AI IN AUTOMOTIVE INDUSTRY

(Driver Assist)

by

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Introduction

The advanced driver assistance systems (ADAS) are electronic systems that reduce the vehicle driver errors during driving or vehicle parking. Many ADAS systems are proposed that consists of adaptive cruise control (ACC), lane keeping assist system (LKAS) and driver monitoring system (DMS). The ACC system in the ADAS provides the ability to drive at a self-contained distance from the other vehicle at a speed set by the driver and it improves the ADAS stability. In LKAS, the system recognizes lanes by using a camera, and when a car changes a lane, the system can either operate the steering wheel by itself or put brake on the wheels to change the lane. The last and important subdivision of ADAS is DMS, which provides a function to check the driver's attention and gives warning when the driver tries to close the eyes for long time or keep the head pose in abnormal positions. The performance of ADAS depends on the ACC, LKAS and DMS results and the embedded board used in ADAS reduces the driver mistakes during driving time. How ever, the complexity of algorithm computation reduces the real time ADAS performance. To improve the ADAS performance in terms of system complexity, we propose a DMS optimization algorithm using camera images. The proposed DMS optimization algorithm uses driver's head pose and eye information for monitoring the driver's state. The proposed system identifies the driver state condition when the driver's head changes abnormally or the driver's gaze is not facing forward. The head pose and gaze features from the input images give driver's current state and the proposed system gives accurate driver state condition without any delays. The experiment result shows that the proposed system reduces the system complexity and gives accurate results for real time ADAS applications.

Driver Assist

Feature Although relatively few corporations are occupied on fully-automated replicas, a growing number of builders are facilitation in that way. By presenting features that assist the motorist without captivating the wheel, many businesses are taking a cautious method to AI-based features, while still rotating out vehicles with progressive safety features. Involuntary braking, crash avoidance systems, ordinary and cyclists' alerts, cross-traffic warnings, and intelligent cruise panels are some of the smaller features being motorized by AI. The willingness of automobile manufacturers to grow automated cars, transmission trucks, and other automobiles opens an affluence of new opportunities. Corporations that can put rubber to the street and revolutionize in this thrilling new bazaar will find asset dollars plenteous.

Advanced driver-assistance system

An advanced driver-assistance system (ADAS) is any of a group of electronic technologies that assist drivers in driving and parking functions. Through a safe human-machine interface, ADAS increase car and road safety. ADAS uses automated technology, such as sensors and cameras, to detect nearby obstacles or driver errors, and respond accordingly. ADAS can enable various levels of autonomous driving, depending on the features installed in the car.

As most road crashes occur due to human error, ADAS are developed to automate, adapt, and enhance vehicle technology for safety and better driving. ADAS are proven to reduce road fatalities by minimizing human error. Safety features are designed to avoid crashes and collisions by offering technologies that alert the driver to problems, implementing safeguards, and taking control of the vehicle if necessary. Adaptive features may automate lighting, provide adaptive cruise control, assist in avoiding collisions, incorporate satellite navigation and traffic warnings, alert drivers to possible obstacles, assist in lane departure and lane centring, provide navigational assistance through smartphones, and provide other features.

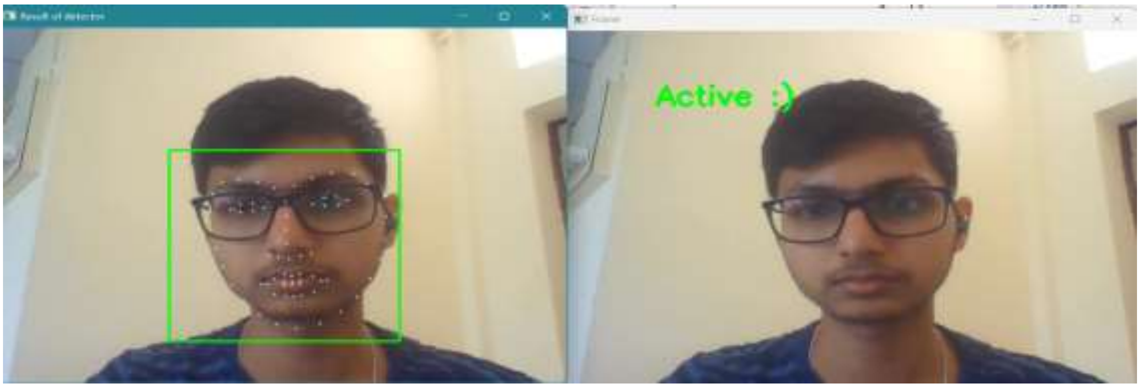
According to a 2021 research report from Canalys, approximately 33 percent of new vehicles sold in the United States, Europe, Japan, and China had ADAS features. The firm also predicted that fifty percent of all automobiles on the road by the year 2030 would be ADAS-enabled.

Driver Monitoring System

Driver Monitoring Systems (DMS) are becoming increasingly important in the automotive industry for improving road safety. AI plays a vital role in these systems by using computer vision algorithms to monitor the driver's behaviour, identify signs of fatigue, distraction, or drowsiness, and issue warnings or take appropriate actions to prevent accidents. AI in Driver Monitoring Systems is a promising area for improving road safety by detecting and mitigating driver fatigue, distraction, or drowsiness, ultimately reducing accidents and fatalities on the road.

Face and Landmark Detection

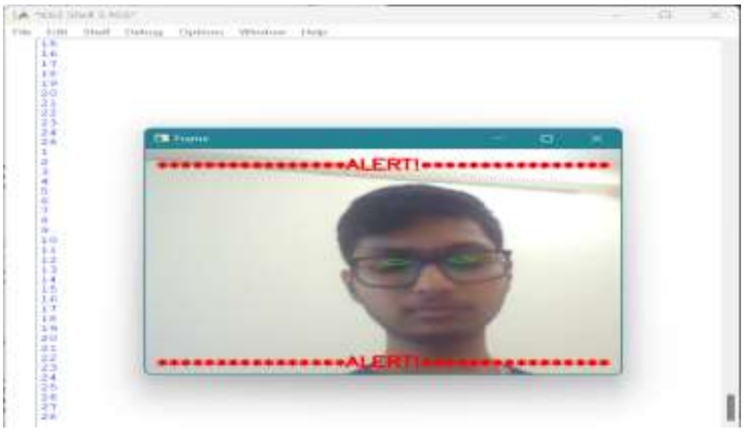
For the face and landmark detection, models of the dlib were used [2]. For more efficient landmark detection, the algorithm sets the face as the ROI (Region of Interest) from the first frame and subsequently tracks it instead of exploring the entire image in the following frames. In case the tracking process fails, face-redetection is performed at an interval of 30 frames. Finally, if more than one person are detected, only the person with the largest face image is identified as the driver.



Blink Detection

The area, width, and height of each eye are used as the main data for blink detection. When the eyes are closed, the area and height of the eyes decrease while the area of the face and width of the eye tend to remain at a similar level. Since these values can change rapidly depending how close to or far from the camera, the ratios in Equation 1 and 2 are used instead of using only the area and height for blink detection. For more accurate results, two ratios are calculated from each eye and a total of four ratios are obtained from one frame. If these ratios vary depending on drivers, it is difficult to make an accurate prediction based on a fixed value of the ratios. To overcome the potential error, the minimum and maximum ratios over the entire frames are constantly updated and every ratio is normalized.

As these normalized ratios were below 0.25 when the eyes were closed, the algorithm is designed to determine whether the eyes are closed in case once more than two of ratios are below the point.

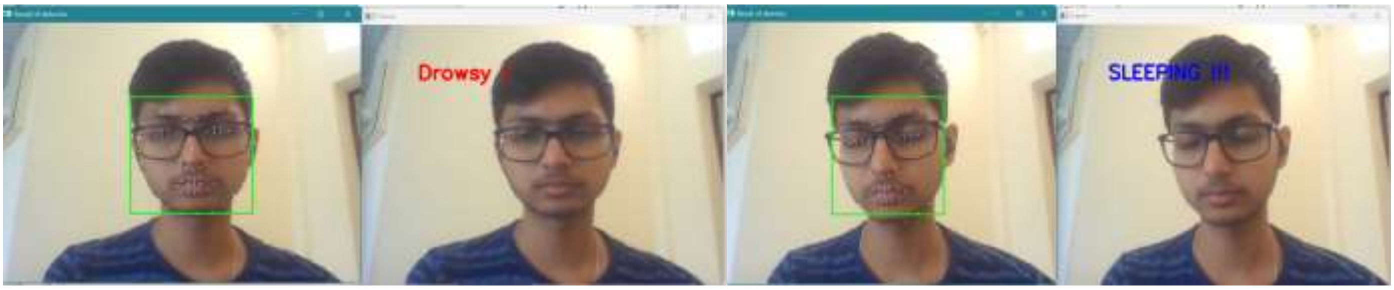


Gaze Estimation

Given the location of pupils is one of the reliable indicators to represent the direction of gaze, the algorithm finds the centre of the driver's pupils. To obtain accurate coordinates of both pupils, eye images are masked and only the centre area of each pupil appears white. Subsequently, the algorithm returns the coordinates of the centre of the pupils.

Result –

One participant participated in the algorithm evaluation, and the distance between the camera and the participants was maintained at 0.6m in consideration of the distance between the driver and the dashboard. Participants were asked to turn their heads, gaze to left and right, close their eyes, and lower their heads for a certain period of time. Figure below shows the prediction results of the DDDA.



Dataset Used – shape_predictor_68_face_landmarks.data

Conclusion –

In this paper, a driver's negligence is defined as the behaviour of closing eyes, and gazing sideward for 3 seconds. In addition, the DDA detects these behaviours and warns the driver in the case of detection. The algorithm determines the status of a driver based on facial movement, blinking, and pupil movement with landmark coordinates. This algorithm is expected to have strengths in the vehicle embedded environment in which resources are limited because the DDDA imposes much less burden with computational algorithms and sliding window technique in lieu of using a machine learning model for predictions. The algorithm needs to be improved because it fails to operate properly when a face is not detected being covered by hands or smartphone, and when inaccurate landmarks are extracted due to a distorted face shape caused by lowering the head too low. If the DDDA is improved by addressing the aforementioned problems, its performance will be significantly improved.

References

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GitHub Links –

akshaybahadur21/Drowsiness_Detection: A simple Drowsiness Detection module for humans. 😴 🚫 🚗 (github.com)

infoaryan/Driver-Drowsiness-Detection: A project using Dlib, OpenCV Python based on facial landmark detection. (github.com)