DRIVER SLEEP DETECTION USING DEEP NEURAL NETWORKS

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Abstract. . Driver errors and carelessness contribute most of the road accidents occurring nowadays. The major driver errors are caused by drowsiness, drunken and reckless behavior of the driver. In this context our paper exploring the vehicle drivers attention in terms of sleep mode and attentive mode detection using AI methods of detecting the various parts of human face with advanced technology of human computer interaction tool and deep learning application . The system uses a small security camera that points directly towards the driver's face and monitors the driver's eyes in order to detect fatigue. In such a case when fatigue is detected, a warning signal is issued to alert the driver. The system deals with using information obtained for image to find the edges of the face, which narrows the area of where the eyes may exist. In this paper we present some of review work on the openCV and deep learning face detection methods.

Keywords: face detection · human computer interaction · eye detection.

1 Introduction

Drivers who do not take regular breaks when driving long distances run a high risk of becoming drowsy, a state which they often fail to recognize early enough according to the experts. The system uses a small security camera that points directly towards the driver's face and monitors the driver's eyes in order to detect fatigue. In such a case when fatigue is detected, a warning signal is issued to alert the driver. The system deals with using information obtained for image to find the edges of the face, which narrows the area of where the eyes may exist. Once the face area is found, the eyes are found by computing the horizontal averages in the area. Taking into account the knowledge that eye regions in the face present great intensity changes, the eyes are located by finding the significant intensity changes in the face. Once the eyes are located, measuring the distances between the intensity changes in the eye area determine whether the eyes are open or closed. A large distance corresponds to eye closure. If the eyes are found closed for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep and issues a warning signal. The system is also able to detect when the eyes cannot be found, and works under reasonable lighting conditions.

Studies show that around one quarter of all serious motorway accidents are attributable to sleepy drivers in need of a rest, meaning that drowsiness causes more road accidents than drink-driving. Driver sleep detection is a car safety technology which prevents accidents when the driver is getting drowsy. The analysis of face images is a popular research area with applications such as face recognition, virtual tools, and human identification security systems. The aim of this project is to develop a prototype sleep detection system. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns. (see Reference1.)

1.1 Reviews on Driver Face Monitoring System For Fatigue And Distraction Detection

Improvement of public safety and the reduction of accidents are of the important goals of the Intelligent Transportation Systems (ITS). One of the most important factors in accidents, especially on rural roads, is the driver fatigue and monotony. Fatigue reduces driver perceptions and decision making capability to control the vehicle. Researches show that usually the driver is fatigued after 1 hour of driving. In the afternoon early hours, after eating lunch and at midnight, driver fatigue and drowsiness is much more than other times. In addition, drinking alcohol, drug addiction, and using hypnotic medicines can lead to loss of consciousness [1, 2]. In different countries, different statistics were reported about accidents that happened due to driver fatigue and distraction. Generally, the main reason of about 20The driver face monitoring system is a real-time system that investigates the driver physical and mental condition based on the processing of driver face images. The driver state can be estimated from the eye closure, eyelid distance, blinking, gaze direction, yawning, and head rotation. This system will alarm in the hypovigilance states including fatigue and distraction. The major parts of the driver face monitoring system are (1) imaging, (2) hardware platform, and (3) the intelligent software.

Techniques for detecting drowsiness:

• Possible techniques for detecting drowsiness in drivers can be generally divided into the following categories: sensing of physiological characteristics, sensing of driver operation, sensing of vehicle response, monitoring the response of driver.

• A video camera placed inside the car is continuously filming the driver's face during the ride.

• A detection system analyses the movie frame by frame and determines whether the driver's eyes are open or shut. If the eyes are shut for more than $\frac{1}{4}$ a second (longer than a normal blink period) then the systems beeps to alert the driver.

System Configuration:

• Background and Ambient Light:-

Because the eye tracking system is based on intensity changes on the face, it is crucial that the background does not contain any object with strong intensity changes. Highly reflective object behind the driver, can be picked up by the camera, and be consequently mistaken as the eyes. Since this design is a prototype, a controlled lighting area was set up for testing. Low surrounding light (ambient light) is also important, since the only significant light illuminating the face should come from the drowsy driver system. If there is a lot of ambient light, the effect of the light source diminishes. The testing area included a black background, and low ambient light (in this case, the ceiling light was physically high, and hence had low illumination). This setup is somewhat realistic since inside a vehicle, there is no direct light, and the background is fairly uniform.

• Camera:-

The drowsy driver detection system consists of a CCD camera that takes images of the driver's face. This type of drowsiness detection system is based on the use of image processing technology that will be able to accommodate individual driver differences. The camera is placed in front of the driver, approximately 30 cm away from the face. The camera must be positioned such that the following criteria are met: 1. The driver's face takes up the majority of the image. 2. The driver's face is approximately in the center of the image.

• Light Source:-

For conditions when ambient light is poor (night time), a light source must be present to compensate. Initially, the construction of an infrared light source using infrared LED was going to be implemented. It was later found that at least 50 LEDs would be needed so create a source that would be able to illuminate the entire face. To cut down cost, a simple desk light was used. Using the desk light alone could not work, since the bright light is blinding if looked at directly, and could not be used to illuminate the face. However, light from light bulbs and even daylight all contain infrared light; using this fact, it was decided that if an infrared filter was placed over the desk lamp, this would protect the eyes from a strong and distracting light and provide strong enough light to illuminate the face. A wideband infrared filter was placed over the desk lamp, and provides an excellent method of illuminating the face. (see Reference 1 and reference 2)

2 Proposed Method

2.1 Dataset and preprocessing

Assuming that the person's face is approximately in the center of the image, the initial starting point used is (100,240). The starting x-coordinate of 100 was chosen, to insure that the starting point is a black pixel (no on the face). The following algorithm describes how to find the actual starting point on the face, which will be used to find the top of the face.

1. Starting at (100,240), increment the x-coordinate until a white pixel is found. This is considered the left side of the face.

2. If the initial white pixel is followed by 25 more white pixels, keep incrementing x until a black pixel is found.

3. Count the number of black pixels followed by the pixel found in step2, if a series of 25 black pixels are found, this is the right side.

4. The new starting x-coordinate value (x1) is the middle point of the left side and right side.

Once the top of the driver's head is found, the sides of the face can also be found. Below are the steps used to find the left and right sides of the face.

1. Increment the y-coordinate of the top (found above) by 10. Label this y1 = y + top.

2. Find the center of the face using the following steps: i. At point (x1, y1), move left until 25 consecutive black pixels are found, this is the left side (lx). ii. At point (x1, y1), move right until 25 consecutive white pixels are found, this is the right side (rx). iii. The center of the face (in x-direction) is: (rx − lx)/2. Label this x2.

3. Starting at the point (x2, y1), find the top of the face again. This will result in a new y-coordinate, y2.

4. Finally, the edges of the face can be found using the point (x2, y2).

2.2 Deep neural network

An explanation is given here of the eye detection procedure. After inputting a facial image, pre-processing is first performed by binarizing the image. The top and sides of the face are detected to narrow down the area of where the eyes exist. Using the sides of the face, the center of the face is found, which will be used as a reference when comparing the left and right eyes. Moving down from the top of the face, horizontal averages (average intensity value for each y coordinate) of the face area are calculated. Large changes in the averages are used to define the eye area.

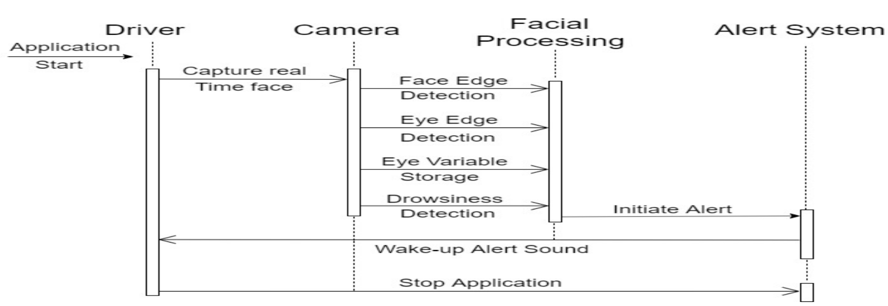

Fig. 1. Sequence Diagram

3 Experimental Results

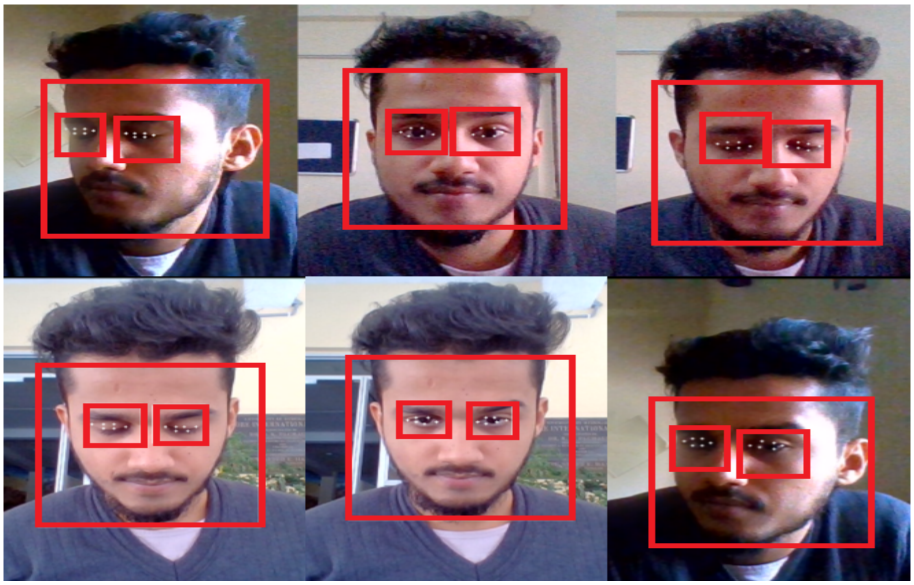

Fig. 2. (a) Driver is sleeping in low light, (b) Driver is awake in mid light, (c) Driver is sleeping in mid light, (d) Driver is sleeping in high light, (e) Driver is awake in highlight, (f) Driver is awake in low light
(see Reference 3 and 4)

4 Conclusion

Implementation of drowsiness detection with Python was done which includes the following steps: Successful runtime capturing of video with camera. Captured video was divided into frames and each frames were analyzed. Successful detection of face followed by detection of eye. If closure of eye for successive frames were detected then it is classified as sleepy condition else it is regarded as normal blink and the loop of capturing image and analyzing the state of driver is carried out again and again. In this implementation during the drowsy state the eye is not surrounded by square or it is not detected and corresponding message is shown. If the driver is not drowsy then eye is identified.

Acknowledgement we have done various miniprojects in Advanced operating system course , among these projects one miniproject is "Driver sleep Detection". we would like to express our special thanks of gratitude to Dr.M Nagamani for her guidance and support in understand how to achieve abstraction.Also, we are appreciating the hard work of the contributors. Also,we would like to thanks School of computer and Information Sciences(SCIS) for providing an environment to work smoothly without any interruption.

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