Vol. XV & Issue No. 12 December - 2022
INDUSTRIAL ENGINEERING JOURNAL

DROWSINESS DETECTION SYSTEM USING OPENCV AND HAAR CASCADE

Ms. Deeksha Yadav
Ms. Shivangi Pandey
Ms. Ankita Kumari
Ms. Smriti Rao
Ms. Deepti Ojha
Umesh Chandra Gupta
Paritosh Kumar
Dr. Ram Gopal

Abstract

Road accidents occur very often, but are the least desirable things that can happen to road users. Driver drowsiness and malaise are reportedly the most important causes of these accidents. Therefore, in order to prevent such accidents, it is necessary to take some measure. One such measure is driver drowsiness detection software that helps prevent traffic accidents. The software is based on a real-time system that continuously captures images, measures eye condition according to specified algorithms, and warns if necessary. Several OpenCv (Computational Vision) libraries, including Haar cascade, are used to implement this system. In addition, to ensure real-time calculations, Haar cascade samples are used to distinguish between blinking and drowsiness and malaise detection.

Keywords: Face detection, Eye Detection, Real-time system, Haar cascade, OpenCV, Drowsy driver detection, Image Processing, Image Acquisition.

1. INTRODUCTION

According to some reports, dozing driving has led to many accidents in recent years. Using technology to detect driver fatigue / drowsiness is an interesting challenge to help prevent accidents. In the last decade alone, many countries have begun to pay close attention to driver safety issues. Researchers have been working on detecting driver drowsiness using a variety of techniques, including: Physiological detection and road monitoring technology. Physiological detection techniques take advantage of the fact that human sleep patterns are highly correlated with brain and heart activity. However, all previous studies of this approach require the electrodes to be in contact with the driver's head, face, or chest, which is not feasible in real-world scenarios. Road surveillance is one of the most commonly used technologies; the system is based on this approach, with the Mercedes Attention Assist, Volkswagen Driver Alert System, Ford Driver Alert System, Volvo Driver Alert System. All of the above techniques monitor the road and driver behavioral characteristics to detect driver drowsiness. Some of the parameters used include whether the driver follows lane rules andthe proper use of turn signals. If these parameters deviate beyond acceptable levels, the system concludes that the driver is drowsy.

This article proposes a direct approach that uses a visual method-based detection technique. The main issues of the proposed method are-

(a) Development of real-time system,

(b) Face recognition,

(c) Iris recognition under various conditions such as driver position, eyeglasses, and presence/ absence of lighting

(d) Blinking detection and

(e) Economic efficiency.

The focus is on the development of real-time systems that accurately monitor the driver's eye open or closed. It is believed that eye monitoring can detect driver fatigue early and avoid car accidents. Fatigue detection involves observing eye movements and blinking patterns in a series of facial images extracted from live video.

In section 2, we study the working description of Drowsiness Detection System Using OpenCV and Haarcascade and System Design in section 3. The high level system flow chart studied in section 4 while their implementation discussed in section 5 respectively. Summary of results is briefly discussed in section 5 and their conclusion given in section 6.

2. WORKING DESCRIPTION

In the past, some important and vivid works were made to monitor and detect sleepiness. Some other programs for detecting driver status drivers have already been developed in real time. They were held with the help of the physical directive of the driver. Yawning, jaw drop, eye closure is some of the features of human fatigue. Cameras can usually clearly recognize the driver's face to recognize and analyze such features. Thus, conclusions from all these works are drawn that computer vision technologies are widely accepted to detect driver's face features to analyze fatigue.

Singh et al. a program for recognizing the eye blink duration was developed with the help of developed technology. Saito et al. Even if the driver is sleepy, use the technology to analyze his / her mental condition using the driver's vision path. Horn et al. It uses edge information-based technology to locate the eyes within the frame, including the full front face. The program then uses dynamic template matching to detect fatigue. Smith etc. We have built a program that predicts related features by tracking head and facial features using optical flow and color predicates. Vural et al. We programmed an automatic classifier for multiple facial features and used sporadic expressions to retrieve them from the Facing Action Coding system database, separating fatigue and driver perception from the feature stack. Vural et al. is developing a system that captures actual drowsiness facial movements and compares these features with the subject's perceived features in real time. It uses not only facial features, but also head movements, collects this data, and then applies automated measurements to compare the data to the subject's movements and classify whether the subject is sleepy. Jietal. recognizing multiple physical cues at the same time, arranging them in an organized pattern, and comparing those patterns with the existing known features of drowsiness and malaise, rather than using a single physical cue. The cue system used in the well-known Bayesian network suggests that it may lead to deeper, more distinctive and more accurate results

3. SYSTEM DESIGN

Figure 1, shows the various important blocks of the proposed system and their high level of interaction. You can see that this system consists of five different modules:

(a) Video capture,

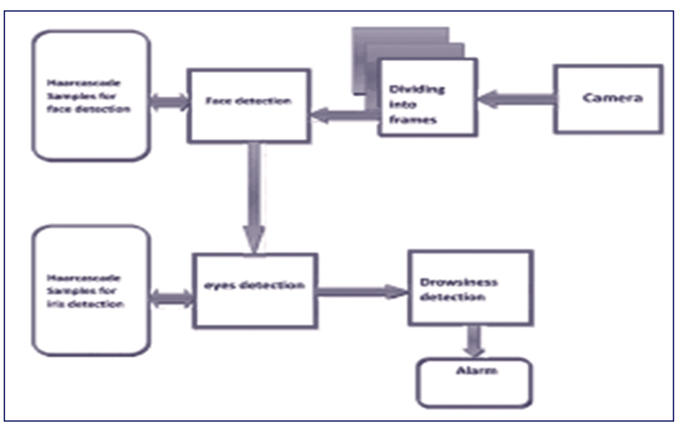
(b) Framing,

(c) Detection,

(d) Eye Detection, and

(e) Drowsiness Detection.

Fig. 1 Block Diagram of the System



In addition to these, there are two typical external hardware components: a camera for video capture and an audio alarm. The capability of every that modules may be defined as follows:

Video Capture: Video capture is primarily to capture the driver's live video feed. Video capture is achieved using a camera.

Framing: This module is used to take live video as input and convert it into a series of still images / images for processing.

Face recognition: The face recognition feature gets one frame at a time from the frames provided by the frame grabber and tries to recognize the driver's face in each frame. This is achieved by using a predefined set of Haarcascade samples.

Eye detection: When the face detection function detects the face of the car driver, the eye detection function tries to detect the eyes of the car driver. This is achieved by using a predefined set of Haarcascade samples.

Drowsiness detection: A function that detects whether the driver of a car feels drowsy by detecting the condition of the eyes after detecting the eyes of the driver of the car. Whether it is open or closed, the blinking speed is taken into account.

The proposed system uses the OpenCV library, so there is no minimum resolution requirement for the camera. Figure 2 shows a schematic diagram of the algorithm of the proposed system. With the proposed algorithm, the first video capture is achieved using an external camera placed in front of the driver. The captured video is converted into a series of still images. The next step is to detect the driver's face in each frame extracted from the video.

Now we will start by discussing face detection, as shown in Figure 2. It has two important functions:

(a) The ability to identify the area of interest, and

(b) The ability to detect faces from the a bove areas using Haarcascade.

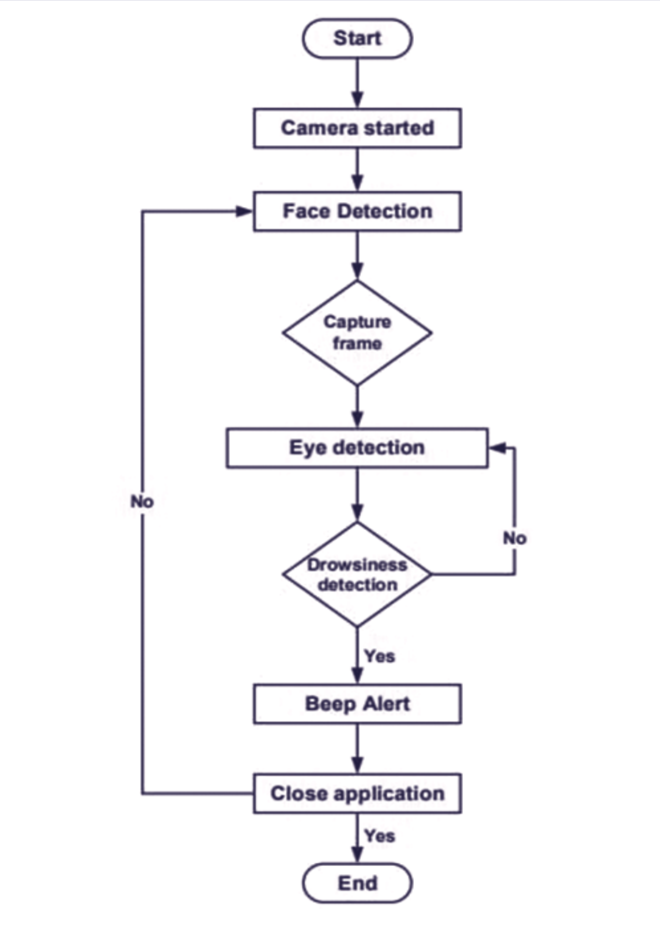
Mark areas of interest to avoid processing the entire image. By considering the area of interest, it is possible to reduce the amount of processing required and to speed up the processing, which is the main purpose of the proposed system.

4. HIGHLEVEL SYSTEM FLOW CHART

The camera focuses on the driver to capture the face, avoiding processing the image in the corners and significantly reducing the amount of processing. Wh e n the area of interest is recognized as a defined face, the area of interest becomes a face because the next step is eye recognition.

Instead of processing the entire face area to detect the eyes, mark the area of interest within the face area. This will further help you achieve the main goals of the proposed system. It then uses the Haarcascade xml file created for eye detection to detect eyes by processing only the areas of interest. Once the eyes are detected, the next step is to determine if the eyes are open / closed. This is done by extracting and examining the pixel values from the eye area. If it is recognized that the eyes are open, no action is taken. However, if a continuous closed eye for 2 seconds, that is, a certain number of frames is detected depending on the frame rate, this will make the driver drowsy and trigger an acoustic alarm. However, if the eyes are closed consecutively, this is declared as a blink.

Fig 2. Flow chart of the System



5. IMPLEMENTATION

The implementation details of each module can be described as follows:

5.1 One video recording: Open CV supports a wide range of live video capture and processing. You can also choose whether to capture the video from the built-in webcam or an external camera by setting the appropriate parameters. As mentioned earlier, OpenCV does not set a minimum camera requirement, but OpenCV expects a certain resolution of the recorded video by default. If the resolutions do not match, an error will be thrown. This error can be addressed by overriding the default value that can be achieved by manually specifying the resolution of the recorded video.

5.2 Split into frames: Once the video is captured, the next step is to split it into a series of frames / images. This was initially done in a two-step process. The first step is to capture the image from the camera or video file. In our case, the video is not saved, so the image is captured by the camera, and once that is achieved, the next step is to get the captured image. When retrieving, the image / frame will be decompressed first and then retrieved. However, the two-step process took a lot of processing time because the captured images had to be cached. Tosolve this problem, I came up with a one-step process where a single function captures a frame, decompresses it and returns it.

5.3 Face Detection: Once the frames have been successfully extracted, the next step is to detect the face in each of those frames. This is achieved by using the Haarcascade file for face recognition. The Haarcascade file contains many facial features such as, height, width and threshold of face colors. It is created using a set of positive and negative patterns. First load the cascading file for face recognition. It then passes the captured frame to an edge detection feature that finds all possible objects of different sizes within the frame. To reduce processing overhead, you can specify an edge detector to detect only objects of a specific size instead of finding objects of all possible sizes. This is because the driver's face occupies most of the image and determines its size based on the Haarcascade file. The output of the edge detector is now stored in the array. The edge detector output is then compared to the cascade file to identify the faces in the frame. Since the cascade consists of both positive and negative samples, you need to specify the number of failures that should be classified as negative samples for the detected objects.For this system, set this value to 3. This has achieved both accuracy and reduced processing time. The output of this module is the frame where the face was detected.

5.4 Eye Recognition: After recognizing the face, the next step is to detect the eye. This can be achieved by using the same technique as used for surface recognition. However, in order to reduce the process, we will mark the area of interest before you try to recognize your eyes. The region of interest is determined in mind, taking into account the following.

- The eye is only available at the top of the recognized face.
- The eye is a few pixels from the top of the face.

Random detection technology is applied only to regions of interest as soon as the region of interest is marked, which significantly reduces the amount of processing. Then use the same technique as face detection to detect the eyes and use the Haarcascade Xml file to detect the eyes. However, the output obtained was not very efficient, with two or more objects classified as positive samples and showing two or more eyes. To resolve this issue, the following steps are performed:

- From the discovered objects, the object with the largest surface area is determined. This is considered as the first positive sample.
- The object with the largest area is determined from the remaining objects. This is considered as the second positive sample.
- Checks if the two positive samples are not the same.
- Now make sure that the two positive samples are at least 30 pixels apart from each edge.
- Next, make sure that the two positive samples are at least 20 pixels apart.

Having passed the above test, we conclude that the two objects i.e. Positive sample 1 and Positive sample 2 which are the eyes of the driver.

5.5 Drowsiness Detection: Once the eyes are detected, the next step is to determine if the eyes are closed or open. This is achieved by extracting the pixel values from the eye area. After extraction, check if these pixel values are white, if it is white, it is determined that the eyes are open, and if the pixel value is not white, it is determined that the eyes are closed. This is done for each extracted frame. Depending on the frame rate, if it is detected that the eyes are closed for 2 seconds or a certain number of consecutive frames, the driver will be perceived as sleepy. If you find that you are closing your eyes in non-contiguous frames, declare it as a blink. When drowsiness is detected, a text message will be displayed and an audible alarm will be triggered. However, we have found that the system cannot run for a long time because it uses too much memory to convert the captured video from RGB to grayscale. To solve this problem, instead of converting the video to grayscale, we used only RGB video for processing. This conversion has the following benefits:

- Multi-channel colors are used to improve color distinction.
- Memory usage is negligible.
- You can also detect blinking when the driver is wearing glasses.

Therefore, there were two versions of the implemented system. Version 1.0 includes the conversion of images to grayscale. Currently version 2.0 uses RGB video for processing.

6. RESULT AND DISCUSSION

The tests were performed under different conditions, including:
1. Different lighting conditions.
2. Driver's posture and driver's face position
3. A driver with glasses.

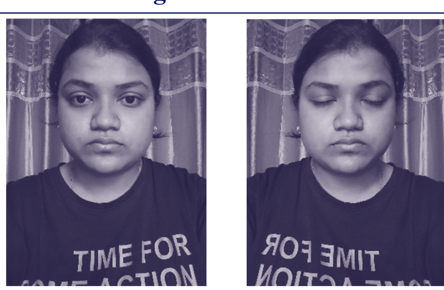
6.1 Test case 1: With ambient light

Fig. 3 Test Scenario #1 – Ambient lighting

Result: As shown in Figure 3, the face and eyes of the card driver are detected normally in the presence of ambient light.

6.2 Test case 2: Position of the car driver's face

6.2.1 Center Positioning



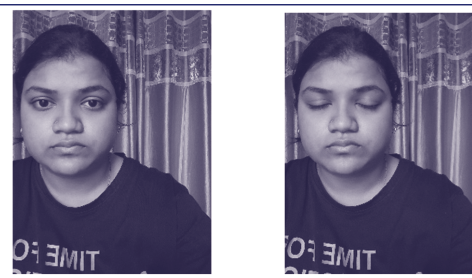
NORMAL FACE **BLINKING**

Fig 4. Test Scenario Sample#2 driver face in center of frame

SLEEPY

Results: Face, eyes, blinks, and drowsiness were successfully detected when the car driver's face was centered, as shown in Figure 4.

6.2.2 Right Positioned



NORMAL **FACEBLINKING**

Fig 5. Test Scenario Sample#3 – driver face to right of frame

SLEEPY

Result: Face, eyes, blinks, and drowsiness were successfully detected when the car driver's face was on the right side, as shown in Figure 5.

6.2.3 Left Positioned

Result: Face, eyes, blinks, and drowsiness were successfully detected when the car driver's face was on the left side, as shown in the Figure 6.

NORMAL **FACE BLINKING**

Fig 6. Test Scenario Sample#4- driver face to left of frame

SLEEPY

6.3 Test Case3: If the driver is wearing glasses

Fig 7. Test Scenario Sample#5 – Driver with spectacles

NORMAL **FACE BLINKING**

SLEEPY

Result: Face, eyes, blinks, and drowsiness were successfully detected when the car driver was wearing glasses, as shown in Figure 7.

7. CONCLUSION

The main goal of this project is to develop a real-time drowsiness monitoring system for automobiles. We have developed a simple system consisting of five modules:

(a) Video capture,

(b) Division into frames,

(c) Face detection,

(d) Eye detection, and

(e) Drowsiness detection.

Each of these components can be implemented individually, providing a way to structure the components based on your requirements.

The four features that distinguish our system from existing systems are:

(a) Driver's focus to detect drowsiness directly

(b) Real-time system to detect driver's face, iris, blinks and drowsiness

(c) A Completely non-intrusive system and

(d) Cost-effective

7.1 Limitations: Some of the proposed system restrictions are listed below.

- If the driver is wearing either type of sunglasses, the system will fail.
- The system will not operate if the camera is exposed to direct light.

7.2 Future Improvement: The developed system is particularly emphasized in real-time monitoring with prerequisites for requirements, adaptability, and improvement. Future improvement should be more planning, budget, and persons who have implemented them. There are recommended fields for future improvements:

- Stand-alone products: Automobile Automotive surveillance can be implemented as a stand-alone product that can be installed in a car.
- Smartphone application: Can be implemented as a smartphone application that can be installed on smartphones. The driver can also launch the application after placing the application in a position where the camera focuses on the driver.

REFERENCES

1. *Ruian Liu (2010), "Design of face detection and tracking system", Image and Signal Processing (CISP), 3rd International Congress on, vol.4, pp.1840-1844.*
2. *Xianghua Fan (2012), "The system of face detection based on OpenCV", Control and Decision Conference (CCDC), 24thChinese, pp.648-665.*
3. *Goel Pet.al. (2012), "Hybrid Approach of Haar Cascade Classifiers and Geometrical Properties of Facial Features Applied to Illumination Invariant Gender Classification System", Computing Sciences (ICCS), International Conference on, pp.132-136.*
4. *Parris J., et.al (2011), "Face and eye detection on hard datasets," Biometrics (IJCB), International Joint Conference on , vol., no., pp.1-10.*
5. *Xia Liu, Fengliang Xu, Fujimura K (2002), "Real-time eye detection and tracking for driver observation under various light conditions", Intelligent Vehicle Symposium, IEEE, vol. 2, pp.344-351.*
6. *Picot A. et.al (2012), "On-Line Detection of Drowsiness Using Brain and Visual Information", Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions, vol. 42, no.3, pp.764-775.*
7. *Ram Gopal, M Sunder Rajan, Priti Sharma, Abhinav K. Gautam (2020), "Dispersive nature of the FEL amplifiers*

in the whistler mode", Soft Computing: Theories and Applications, Springer, AISC, vol. 1154, pp 869-881.

8. *Ram Gopal, Abhisek Sharma, Sandeep Kumar Gupta, Edna Mello de Liz, Sayonara de Fátima Teston, Rabi Kumar (2020), "The Performance Improvement of an Automatic Tire Air Filed and Air Pressure Display System-An analysis of sustainability development", International Journal of Advanced Science and Technology(IJAST), vol. 29, no. 4s, pp. 1447-1457.*

9. *Ram Gopal, Serdar Vural UYGUN, Sandeep Kumar Gupta, Inna TsvihunLaodiceia Amorim Weersma, Rainu Gupta, Svetlana Ilinich (2019), "Sustainable Development and Intelligent Real-Time Vehicle Mileage Calculation Device: An Analysis", International Journal of Recent Technology and Engineering (IJRTE), vol. no. 8, no. 1S4, pp. 1043-1045.*

10. *Abhishek Sharma, Sandeep Kumar Gupta, Abhishek Pandey, Giridhari Paul, Biplab Kumar Sarkar, Ram Gopal (2019), "Four-Level Biometric Security System to Protect The Crucial Information from Unauthorized Access", International Journal of Recent Technology and Engineering (IJRTE), vol. no. 7, no. 5S4, pp. 767-772.*

11. *Ram Gopal and P. K. Jain, "Effect of axial magnetic field tapering on whistler-pumped FEL amplifier in collective Raman regime operation (2018)," International Journal of Engineering & Technology, vol. 7, no. 4, pp. 2044-2050.*

12. *Ram Gopal and P. K. Jain (2018), "Effect of axial magnetic field tapering on whistler-pumped FEL amplifier in collective Raman regime operation," International Journal of Engineering &Technology, vol. 7, no. 4, pp. 2044-2050.*

13. *Ram Gopal and P. K. Jain (2018), "Design methodology and simulation study of a free electron laser amplifier", International Journal of Engineering & Technology, vol. 7, no. 4, pp. 3175-318.*

14. *Ram Gopal and P. K. Jain (2018), "Tapering effect of an axial magnetic field on whistler-pumped FEL Amplifier", Engineering Science and Technology: an International Journal, vol.8, no.2, pp. 4-10.*

15. *Yashvir Singh, Abhishek Sharma, Pankaj Rastogi, Sandeep Kumar Gupta, Ram Gopal (2019), "Performance and emission analysis on direct injection diesel engine implementing MADHUKA INDICA biodiesel with aluminum oxide nanoparticles", International Journal of Ambient Energy, Taylor & Francis, 14 August.*

16. *Sandeep Kumar Gupta, Rainu Gupta, Vivek Srivatava, Ram Gopal(2019), "The digitalization of the monetary system in India: Challenges and significance for economic development", Journal of Emerging Technology and Innovative Research, vol. 6, no. 3, pp. 1-4.*

17. *Ram Gopal, Anand Gandhi Patel and Vikas Mishra(2012), "An effect of Plasma physics in High Power Microwave Modules and Terahertz Devices", Anvikshiki, the Indian Journal of Research, vol. 6, no. 2, pp. 139-153.*

18. *Ram Gopal, Anand Gandhi Patel and Avadh Pati (2012), "An Analysis of Synchronous Coherent Optical Code Division Multiple Access (OCDMA) Network", Anvikshiki, the Indian Journal of Research, vol. 6, no. 2, pp. 88-101.*

19. *Ram Gopal, Jitendra Kumar and Anand Gandhi Patel (2012), "The Performance Analysis of High Speed Permanent Magnet AC Synchronous Drives Using Digital Signal Processing", Anvikshiki, the Indian Journal of Research, vol. 6, no. 2, pp.*

AUTHORS

Ms. Deeksha Yadav, Ms. Shivangi Pandey, Ms. Ankita Kumari, Ms. Smriti Rao, B. Tech, Department of ECE, Institute of Technology and Management, GIDA Gorakhpur (India)

Ms. Deepti Ojha, Assistant Professor, Department of ECE, Institute of Technology and Management, GIDA Gorakhpur (India)

Umesh Chandra Gupta, Assistant Professor, Department of ECE, Institute of Technology and Management, GIDA Gorakhpur (India)

Paritosh Kumar, Assistant Professor, Departmentof ECE, Institute of Technology and Management, GIDA Gorakhpur (India)

Dr. Ram Gopal, Corresponding Author, Associate Professor, Department of ECE, Institute of Technology and Management, GIDA Gorakhpur (India), e-mail: ramgopal.iitbhu@gmail.com