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Prevention of Road Accident by Implementing the Driver Drowsiness Detection and Driver Alert System

S. Razaul Karim Raju [1,], Md. Abu Bakkar Sikder[2], Rishikesh Chowdhury[2]*

[1] Department of Industrial Engineering and Management, Khulna University of Engineering and Technology, Khulna, Bangladesh
[2] Department of Mechanical Engineering, Chittagong University of Engineering and Technology, Chattogram-4349, Bangladesh.

ABSTRACT

Nowadays, one of the main reasons for traffic accidents that result in fatalities, serious injuries, and large financial losses is driver fatigue. The challenge for researchers is to develop an accurate fatigue detection system that will maintain an eye on physical conditions and ensure that drivers are paying attention. This study presents a smart and flexible real-time vehicle safety prototype capable of detecting driver fatigue and implementing preventive measures before an accident happens. The suggested approach tracks fatigue indicators using an eye-blink sensor built into spectacles. When the system detects the driver's tiredness, it swiftly stops the vehicle, triggers a buzzer, and displays a "Danger" notice to alert other drivers and passengers regarding the driver's status. Once the driver is back to normal, the system stops the alarm and permits the vehicle to safely resume movement. So, the accuracy of the system is more than 80%. The percentage of accuracy at night is more than at day light. The purpose of the system is not only to alert the driver and surrounding individuals but also to actively prevent accidents by controlling vehicle under fatigue conditions. This study aids in decreasing traffic accidents, boosting driver alertness, and improving overall road safety.

Keywords: Driver Drowsiness Detection, Intelligent Vehicle Safety, Eye-Blink Sensor, Fatigue Monitoring, Accident Prevention.

1. Introduction

Driver fatigue is a significant issue that contributes to numerous road accidents annually. It is not possible to calculate the exact number of drowsy-related accidents, but research shows that driver fatigue may be a contributory factor in up to 20% of road accidents and up to one quarter of fatal and serious accidents [1]. These types of crashes are about 50% more likely to result in death or serious injury, as they tend to be high-speed impacts because a driver who has fallen asleep cannot brake or swerve to avoid or reduce the impact. Drowsiness reduces reaction time (a critical element of safe driving) [2]. It also reduces vigilance, alertness, and concentration so that the ability to perform attention-based activities (such as driving) is impaired. The speed at which information is processed is also reduced by sleepiness. The quality of decision-making may also be affected. The primary purpose of the Driver Drowsiness Detection is to develop a technique that can reduce the number of road accidents due to the drowsiness of drivers while driving. The implementation of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident-avoidance systems. The aim of this project is to develop a prototype that can detect the drowsiness of drivers or the driver who is drunk. The target will be to devise a technique that accurately detects the open or closed state of the driver's eyes in real-time. In recent times, amazing advanced vehicles have been invented in the world. These cars are more advanced than ever. But nowadays, due to driver drowsiness, accidents are increasing day by day. Driver Drowsiness and then they do rash driving as if they do not have control over themselves. Drowsy driving increase road crashes by 1.29 to 1.34 times higher than driving without sleepiness [3]. To reduce that kind of incident, we scheme a system which will detect driver drowsiness. In the detecting stage, the eye blink sensor always monitors the eye blink moment. It continuously monitors eye blinks. At first, the sensor measures the open value of eyes of the driver and then it will take the closed value of eyes of the driver [4]. Then the threshold value will be measured, and then the vehicle will be ready to start. The vehicle will remain in running condition until it finds any fatigue. If the driver is found in drowsy condition, it can be detected from the output of the eye blink sensor and then the buzzer will start buzzing, display will show the 'Dangerous' message and vehicle will stop automatically [5]. The driver could start the vehicle again when he gets back to normal condition, and the alarm will stop immediately.

1.1 Objectives and Problem Definition

The present study aims to:

1. Design a simple, camera-free, sensor-based system for detecting drowsiness through analysis of eye-blink detection.
2. Develop an audible and visual alert mechanism to notify both driver and surroundings during fatigue onset.

The problem addressed is the absence of a low-cost, easily deployable fatigue-detection device capable of both warning the driver and initiating corrective action in real time.

1.2 Road Accidents in Bangladesh

According to World Bank research, road accidents in Bangladesh cost the country about Taka 5,000 crore annually, nearly one percent of the GDP. In 2023, the BRTA Accident Monitoring Cell recorded 5,495road accidents across the country that caused 5,024 deaths and 7,495 serious injuries [6]. 6,927 traffic accidents occurred in Bangladesh in 2024, leading to 12,019 injuries and 7,294 fatalities [7]. 35.76% of fatalities used motorcycles, and the most accidents and fatalities recorded in the Dhaka division. According to the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), about one-fifth of the injury-related admissions in Bangladesh hospitals are due to traffic accidents. About 15 percent of disabilities are caused by these accidents [8]. According to a 2008 Accident Research Centre survey of BUET, there are 54 accident-prone spots in Dhaka city. The number of fatalities is just the tip of the iceberg. In the name of rendering transport services, all modes of public transport of the city are enjoying a free rein, where they generally do not abide by the traffic laws and where they just get away with murder, as the law enforcers remain mysteriously silent about them. Instead of the traffic police, public transport vehicles, often not roadworthy, control the traffic movement pattern in the capital. The Daily Star brought out this special jacket to pinpoint various dimensions of traffic traumas caused by unfit vehicles and reckless driving.

2. Methodology And Implement

This project aims to develop an automated and adaptive drowsiness-detecting system for vehicles that provides high security to drivers, passengers, and other nearby vehicles, designing an eye blink sensor on spectacles, which continuously counts the number of times the eye blinks and observe the reading of eyes. The eye blink sensor counts the opened and closed states of the eyes and then measures a threshold value as a standard value for eye blinks. It will make a decision according to the threshold value. If the eye blink count increases, that means the driver is drowsy (that means sleepy) at that time, then the buzzer will start buzzing, the display will show the ‘Danger’ message, and the vehicle will stop automatically. This paper involves measuring the eye blinks using an IR sensor. There are two sections in the IR sensor. The IR transmitter is used to transmit the infrared rays to our eyes. The IR receiver is used to receive the reflected infrared rays of the eye. If the eye is closed, then the output of the IR receiver is higher than the threshold value; otherwise, the IR receiver output is lower than the threshold value. Thus, we could know whether the eye is in a closed or open position under that condition. In the transmitter section, an eye blink sensor is placed near the eye to sense the blink count, and this information is transmitted in the form of pulses and is given to the ATMEGA328P-PU Microcontroller [9]. The ATMEGA328P-PU processor uses this information to compare with the normal eye blink programmed in the chip and if the driver is found in drowsy condition, the vehicle is stopped with a buzzer indication and shown a “Danger” message on LCD, this operation is enabled by means of the driver circuit connected to the vehicle motor and the signal is transmitted via RF-transmitter at the frequency of 433.92 MHz’s [10]. In the Receiver section, the transmitted signal is received, and the signal is decoded and given to the Microcontroller, which uses this information for displaying the alert message in the LCD as programmed. Simultaneously, a buzzer alert is given the vehicle is stopped immediately. A L293D IC is used to control the motor, which is the major part of this project, and acts as a vehicle that is also connected to the Microcontroller and works according to the signal.

The block diagram of the driver drowsiness detection system is given in the Figure 1.

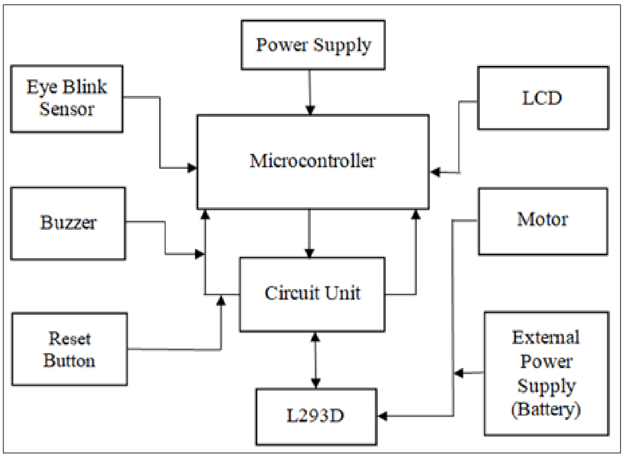

Fig 1: Block Diagram of Driver Drowsiness Detection System

2.1 Setup of Drowsiness Detection

To implement the project, we have designed an eye blink sensor on glasses that continuously detects the number of times the eye blinks and determine the reading of eyes. All the instruction is shown on the LCD, which helps the user to use the device. We use a motor that is controlled by an L293D IC that acts as a vehicle. The open and closed value of eye blinks is counted, and then the vehicle will be ready to start running. The vehicle will remain in running condition until it finds any fatigue. If the eye blink count increases, that means the driver is sleepy. In that case, the buzzer will start buzzing, the LCD display will show the ‘Dangerous’ message, and the motor will stop automatically. If the user gets back to normal condition, then the buzzer will stop buzzing and the motor will start to run again. All the information in real-time will be shown on the LCD display so that the passengers can be alerted about the driver's physical condition. The whole setup of the prototype is shown in Figure 2

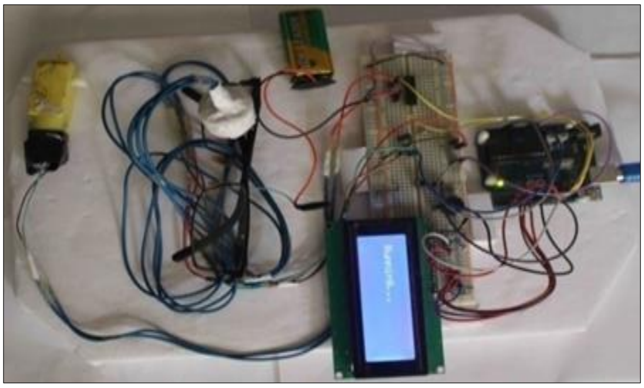

Fig. 2: Proto-type of driver drowsiness detection system

2.2 System Flowchart

The flowchart of the major functions of the drowsy driver detection system is shown in the Figure 3.

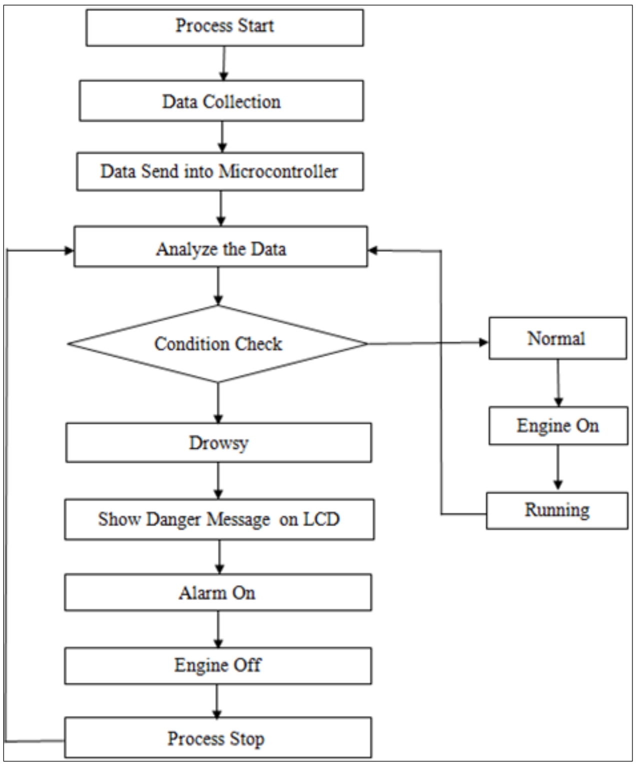

Fig.3.Flow chart of the driver drowsiness detection system

2.3 Component List

This design is comprised of two types of components. One is the structural components that are not related to power transmission directly. Another is the electrical components that are directly related to the power generation. All the structural and the electrical components that are required to construct the driver drowsiness detection system setup is demonstrated in the Figure 4, Where (a) Arduino Board with ATMEGA328P; (b) Eye glass that is a module of eye blink detection; (c) IR sensor; (d) LCD; (e) DC Motor; (f) Buzzer which acts as alarm system

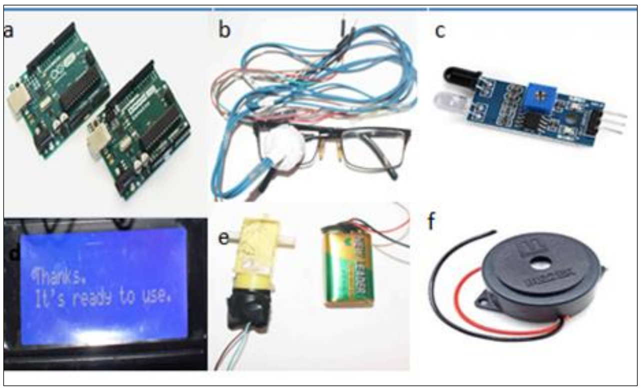

Fig.4: (a)Arduino Board; (b)Eye glass; (c)IR Sensor; (d)LCD; (e)DC Motor; (f)Buzzer

a. Arduino board: Arduino is an open-source prototyping platform based on easy-to-use hardware and software.
b. Eye glasses: It is necessary to find the blinking of the eye, since it is used to drive the project and to operate the system.
c. Infrared transmitter (IR sensor): It is one type of LED that emits infrared rays, generally called an IR Transmitter. Similarly, IR Receiver is used to receive the IR rays transmitted by the IR transmitter.
d. LCD: Liquid Crystal Display screen is an electronic display module and finds a wide range of applications.
e. DC motor: In this project, a DC motor is used, which indicates the vehicle's position. A +9V battery is used to generate power for the motor. The motor is mainly controlled by a L293D IC.
f. Buzzer: A buzzer is used, which is an important part of this project, and is the indicator of the alarm system.

3. Function of Drowsiness Detection

The driver should follow the instructions that are visualized on the LCD screen. At first, a tune is heard, and then it will take a reading, which is the open state value of the eyes. After the second tune is heard, it will take the closed value of the eyes. From the open and closed state values of the eyes, a threshold value is calculated, which is the standard value of the user's eye blinking. Then it will verify almost 10 values to justify the user condition. If the user is ok, then it will start running. The whole process is run as Figure 5.

3.1 Operational Flow

The control logic is illustrated in Figure 3. Note – In the prototype, the DC motor represents vehicle motion. The state labelled "Engine Off" refers to deactivation of this motor (vehicle-stop simulation). In real vehicles, the same signal would instruct the ECU to initiate a controlled deceleration rather than a full shutdown.

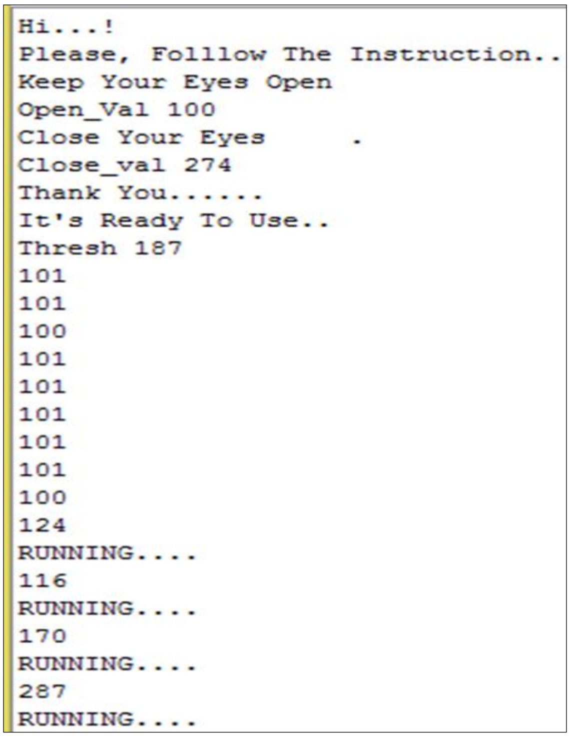

Fig.5: Method of using the module is shown on computer screen

3.2 Determining the State of Eyes

Here, we determined the whole system for the same person. At the first stage, the instruction is shown on the LCD display that keeps the driver's eyes open, and then it detects the open state value of the eyes, which is determined by the eye blink sensor. The open state value of eyes is measured as 252, and the process of taking the open eyes value is shown in Figure 6.

Fig. 6: Instruction is shown on LCD under to take value under normal condition

At the second stage, the LCD display shows the instruction to keep eyes closed, and the closed state value is measured by the eye blink sensor, which is found as 438, and the process of taking the closed state value is shown in Figure 7.

Fig. 7: Instruction is shown on LCD to take value of closed eyes

After completing the two stages the threshold value is measured as the average of open state and closed state eye values. The threshold value of 345 is measured for the selected individual using Eq.(1).

$$\text{Threshold value} = \left(\frac{\textbf{Open+Close}}{\textbf{2}}\right) = \left(\frac{\textbf{252+438}}{\textbf{2}}\right) = 345 \qquad (1)$$

The graphical representation of normal condition is shown in the figure 8, where eye value < threshold value (345).

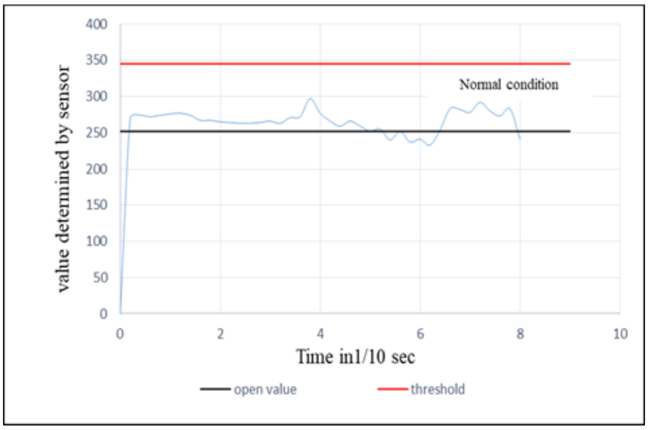

Fig. 8: Graphical representation of driver normal condition.

The graphical representation of drowsy condition is shown in the figure 9, where eye value > threshold value (345).

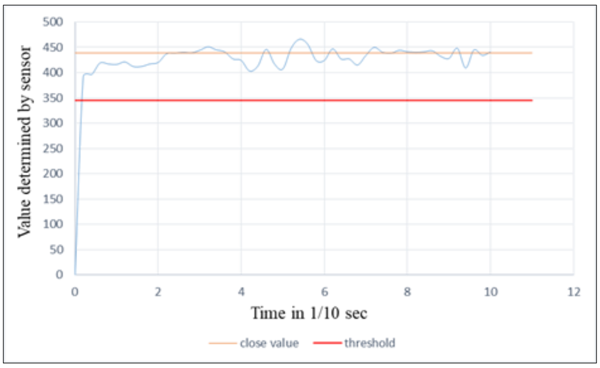

Fig. 9: Graphical representation of driver drowsy condition.

When the vehicle runs under normal condition, the LCD display shows the message "Running"; as illustrated in Figure 10.

Fig. 10: Vehicle is running under normal condition

Under drowsy condition the buzzer starts buzzing, the vehicle stops, and the following message pops up in the LCD display: "User is Drowsing", as illustrated in Fig.11

Fig.11: Vehicle is stopped under drowsy condition and message is shown in LCD display.

3.3 Monitoring Driver's Eye Blinks Condition

The zone of normal condition is defined between 252 and 345 or less than 252; elsewhere, the closed zone is defined between 345 and 439 or more than 439. The comparison of open and closed eye blinking values is graphically shown in Figure 12.

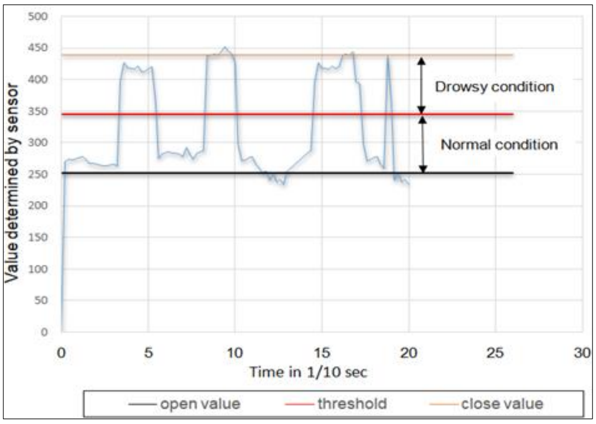

Fig. 12: Graphical view of driver eye blinks condition

4. Result

To determine the accuracy of the project, the system was applied to 12 people more than three times, so the total observations are more than 36 times, where 29 times the observation was successful and almost 6 times failed to detect the exact condition of the user. So, the accuracy of the system is 80.56%. The percentage of accuracy at night is more than during daylight. Some reading of the eye blinking is given in Table 1. In this system, the eye sensor records total 10 values per second.

Table 1: Decision making about the driver eye blinking condition.

Eye blinking reading				
Open value	Close value	Threshold [(open + close)/2]	Decision making	
			Normal	Drowsy
252	439	345	Value<345	345<Value

Start To Determine the Driver Conditions					
Time(s)	Value	Decision	Time (s)	Value	Decision
0.5	270	Normal condition Because more than 5 values satisfy value <345	3.5	285	Normal condition Because more than 5 values satisfy value <345
	274			283	
	272			283	
	274			282	
	276			278	
1.0	277		4.0	292	
	274			280	
	267			273	
	267			283	
	265			286	
1.5	264	Normal condition Because more than 5 values satisfy value <345	4.5	287	Drowsy condition Because more than 5 values satisfy value <345
	263			437	
	263			438	
	264			440	
	266			439	
2.0	263		5.0	444	
	396			451	
	427			445	
	419			441	
	417			427	
2.5	416	Drowsy condition Because more than 5 values satisfy value >345	5.5	298	Normal condition Because more than 5 values satisfy value <345
	421			271	
	412			272	
	412			276	
	417			277	
3.0	420		6.0	266	
	364			259	
	275			252	
	281			255	
	284			248	

5. Conclusion

This project presents the analysis and implementation of an intelligent and adaptive system designed to detect driver drowsiness. The proposed solution aims to prevent serious road accidents caused by drivers experiencing drowsiness while driving. Additionally, this system serves the purpose of ensuring the driver's security. This paper focuses on reducing accidents caused by unconsciousness through the use of an eye blink sensor that continuously monitors the driver's blinking patterns. An eye blink sensor is installed in the eye glass, and if the driver becomes unresponsive, it triggers a buzzer to alert them and help avert an accident. Furthermore, it also notifies passengers and nearby vehicles about the driver's signs of fatigue to help prevent a serious road incident. In each second, a total of 10 values is recorded via eye sensor. The normal condition is determined if more than 5 of these values satisfy the condition eye value < threshold value (345). Conversely, the drowsy condition is identified when more than 5 out of 10 recorded values satisfy the condition eye value > threshold value (345). The experiment was conducted on 12 individuals, each tested three times, and therefore the total number examination is 36 where for the 29 times got accurate results. Thus, the accuracy of the system is more than 80%. Our future goal is to implement an image processing scanner to enhance the accuracy of this project.

6. References

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