Driver Drowsiness Detection using Face Monitoring and Pressure Measurement

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Abstract
Fatigue driving is the driver, after long periods of continuous driving, experiences mental and physical functional disorder. The international statistics shows that it is one of the major causes of accidents in the world. Detecting the drowsiness of the driver can issue timely warning that could help in preventing many accidents. In this research a system is designed to detect the drowsiness of a driver through face monitoring techniques and pressure measurement. The proposed approach is divided into two steps: detecting driver’s physiological performance and measuring the driver’s state. Physiological performance can be measured through pressure measurement using a force sensitive resistor. The second step is a computer vision method done by image processing. The computer vision method captures images and detects yawn and eye state. The results collected from the two of the above steps are merged with a drowsiness evaluation technique to detect drowsiness. The algorithm is proposed, implemented and tested and the experimental results provide a promising drowsiness indicator to prevent road accidents.

Keywords: Fatigue detection, drowsiness, face detection, eye detection, pressure sensor, viola-jones algorithm

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INTRODUCTION
Sleep deprivation and sleep disorders are becoming one of the common problems of road accidents these days. A significant portion of the accidents occurring on highways is due to driver fatigue. A system that can detect oncoming driver fatigue and issue timely warnings could help prevent many accidents, and consequently save money and reduce suffering. According to available statistical data, over 1.3 million people die each year on the road and 20 to 50 million people suffer non-fatal injuries due to road accidents [9]. Based on police reports, the US National Highway Traffic Safety Administration (NHTSA) conservatively estimated that a total of 100,000 vehicle crashes each year are the direct result of driver drowsiness. These crashes resulted in approximately 1,550 deaths, 71,000 injuries and $12.5 billion in monetary losses [10].

Bangladesh has a very high road accident fatality rate with official figures indicating more than 60 deaths per 10,000 motor vehicles [8]. Everyday around eight persons die in road accidents. The actual rate of fatality is likely to be even higher. The problems related to the accident reporting system and the data derived from it, as reported by Quium [8], have not been resolved and official statistics are prone to under reporting. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects.

This paper proposed a drowsiness detection system using face monitoring techniques which are extracting features from the face and detect eye and yawn state and measuring pressure using a sensors. Description of the proposed approach is given in section III and the experimental data is shown in section V.

LITERATURE REVIEW
The drowsiness detection can be divided into 3 main categories [11].
Biological Indicators
Measures biological indicators such as brain waves, heart rate. Best detection accuracy. Require physical contact with the driver.

Vehicle Behavior
Measures vehicle behaviors such as speed, turning angle [11]. Have several limitations such as the vehicle type, driver experience and driving conditions.

Face Analysis
Human face is dynamic and has a high degree of variability. Face detection is considered to be a difficult problem in computer vision research. Human eyes play an important role in face recognition and facial expression analysis.

PROPOSED APPROACH
This work focuses in providing a solution that detects and monitors vigilance of the operator working behind the workstation. It consists only of a low budget webcam to capture the image, a pressure sensor to measure the pressure and then it will be analyzed by our program. The system detects drowsiness on basis of eye state, yawning and pressure rate and calculates drowsiness.

Flowchart of the proposed method has been shown in Figure 1.

![Flowchart of the Proposed Approach](image-url)

**Fig. 1:** Flowchart of the Proposed Approach.
These approaches will be followed:
- Capture image from the webcam.
- Detect and Extract feature from the face.
- Detects eye and measure the iris size.
- Detects mouth and measure yawing state.
- Calculate pressure from the pressure sensor.
- Store the data to the database.
- Combine the data to give result.

IMPLEMENTATION
There are 120 different kinds of face images used in my experiment. And pressure is measured for exactly 2mins. Finally there’s 2 minutes of drowsy dataset for this experiment.

Face Feature Extraction
For face detection the first step is to load the image. Then using the image processing toolbox face is detected. Here Cascade Object Detector of viola-jones algorithm is used. Here FrontalFaceLBP mode is used. Then the face is separated from the original image. The face is shown by a boundary box as shown in the Figure 2.

Eye State Measurement
To measure the state of the eye whether the driver’s eyes are closed or open or nearly close state. Took the cropped eye image and masked the image for morphological operation. Complement the image and filled necessary holes. Disk shaped structuring element is used to erode the image. After the erosion, A boundary function is used to get the boundary value of the circular objects i.e. iris and draw the boundaries. After extracting the region properties of the boundary values, calculate the parameter using the following equation

boundary = B{k};

delta_sq = diff(boundary).^2;

perimeter =

sum(sqrt(sum(delta_sq,2)));………..               (1)

Using the statistics taken from the region properties function, I calculated the area.

area=stats(k).Area; ...............................   (2)

where, k = 1,2,3…………length(B)

Then the following matric equation is used to get the value of the objects. This matric would tell if the objects are round or in other shape.

metric = 4*pi*area/perimeter^2;…………  (3)

Round objects will give a value closer to 1. And other objects will give a lesser value (Figure 3).
Yawn Detection
Took the cropped mouth image and masked the image so for morphological operation. Diamond shaped structuring element to erode the image. After the erosion detect the mouth edge using Laplacian of Gaussian method. To measure the widths simply subtract the leftmost maximum pixel from the rightmost pixel and get the value (Figure 4).

\[ y_2 = \text{max}(\text{column}); \]
\[ y_1 = \text{min}(\text{column}); \]
\[ w = y_2 - y_1; \]

To measure the heights simply subtract the upmost maximum pixel from the lower pixel and get the value.

\[ x_2 = \text{max}(\text{row}) \]
\[ x_1 = \text{min}(\text{row}) \]
\[ h = x_2 - x_1; \]

Pressure Measurement
For pressure measurement, following tools are needed:
Arduino, Force sensitive resistor 0.5, bread board, wires, cable (Figure 5).
Drowsiness Evaluation

Drowsiness can be detected using the scenarios in Table 1.

RESULTS AND ANALYSIS

The Driver drowsiness detection result are calculated by finding number of truly drowsy face detected and the false face detected. By Using Eye, the calculated accuracy is 87.87% and by using mouth calculated accuracy is 92.30% shown in table II. In the table III, the drowsy face detected manually and the accuracy 88.571% calculated.

Results and their analysis are given in Tables 2 to 4.

A comparison between yawn, eye and pressure state of drowsiness is given in Figure 6.

<table>
<thead>
<tr>
<th>Eyes Closed (3-4se)</th>
<th>Yawning (0-60s)</th>
<th>Pressure (~5secs)</th>
<th>Drowsy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes (low)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes (low)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes (High)</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes (High)</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes (Low)</td>
<td>Maybe</td>
</tr>
</tbody>
</table>

Table 1: Drowsiness Evaluation.

<table>
<thead>
<tr>
<th>Feature</th>
<th>No of images</th>
<th>Detected</th>
<th>Total Drowsy faces</th>
<th>Drowsy Face found</th>
<th>False Detection</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye</td>
<td>120</td>
<td>120</td>
<td>33</td>
<td>31</td>
<td>2</td>
<td>87.87%</td>
</tr>
<tr>
<td>Mouth</td>
<td>120</td>
<td>120</td>
<td>13</td>
<td>13</td>
<td>1</td>
<td>92.30%</td>
</tr>
</tbody>
</table>

Table 2: Data based on Eye and Yawn State.

<table>
<thead>
<tr>
<th>Total Face (According to Time)</th>
<th>Total Drowsy Face</th>
<th>Drowsy Face Detected Manually</th>
<th>Accuracy of Drowsy Faces</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>31</td>
<td>35</td>
<td>88.571%</td>
</tr>
</tbody>
</table>

Table 3: Data Based on Drowsy Faces.

Fig. 4: Comparison Graph Between Yawn State, Eye State and Combination of Eye, Yawn and Pressure.
**Table 4:** Data Based on Drowsiness.

<table>
<thead>
<tr>
<th>Total Time (sec)</th>
<th>Drowsiness detected manually</th>
<th>Total Drowsiness Detected (eye and Yawn)</th>
<th>Accuracy of Drowsiness (Eye and Yawn)</th>
<th>Chances of Drowsiness (Adding Pressure)</th>
<th>Accuracy of Drowsiness (Eye, Yawn and Pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
<td>10</td>
<td>4</td>
<td>40%</td>
<td>4</td>
<td>88.571%</td>
</tr>
</tbody>
</table>

**Table 5:** Comparison Between Drowsiness Detection Systems.

<table>
<thead>
<tr>
<th>References</th>
<th>Component</th>
<th>Glasses</th>
<th>Sensor Used</th>
<th>Dependent on lighting conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>[12]</td>
<td>Eye</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>[9]</td>
<td>Mouth</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>[6]</td>
<td>Eye</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>[4]</td>
<td>Eye, Eyebrow, Mouth</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Proposed Method</td>
<td>Eye, Mouth, Pressure</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Comparison between proposed method and different methods are shown in this Table 5.

**CONCLUSION**

In this, a driver’s drowsiness detection system has been proposed using viola-jones object detection techniques. The proposed system is based on eyes closer, yawning and pressure measurement of the driver. System can be improved in many dimensions such as some more sensors like motion sensor, vehicle’s steering angle to get the better vigilance status of the driver. The warning system should be modified to either stop the car slowly or make some vibrations to wake up the driver.

**REFERENCES**


Cite this Article