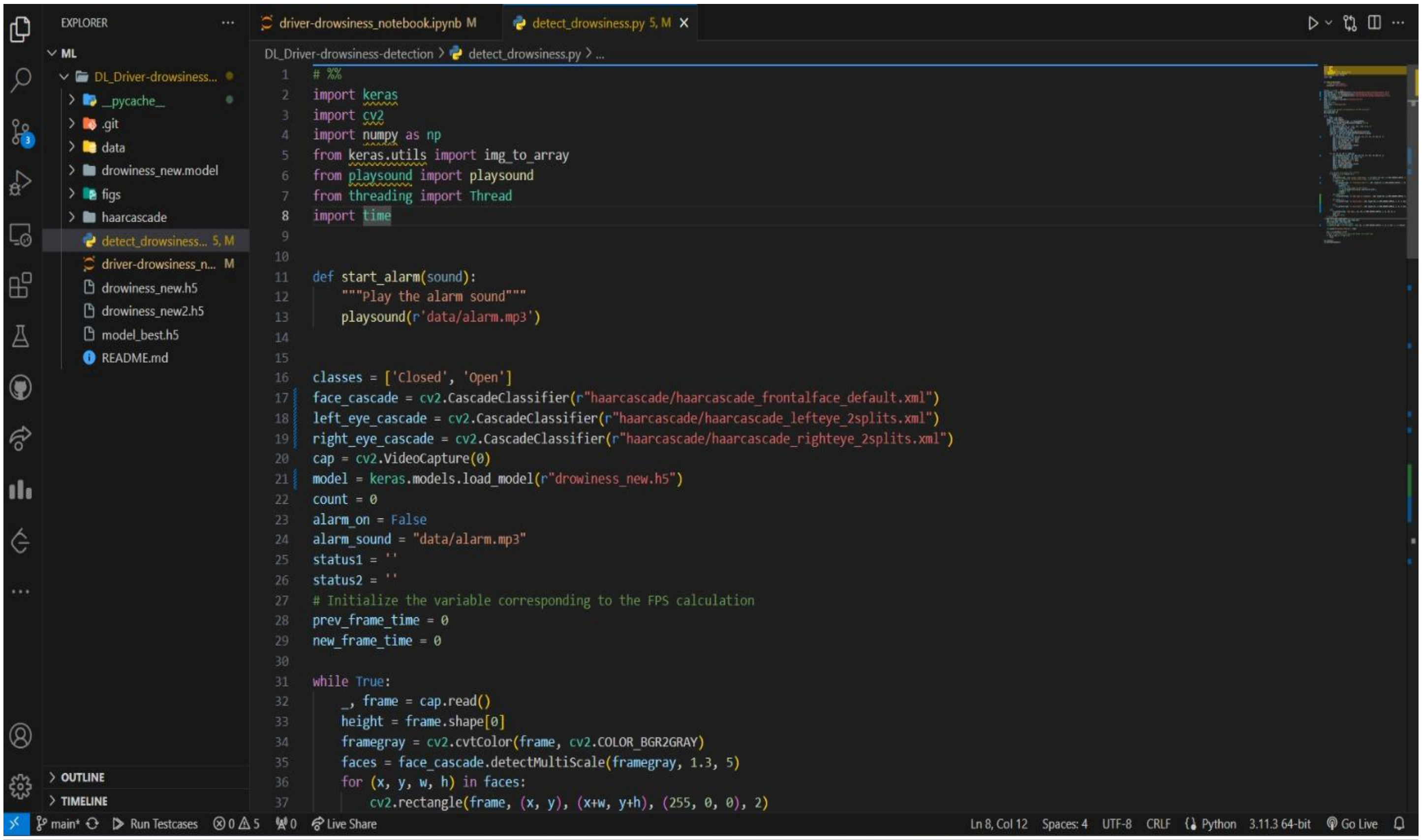
8. **Evaluation:**Assess performance using test datasets.Fine-tune based on accuracy and other metrics.

9. **Deployment**:Integrate the algorithm into vehicles for real-world testing.

FLOWCHART



.PROGRAM

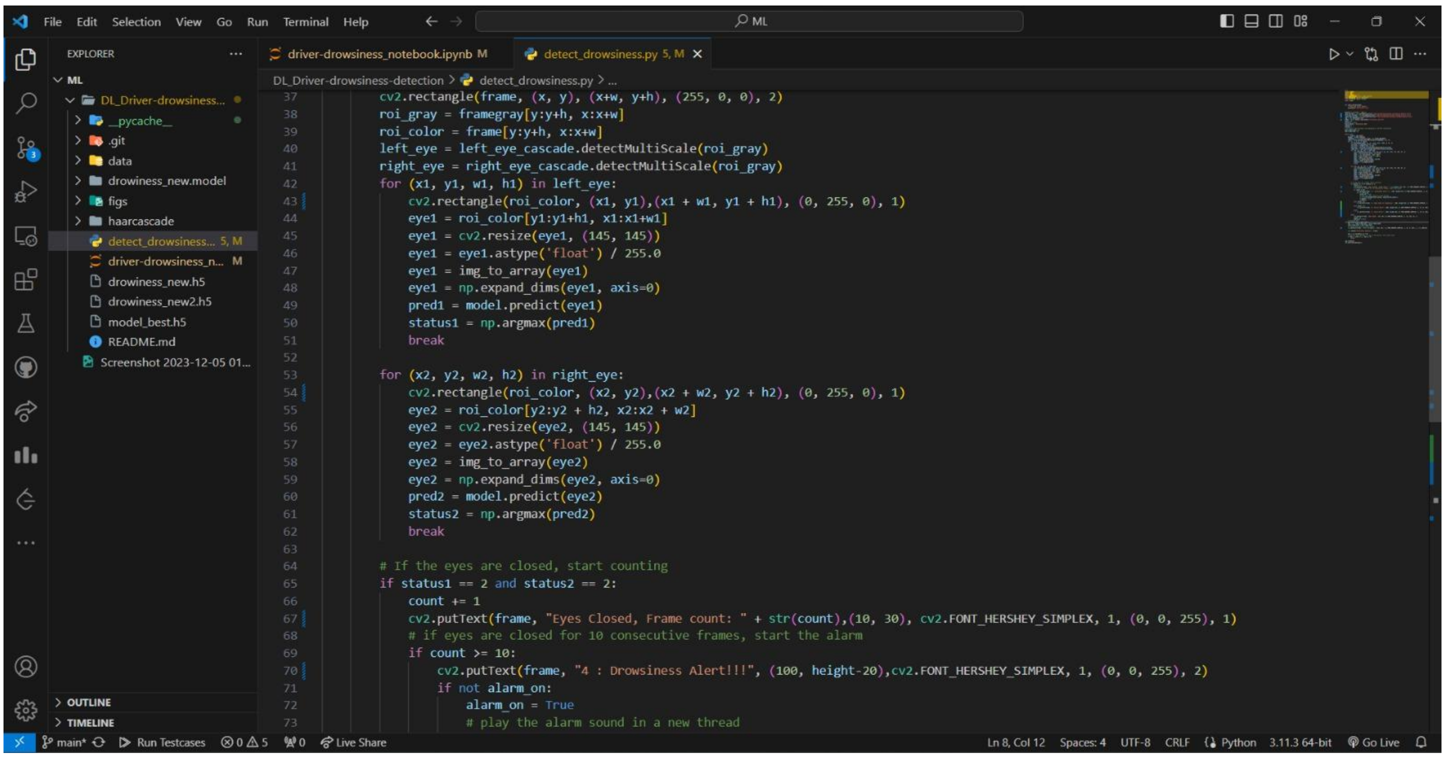


```python
# %%
import keras
import cv2
import numpy as np
from keras.utils import img_to_array
from playsound import playsound
from threading import Thread
import time


def start_alarm(sound):
    """Play the alarm sound"""
    playsound(r'data/alarm.mp3')


classes = ['Closed', 'Open']
face_cascade = cv2.CascadeClassifier(r"haarcascade/haarcascade_frontalface_default.xml")
left_eye_cascade = cv2.CascadeClassifier(r"haarcascade/haarcascade_lefteye_2splits.xml")
right_eye_cascade = cv2.CascadeClassifier(r"haarcascade/haarcascade_righteye_2splits.xml")
cap = cv2.VideoCapture(0)
model = keras.models.load_model(r"drowiness_new.h5")
count = 0
alarm_on = False
alarm_sound = "data/alarm.mp3"
status1 = ''
status2 = ''
# Initialize the variable corresponding to the FPS calculation
prev_frame_time = 0
new_frame_time = 0

while True:
    _, frame = cap.read()
    height = frame.shape[0]
    framegray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)
    faces = face_cascade.detectMultiScale(framegray, 1.3, 5)
    for (x, y, w, h) in faces:
        cv2.rectangle(frame, (x, y), (x+w, y+h), (255, 0, 0), 2)
```

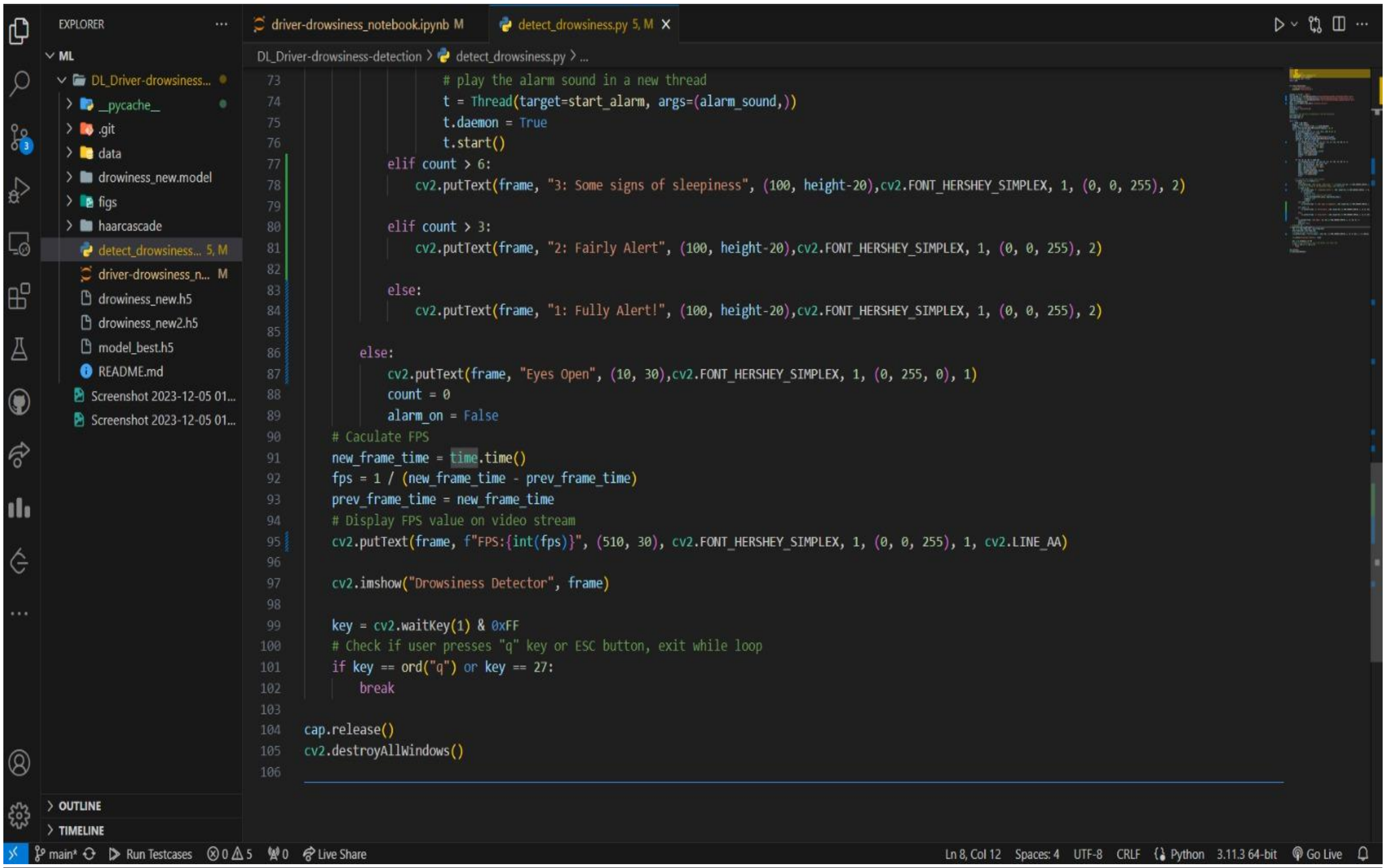


```python
        cv2.rectangle(frame, (x, y), (x+w, y+h), (255, 0, 0), 2)
        roi_gray = framegray[y:y+h, x:x+w]
        roi_color = frame[y:y+h, x:x+w]
        left_eye = left_eye_cascade.detectMultiScale(roi_gray)
        right_eye = right_eye_cascade.detectMultiScale(roi_gray)
        for (x1, y1, w1, h1) in left_eye:
            cv2.rectangle(roi_color, (x1, y1),(x1 + w1, y1 + h1), (0, 255, 0), 1)
            eye1 = roi_color[y1:y1+h1, x1:x1+w1]
            eye1 = cv2.resize(eye1, (145, 145))
            eye1 = eye1.astype('float') / 255.0
            eye1 = img_to_array(eye1)
            eye1 = np.expand_dims(eye1, axis=0)
            pred1 = model.predict(eye1)
            status1 = np.argmax(pred1)
            break

        for (x2, y2, w2, h2) in right_eye:
            cv2.rectangle(roi_color, (x2, y2),(x2 + w2, y2 + h2), (0, 255, 0), 1)
            eye2 = roi_color[y2:y2 + h2, x2:x2 + w2]
            eye2 = cv2.resize(eye2, (145, 145))
            eye2 = eye2.astype('float') / 255.0
            eye2 = img_to_array(eye2)
            eye2 = np.expand_dims(eye2, axis=0)
            pred2 = model.predict(eye2)
            status2 = np.argmax(pred2)
            break

        # If the eyes are closed, start counting
        if status1 == 2 and status2 == 2:
            count += 1
            cv2.putText(frame, "Eyes Closed, Frame count: " + str(count),(10, 30), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 1)
            # if eyes are closed for 10 consecutive frames, start the alarm
            if count >= 10:
                cv2.putText(frame, "4 : Drowsiness Alert!!!", (100, height-20),cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 2)
                if not alarm_on:
                    alarm_on = True
                    # play the alarm sound in a new thread
```

PROGRAM



```python
                    # play the alarm sound in a new thread
                    t = Thread(target=start_alarm, args=(alarm_sound,))
                    t.daemon = True
                    t.start()
            elif count > 6:
                cv2.putText(frame, "3: Some signs of sleepiness", (100, height-20),cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 2)

            elif count > 3:
                cv2.putText(frame, "2: Fairly Alert", (100, height-20),cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 2)

            else:
                cv2.putText(frame, "1: Fully Alert!", (100, height-20),cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 2)

        else:
            cv2.putText(frame, "Eyes Open", (10, 30),cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 255, 0), 1)
            count = 0
            alarm_on = False
    # Caculate FPS
    new_frame_time = time.time()
    fps = 1 / (new_frame_time - prev_frame_time)
    prev_frame_time = new_frame_time
    # Display FPS value on video stream
    cv2.putText(frame, f"FPS:{int(fps)}", (510, 30), cv2.FONT_HERSHEY_SIMPLEX, 1, (0, 0, 255), 1, cv2.LINE_AA)

    cv2.imshow("Drowsiness Detector", frame)

    key = cv2.waitKey(1) & 0xFF
    # Check if user presses "q" key or ESC button, exit while loop
    if key == ord("q") or key == 27:
        break

cap.release()
cv2.destroyAllWindows()
```

RESULT

After implementing the drowsiness detection algorithm, the system's performance is evaluated based on various metrics. The results showcase the algorithm's effectiveness in accurately identifying drowsiness and its severity.

Performance Metrics:

1. **Accuracy:** The percentage of correctly classified instances.
2. **Precision:** The ratio of correctly predicted drowsy instances to the total predicted drowsy instances.
3. **Recall:** The ratio of correctly predicted drowsy instances to the total actual drowsy instances.
4. **F1 Score:** The harmonic mean of precision and recall.

TEST CASES

1.**Normal Alertness:**

Scenario: The driver is fully alert with normal facial expressions and eye movements.

Expected Result: Algorithm predicts an alert state with high accuracy.

2. **Mild Drowsiness:**

Scenario: The driver shows slight signs of drowsiness, such as occasional blinking or minor facial expressions.

Expected Result: Algorithm detects mild drowsiness with high precision and recall.

3. **Severe Drowsiness:**

Scenario: The driver exhibits significant signs of drowsiness, including prolonged eye closure and noticeable changes in facial expression.

Expected Result: Algorithm accurately identifies severe drowsiness with high sensitivity.

4. **False Positive:**

Scenario: The algorithm incorrectly predicts drowsiness when the driver is fully alert.

Expected Result: Investigate and fine-tune the algorithm to reduce false positives.

5. **False Negative:**

Scenario: The algorithm fails to detect drowsiness when the driver is actually drowsy.

Expected Result: Identify the cause (e.g., insufficient training data) and refine the model to reduce false negatives.

6. **Changing Lighting Conditions:**

Scenario: Testing the algorithm's robustness under varying lighting conditions.

Expected Result: The algorithm should maintain accuracy across different lighting scenarios.

7. **Head Movement:**

Scenario: The driver's head movements are erratic, but they are not drowsy.

Expected Result: The algorithm should prioritize eye and facial features over head movements to avoid false positives.

8. **Real-time Performance:**

Scenario: Evaluate the algorithm's performance in real-time conditions with continuous monitoring.

Expected Result: The system should provide timely and accurate alerts during ongoing monitoring.

9. **Long Duration Monitoring:**

Scenario: Monitor the driver over an extended period to assess the algorithm's reliability.

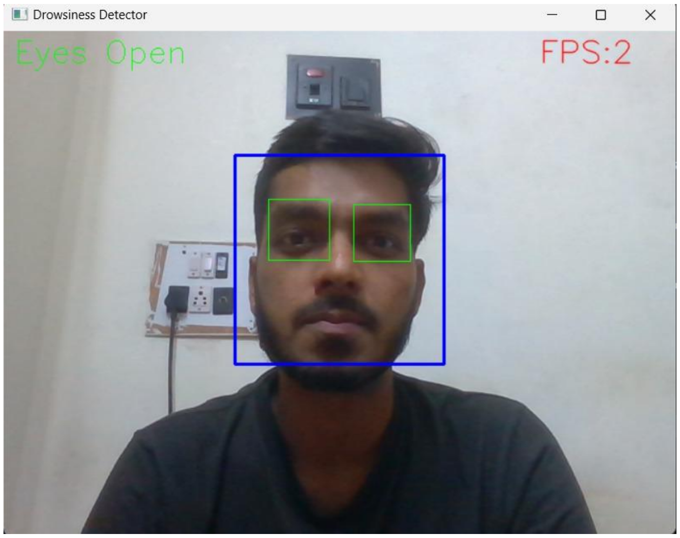
Expected Result: The algorithm should maintain consistent performance without degradation over time.

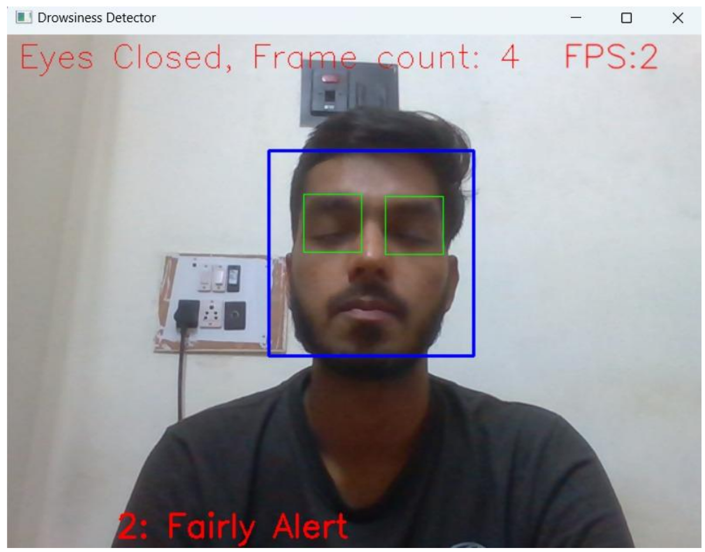
10. **Cross-dataset Validation:**

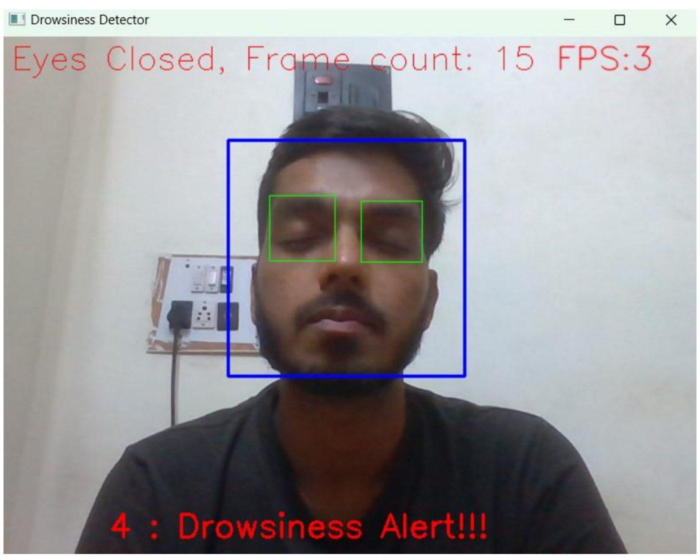
Scenario: Test the algorithm on a different dataset to evaluate generalization capabilities.

Expected Result: The algorithm should demonstrate adaptability to diverse datasets with reliable drowsiness detection.

PICTURES OF EXECUTION







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