Driver Behavior Monitoring System

A Project Report

Submitted in partial fulfilment of the requirements

Of

Industrial Artificial Intelligence with Cloud Computing

By

Rishabh Parmar
Parth Gandhi
Jagdish Suthar

Under the Esteemed by
Jay Rathod

ACKNOWLEDGEMENT

We extend our heartfelt appreciation to Edunet Foundation for organizing the AI Saksham internship program at BVM College. This opportunity has been instrumental in enhancing our knowledge and skills in AI.

We are deeply grateful to our mentor, Jay Rathod, for his invaluable guidance, encouragement, and expertise throughout this internship. His teachings and mentorship have been pivotal in shaping our understanding of AI concepts and in the successful completion of our project.

Special thanks to the IT department for their unwavering support and provision of essential resources. We are also thankful to the Head of IT, Dr. Keyur Brahmbhatt, for his leadership and encouragement, which has fostered an environment conducive to creativity and innovation.

We express our gratitude to our Principal, Dr. Indrajit Patel, for his overall support and vision, which have been crucial in our academic and professional growth.

Lastly, we would like to thank BVM College for providing us with the necessary infrastructure and support to carry out our project. The conducive learning environment has greatly contributed to our growth and development during this internship.

Together, we have achieved a significant milestone, and we are thankful to each individual and organization mentioned above for their contributions to this project.

Thank you.

Rishabh Parmar, Jagdish Suthar & Parth Gandhi

ABSTRACT

Driver behavior monitoring system are advancing by integrating sophisticated technologies to enhance road safety by detecting and analysing driver states and actions. This system employs advanced computer vision and machine learning techniques to monitor drivers' eyes for signs of drowsiness, such as prolonged closure, and their mouths for yawning, indicative of fatigue.

Additionally, the system can identify the presence and usage of mobile devices, a common cause of distracted driving. By continuously analysing these critical factors in real-time, the system provides timely alerts and interventions, significantly reducing the risk of accidents and promoting safer driving habits.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1. Problem Statement:

Road accidents due to driver drowsiness, distraction, and negative emotions remain a significant concern. Existing solutions lack real-time monitoring of these factors, leading to preventable accidents.

1.2. Problem Definition:

The Driver Behavior Monitoring System aims to prevent accidents by continuously monitoring drivers for signs of drowsiness, distraction, and negative emotions like anger. It utilizes computer vision and machine learning to analyse facial expressions and eye movements in real time.

1.3. Expected Outcomes:

1. **Accurate Detection and Alerts:** The system should correctly detect and alarm about driver drowsiness and negative emotions.

2. **Distraction Detection:** It should successfully identify distractions such as the use of mobile phones.

3. **Real-Time Operation:** The system should function effectively in real-time to provide timely interventions.

4. **Model Development:** Focus on creating a robust and accurate model for driver behavior monitoring using advanced technologies.

CHAPTER 2

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

2.1. Paper

Driver Behavior Monitoring Based on Smartphone Sensor Data and Machine Learning Methods.

Link - https://www.researchgate.net/publication/339094926_Driver_Behavior_Monitoring_Based_on_Smartphone_Sensor_Data_and_Machine_Learning_Methods

2.1.1. Brief Introduction of Paper:

This paper explores the application of smartphone sensor data and machine learning techniques to identify abnormal driver behavior, with a focus on improving traffic safety. It begins by examining existing literature to understand the current landscape of machine learning approaches and sensor data usage. The proposed approach involves using neural networks for classification tasks within a driver decision support system, leveraging smartphone sensor data for accessibility across various vehicles. The study underscores the significance of addressing driving behavior in reducing traffic accidents and associated economic costs. It concludes with a proposed methodology and future directions for implementation.

2.1.2. Techniques used in Paper:

Support Vector Machine (SVM): SVM is utilized for classification tasks within the proposed driver decision support system. It aims to find a hyperplane in an N-dimensional space to separate data points effectively.

K-nearest neighbour (KNN): KNN is employed for classifying data points based on the majority of features shared by their nearest neighbours. It is part of the machine learning approach for driver behavior identification.

Neural Networks: Neural networks are chosen for the classification task in the proposed driver decision support system. They are used to classify input data according to weighted interconnections, mimicking the neuronal structure of the human brain.

Decision Trees: Decision trees are represented as a tree-like graph to aid in the classification of data points based on various features. They are part of the machine learning approach for driver behavior identification.

K-means: K-means algorithm is utilized as an unsupervised learning method to find K clusters within a dataset. It helps in effectively grouping data points, contributing to analysing driver behavior.

Logistic Regression: Logistic regression models are employed to model probabilities for binary classification independent variables. They are part of the machine learning approach for driver behavior identification.

CHAPTER 3

PROPOSED METHODOLOGY

CHAPTER 3

PROPOSED METHODOLOGY

3.1. System Design:

The Driver Behavior Monitoring System is designed to utilize advanced computer vision and machine learning techniques to monitor and analyse driver behavior in real-time. The system consists of several key components and modules that work together to detect drowsiness, distraction, and emotional states.

3.1.1 Data Acquisition:

The system uses a camera installed in the vehicle to capture continuous video footage of the driver's face. This camera feeds live video data to the system for further processing.

3.1.2 Data Processing:

The captured video frames are processed in real-time to detect facial features, eye movements, and the presence of mobile devices. The system employs computer vision algorithms to extract relevant features from each frame.

3.1.3 Behavior Analysis:

Using machine learning models, the system analyses the extracted features to identify signs of drowsiness (e.g., prolonged eye closure), distraction (e.g., mobile phone usage), and emotional states (e.g., anger, happiness). The models are trained on a diverse dataset to ensure accurate detection.

3.1.4 Alert Generation:

When the system detects drowsiness, distraction, or negative emotions, it generates immediate alerts to warn the driver. These alerts can be in the form of visual or auditory feedback to ensure the driver's attention is regained.

3.2 Modules Used:

The system is composed of several critical modules that work in coordination to monitor driver behavior effectively.

3.2.1 Face Detection:

This module is responsible for locating the driver's face within the video frames. It uses advanced face detection algorithms to ensure accurate and fast detection under various lighting conditions and angles.

3.2.2 Eye and Mouth Detection:

Once the face is detected, this module focuses on identifying the eyes and mouth. It tracks eye movements and mouth openings to detect signs of drowsiness and yawning, which are indicators of fatigue.

3.2.3 Emotion Recognition:

This module analyses facial expressions to determine the driver's emotional state. It can identify emotions such as happiness, neutrality, and anger by analysing subtle changes in facial features.

3.2.4 Distraction Detection:

This module monitors the driver's actions to detect the use of mobile devices. It identifies when the driver is looking away while handling a phone, indicating distraction.

3.3 Data Flow Diagram

The Data Flow Diagram (DFD) illustrates the flow of data through the system, from data acquisition to alert generation. It helps in understanding how each module interacts and how data is processed at each stage.

Level 0: Context Diagram

- **Input:** Video footage of the driver.
- **Processes:** Data acquisition, data processing, behavior analysis, alert generation.
- **Output:** Real-time alerts to the driver.

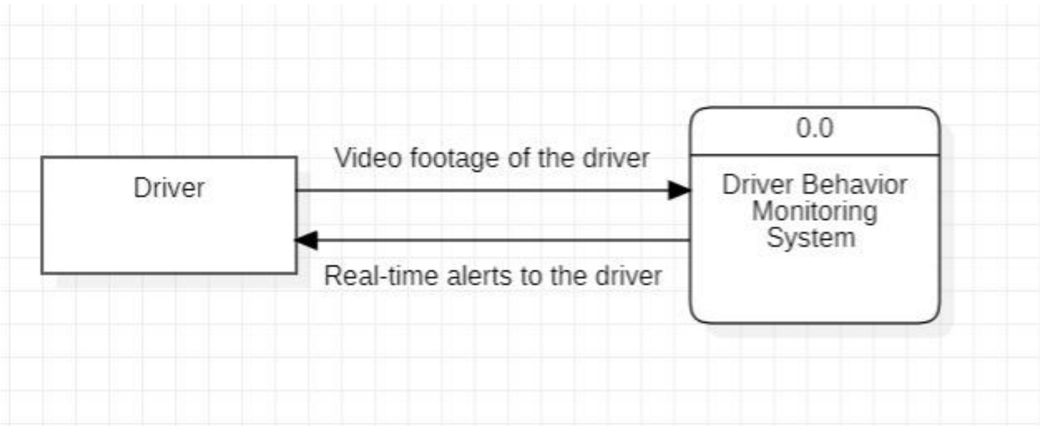

Figure 3.1: Context Diagram

Level 1: Detailed Diagram

1. **Data Acquisition Module:**
    - **Input:** Live video feed
    - **Output:** Video frames to Data Processing Module
2. **Data Processing Module:**
    - **Input:** Video frames
    - **Processes:** Face detection, eye and mouth detection
    - **Output:** Extracted features to Behavior Analysis Module
3. **Behavior Analysis Module:**
    - **Input:** Extracted features
    - **Processes:** Drowsiness detection, emotion recognition, distraction detection
    - **Output:** Analysis results to Alert Generation Module
4. **Alert Generation Module:**
    - **Input:** Analysis results
    - **Processes:** Determine if the alert is needed
    - **Output:** Alerts to the driver

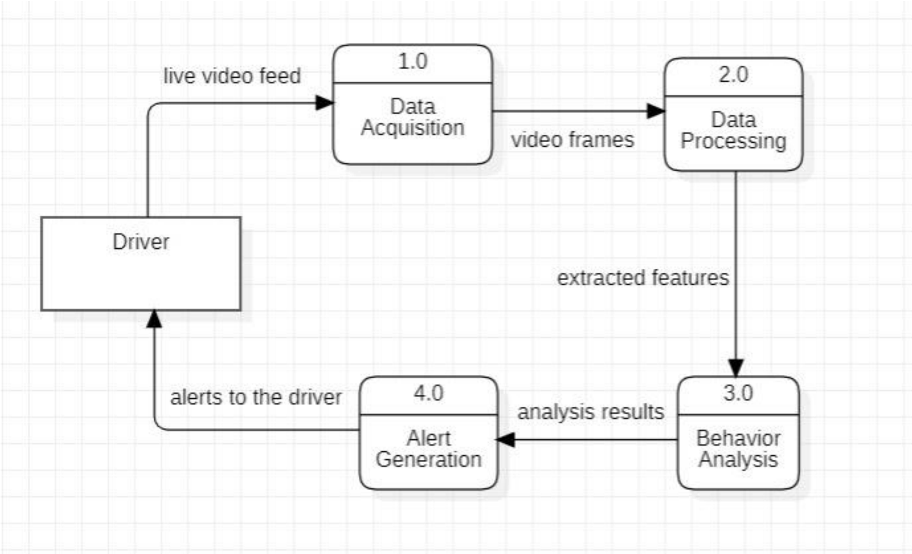

Figure 3.2: Level 1

This structured approach ensures that the system effectively monitors and analyzes driver behavior to enhance road safety.

3.4 Advantages

1. **Improved Road Safety**: The system provides real-time alerts, significantly reducing the risk of accidents caused by drowsiness, distraction, and negative emotions.

2. **Real-Time Monitoring**: Continuous monitoring ensures that any signs of unsafe behavior are detected and addressed immediately.

3. **Comprehensive Analysis**: The system analyzes multiple factors (drowsiness, distraction, emotions), providing a holistic view of driver behavior.

4. **Non-Intrusive**: The system operates without interfering with the driver, making it more likely to be accepted and used regularly.

5. **Data-Driven Insights**: Collects valuable data that can be used for further research and to inform policy decisions.

3.5 Requirement Specification

3.5.1 Hardware Requirements:

1. **Camera:** High-resolution camera capable of capturing clear video footage of the driver's face under various lighting conditions.

2. **Processor:** Powerful CPU/GPU to handle real-time video processing and machine learning computations.

3. **Memory:** Sufficient RAM to process video frames and run complex algorithms without latency.

4. **Storage:** Adequate storage for saving video data and model parameters.

5. **Alert System: S**peakers or haptic feedback devices to deliver real-time alerts to the driver.

3.5.2 Software Requirements:

1. **Operating System:** Compatible with popular operating systems like Windows, Linux, or macOS.

2. **Programming Languages:** Python is suitable for machine learning and computer vision tasks.

3. **Libraries and Frameworks:**
   - OpenCV for computer vision tasks.
   - TensorFlow or PyTorch for machine learning model development.
   - Dlib for facial recognition and feature extraction.

4. **Development Environment:** IDEs like PyCharm, Visual Studio Code, or Jupyter Notebook for development and testing.

5. **Data Management:** Tools for managing and processing datasets, such as pandas and NumPy.

CHAPTER 4

IMPLEMENTATION AND RESULT

CHAPTER 4

IMPLEMENTATION AND RESULT

4.1. Result of Mobile Detection

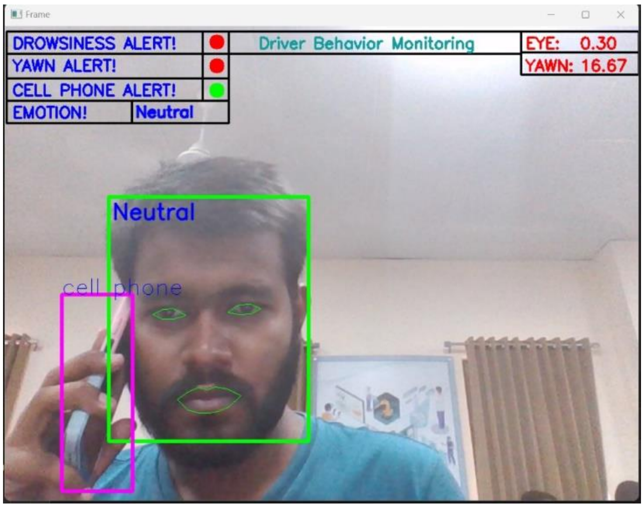

Figure 4.1: Mobile phone detection

4.2. Results of Facial Expressions

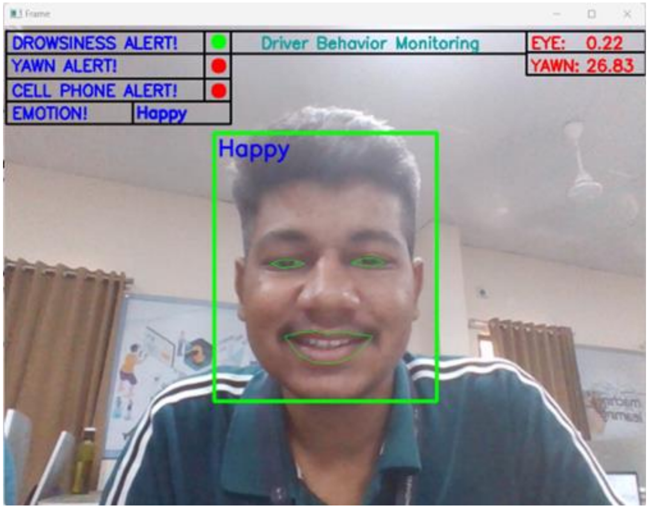

Figure 4.2.1: Happy Expression detection

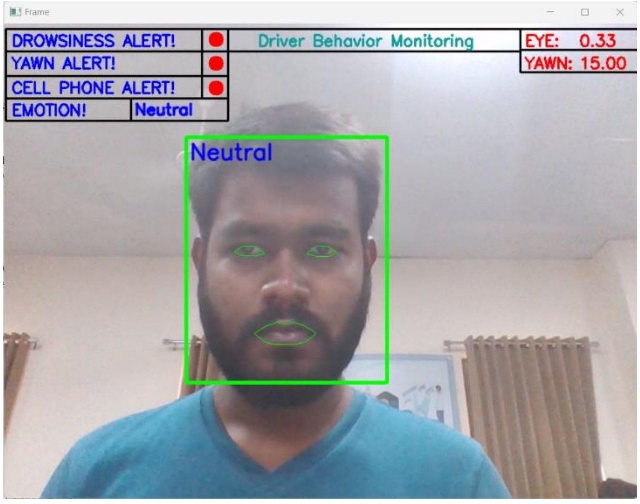

Figure 4.2.2: Neutral Expression detection

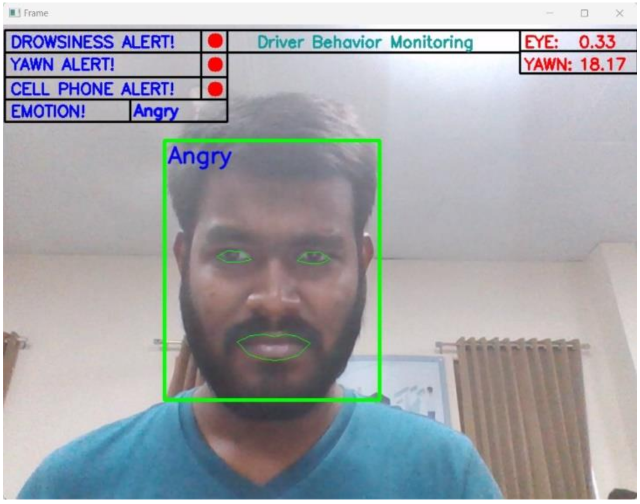

Figure 4.2.3: Angry Expression detection

4.3. Result of Drowsiness

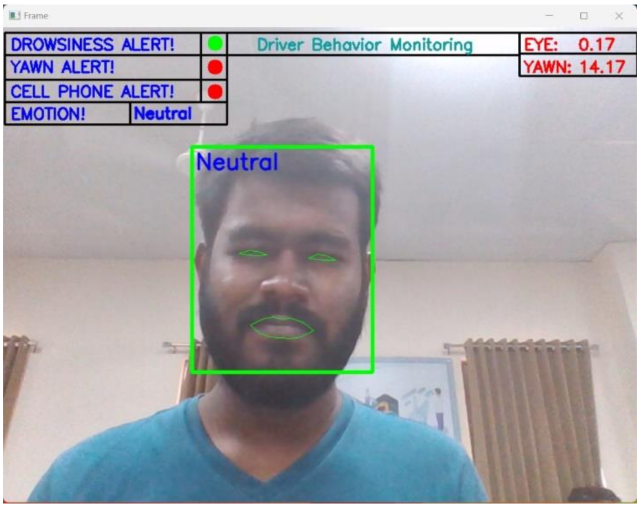

Figure 4.3: Drowsiness Alert

4.4 Result of Yawning

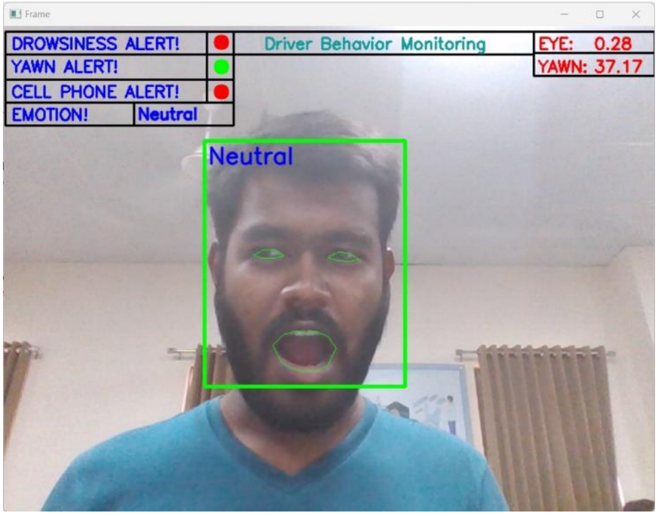

Figure 4.4: Yawn Alert

CHAPTER 5

CONCLUSION

CHAPTER 5

CONCLUSION

5.1 Advantages:

1. **Improved Road Safety**: The system provides real-time alerts, significantly reducing the risk of accidents caused by drowsiness, distraction, and negative emotions.

2. **Real-Time Monitoring**: Continuous monitoring ensures that any signs of unsafe behavior are detected and addressed immediately.

3. **Comprehensive Analysis**: The system analyzes multiple factors (drowsiness, distraction, emotions), providing a holistic view of driver behavior.

4. **Non-Intrusive**: The system operates without interfering with the driver, making it more likely to be accepted and used regularly.

5. **Data-Driven Insights**: Collects valuable data that can be used for further research and to inform policy decisions.

5.2 Scope:

The Driver Behavior Monitoring System has a broad scope with potential applications in various domains related to road safety and driver behavior analysis. Some key areas of scope include:

1. **Vehicle Safety**: Integration of the system into vehicles to provide real-time feedback and alerts to drivers, thereby enhancing vehicle safety and reducing the risk of accidents.
2. **Fleet Management**: Implementation of the system in commercial vehicle fleets to monitor driver behavior and ensure compliance with safety regulations, ultimately improving overall fleet safety and efficiency.
3. **Driver Training**: Utilization of the system in driver training programs to provide objective feedback and guidance to trainees, helping them develop safer driving habits and behaviors.
4. **Research and Development**: Use of the system as a tool for research and development in the fields of computer vision, machine learning, and transportation engineering, to advance knowledge and technology in driver behavior analysis and road safety.

The scope of the Driver Behavior Monitoring System extends beyond individual vehicles to encompass broader societal benefits, including reduced accidents, injuries, and fatalities on the roads, ultimately contributing to safer and more sustainable transportation systems.

GITHUB LINK

GitHub Link: https://github.com/Rishabh3243/AI_Saksham_Project.git

VIDEO LINK

Video Link:
https://drive.google.com/drive/folders/1TtH8oYM0rW0kWkhbjXOM_e28p6VGqupA?usp=sharing

REFERENCES

Link:
https://www.researchgate.net/publication/339094926_Driver_Behavior_Monitoring_Based_on_Smartphone_Sensor_Data_and_Machine_Learning_Methods

APPENDIX

Appendix A: Sample Data

This appendix includes sample data used to train and test the Driver Behaviour Monitoring System. The data may consist of:

- **Images:** A collection of images containing faces with various expressions (happy, neutral, angry), mobile phone usage examples, and closed/open eye states.
- **Videos:** Short video clips showcasing real-world driving scenarios with instances of emotional expressions.

Appendix B: System Architecture Diagram

This appendix provides a visual representation of the system architecture, illustrating the interaction between different components. It can be a block diagram showcasing:

- **Data Acquisition Module:** Captures video footage of the driver.
- **Preprocessing Module:** Performs tasks like image resizing, normalization, and noise reduction.
- **Face Detection Module:** Locates the driver's face within each frame.
- **Feature Extraction Module:** Extracts relevant features from the face region (eye coordinates, mouth position, etc.).
- **Machine Learning Model:** Trained to analyse features and classify driver behaviour (drowsy, distracted, emotional state).
- **Alert Generation Module:** Generates audio or visual alerts based on the model's output.

Appendix C: Performance Metrics

This appendix details the performance metrics used to evaluate the Driver Behaviour Monitoring System's effectiveness. Examples include:

- **Accuracy:** The percentage of correctly classified driver behaviour instances (drowsy vs. not drowsy, distracted vs. not distracted, etc.).
- **Precision:** The ratio of true positives (correctly identified behaviour) to the total number of positive predictions.
- **Recall:** The ratio of true positives to the total number of actual positive cases.
- **False Positive Rate:** The percentage of incorrectly classified cases as a particular behaviour (e.g., drowsy when not drowsy).
- **False Negative Rate:** The percentage of missed detections of a specific behaviour.

Appendix D: Code Snippets

This appendix can include relevant code snippets showcasing the implementation of key functionalities, such as:

- Face detection using OpenCV.
- Feature extraction with libraries like dlib.
- Machine learning model training and prediction using TensorFlow or PyTorch.