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AUTOMATIC BRAKING USING DROWSINESS DETECTION SYSTEM

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ABSTRACT: Driver fatigue is a leading global cause of road accidents, with serious injuries and fatalities often as a result. In order to improve road safety, this project suggests an Automatic Braking System coupled with Drowsiness Detection. The system continuously checks for the driver's alertness based on real-time video analysis and facial features, including eye blink rate, duration of eyelid closure, and head position. Sophisticated computer vision methods, in association with machine learning principles, are utilized to correctly identify indicators of drowsiness. If it identifies drowsy action, the system issues a warning signal to the driver. In case the driver does not respond in a pre-specified period of time, the system automatically engages the braking system of the vehicle in order to avoid the possible accident. This smart safety solution is specifically valuable for truck drivers who work long hours on the road and can significantly cut the risk of collision from driving while tired. The application displays a realistic and effective way to incorporate human behavior monitoring into motor vehicle control systems to advance intelligent and safe transport.

INTRODUCTION

Road safety is an important issue in the present fast-paced era, with motor vehicle accidents ranking .Among the main causes of fatalities and injuries. Among several contributory factors, driver fatigue is a major yet underappreciated cause of accidents, particularly on highways and long-distance drives. Fatigue slows down the reaction time of a driver, reduces alertness, and makes decision-making harder, making him or her prone to collisions. Conventional driver aid systems are directed towards external danger, but with the latest in intelligent transportation systems, it has become crucial to monitor the driver's physical as well as mental condition. Detecting drowsiness and adopting preventive measures can be a deciding factor in cutting down accidents .The project has been undertaken with the objective of creating a Drowsiness Detection System coupled with an Automatic Braking system that tracks the driver's facial structure in real-time through a camera. Through examination of essential indicators like eye closure, blink rate, and head nodding, the system detects signs of drowsiness or distraction. If the driver is found to be sleepy, the system initially provides an alert to get the driver's attention. If the driver does not respond, the system automatically presses the brakes to stop the car safely, thus avoiding the chances of an accident.

OBJECTIVE OF THE STUDY

1. The specific purposes of this investigation are listed below.
2. To create an actual-time drowsiness detection system that tracks the facial features of the driver—like eye movement, blink rate, and head position—through computer vision methods.
3. To correctly detect symptoms of driver fatigue or distraction through image processing and machine learning algorithms.
4. To create and implement an automatic braking system that kicks in when the system detects the driver is drowsy and not responding to initial alerts.

LITERATURE SURVEY

LITERATURE REVIEW-----Numerous studies and technologies have been researched and developed in recent years to counteract driver drowsiness and enhance road safety.

Eriksson and Papanikotopoulos (1997) had suggested a real-time system to monitor driver alertness through eye tracking. They provided the groundwork for numerous vision-based methods that monitor eyelid movement and direction of gaze in order to detect drowsiness.

Viola-Jones Algorithm (2001), which is commonly employed in face and eye detection, provides a real-time efficient means for detecting facial features. Most contemporary systems use this algorithm as a foundation for tracking eye closure and blinking.

Dinges et al. (2005) stressed the significance of PERCLOS (Percentage of Eye Closure) as a good measure for detecting drowsiness. PERCLOS-based systems have proven to be highly accurate in differentiating alertness and drowsiness.

Abtahi et al. (2011) proposed a non-intrusive driver drowsiness detection system based on a webcam and image processing methods for observing facial expressions and blinking. Their system performed well under laboratory-controlled situations.

Tian et al. (2013) proposed a hybrid approach that integrates eye aspect ratio (EAR) with head movement analysis to enhance detection accuracy. The integration lowered false positives and increased the reliability of drowsiness detection.

Studies of automatic emergency braking (AEB) systems, according to NHTSA (National Highway Traffic Safety Administration) guidelines, have shown dramatic reductions in rear-end crashes. Coupling AEB with driver monitoring also increases safety by minimizing the need for manual response.

SYSTEM REQUIREMENTS

Hardware Requirements

Camera (Webcam or IR Camera): This records live video of the driver's face to track eye movement, blinking, and head position. An IR camera can be beneficial in low-light environments.

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Arduino / Raspberry Pi: This is the control unit to receive inputs from the processing system and manage the braking mechanism or alert system

Computer / Embedded Board: This runs the master program (Python script) that takes the video input and identifies drowsiness with image processing and machine learning-based algorithms.

DC Motor / Servo Motor (for brake simulation): Utilized to simulate or engage the braking system in a prototype. The motor can be made to activate the brakes if drowsiness is identified.

Relay Module or Motor Driver: Assists in driving high-power devices such as motors utilizing low-power control signals from the microcontroller.

Buzzer / Alert System: Gives an audio warning to the driver upon initial detection of drowsiness, allowing them to wake up before automatic braking is initiated.

Power Supply: Supplies the required power (typically 5V or 12V) to the camera, microcontroller and other electronic components.

IR Sensor: An Infrared (IR) sensor is an electronic sensor that senses objects or determines distance by sending and receiving infrared light. In a drowsiness detection system, it can be employed for obstacle detection to make the vehicle brake only when there is an object in front, increasing safety.

Software Requirements

Python: The primary programming language for coding the drowsiness detection algorithm and managing the system's logic.

OpenCV: An open-source vision library utilized to detect the driver's face and eyes from the camera input.

Dlib or Media pipe: Libraries utilized to detect facial landmarks more precisely, including the eye corners and eyelid positions, for enhanced drowsiness detection.

Arduino IDE: Optional if the Arduino board is used to regulate the braking system. It is utilized to program the microcontroller.

Operating System (Windows): The OS must be compatible with the software libraries. For instance, Raspbian is employed with Raspberry Pi, whereas Windows may be employed in a PC-based system.

Machine Learning Libraries (TensorFlow / Keras): If a model based on deep learning is employed for drowsiness detection, these libraries are needed to construct and execute the model.

METHODOLOGY

OVERVIEW The system to be proposed is a system that would monitor the facial features of the driver in real time and trigger an automatic braking when drowsiness is sensed. The methodology consists of a number of steps: image acquisition, drowsiness detection, alert generation, and braking control.

Step 1: Image Acquisition ---A webcam or IR camera is installed in front of the driver to capture real-time video frames of the driver's face continuously. The video feed is then routed to the analysis system for evaluation.

Step 2: Detection of Face and Eyes---Based on OpenCV and potentially Dlib or Mediapipe, the system finds the face and eyes in every video frame. Facial features are detected in order to detect specific areas like the eyes, eyelids, and head pose.

Step 3: Drowsiness Detection---The system computes the Eye Aspect Ratio (EAR) to check if the eyes are closed or open. A low EAR across a fixed number of consecutive frames signals eye closure, which is a prevalent indicator of drowsiness. Blink frequency and eye closure duration (PERCLOS method) can be employed for better detection as well. Other features such as head nodding or tilting can be utilized for enhancing detection reliability.

Step 4: Alert Generation---When drowsiness is indicated, an initial warning (buzzer or sound alert) is activated to notify the driver. If the driver reacts by opening their eyes or exhibiting signs of alertness, the system reinitializes and resumes monitoring.

Step 5: Automatic Braking Activation---If the driver fails to react within a predetermined time, the system deems a critical level of inattention. It transmits a signal from the base system (Python code) to the microcontroller (e.g., Arduino) through serial communication. The microcontroller then acts on a motor or relay in order to actuate or replicate the vehicle's braking system.

Step 6: System Reset and Continuation---Once braking is engaged, the system makes a record and continues to monitor the driver upon the vehicle being brought to standstill. The system is equipped to run on a continuous cycle for real-time monitoring.

SYSTEM DESIGN

The system is programmed to track the alertness of the driver and automatically take control of the braking system of the vehicle if drowsiness is recognized and the driver does not react. It integrates computer vision, sensor data, and microcontroller-based control in the following principal components:

1. Input Stage – Camera Module: A camera (webcam or IR camera) is fixed on the steering column or dashboard to continuously scan the face of the driver. The video feed is transferred to a processing platform (PC or Raspberry Pi) to monitor the eye behavior of the driver.

2. Processing Stage – Drowsiness Detection: Live video is processed with OpenCV and optionally with Dlib or Media pipe libraries. Facial landmarks are detected, and the Eye Aspect Ratio (EAR) is computed to track the blinking and closing duration of eyes. If the EAR is low for some amount of frames, the system presumes the driver is sleepy.

3. Warning Stage – Driver Alert System: After recognizing drowsiness, the system produces an audio or vibration signal (such as a buzzer or speaker) to alert the driver. If the driver reacts and opens their eyes once more, the system resets and resumes surveillance.

4. IR Sensor Integration – Obstacle Detection: An IR sensor is fitted at the front of the car model to identify close-by obstacles. This ensures braking is only implemented when something is sensed in a set distance (e.g., <50 cm).

5. Control Stage – Automatic Braking: If the driver fails to react to the alert and there is an obstruction detected, the system triggers a signal to a microcontroller (for example, Arduino). The microcontroller turns on a motor or relay to fake or activate brakes on the car.

6. Reset and Resume: When braking is triggered and the car has come to a halt, the system records the incident and reinitializes to resume monitoring the driver as soon as the car begins driving again.

RESULTS

The Automatic Braking Using Drowsiness Detection System was successfully implemented and tested under different simulated driving conditions using a prototype vehicle model. The system was tested on whether it was able to correctly detect drowsiness and respond appropriately with warnings and braking maneuvers.

Drowsiness Detection Accuracy: When the driver's eyes were closed for longer than the threshold time (e.g., 2 seconds), the system consistently recognized a drowsy condition with more than 90% accuracy under bright conditions. Under low-light conditions, the application of IR lighting enhanced eye and face detection.

Response Time: The warning alert (buzzer) was triggered within 1 second once drowsiness was detected. If the driver did not react within 3–5 seconds, the automatic braking system activated.

IR Sensor Functionality: The IR sensor properly identified obstacles at a distance of 50 cm, such that the braking mechanism did not activate unnecessarily if the way ahead was clear. This enhanced safety and minimized false positive braking operation.

Braking Mechanism Performance: The microcontroller effectively accepted instructions from the processing system and engaged the braking motor. The braking was smoothly applied and brought the vehicle model to a halt within a brief distance, proving the realizability of implementing such systems on actual cars.

System Stability and Reliability: The system operated for extended periods continuously without crashes or false alarms during regular tests. False detection occurred at times under extreme lighting or when the face was out of camera view, reflecting the need for improved face-tracking for future enhancements.

CONCLUSION

The project "Automatic Braking Using Drowsiness Detection System" effectively illustrates a practical and effective method of improving road safety through monitoring driver alertness and automatically reacting to fatigue symptoms. Employing computer vision methods like facial landmark detection and Eye Aspect Ratio (EAR) analysis, the system can effectively detect drowsiness in real-time. When the driver does not react to initial signals, the incorporation of an IR sensor for detecting obstacles provides a secondary level of safety by ensuring that the automatic braking system is engaged only when it is needed.

The integration of drowsiness detection, driver alert systems, and automatic braking gives a complete safety solution that can assist in minimizing accidents due to driver fatigue. The system worked effectively under different test scenarios and was cost-effective and flexible enough for practical implementation. With additional development and testing, this system can be integrated into contemporary vehicles, particularly in the area of Advanced Driver Assistance Systems (ADAS)

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