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Distracted Driving: A Novel Approach towards Accident Prevention

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Abstract

Roads accidents are increasingly being recognized as a growing public health problem. According to statistic over 1, 37, 000 people were killed in road accidents in 2013 and more than 16 children die every day in India because of road accident. There is one death every four minutes due to a road accident in India. Roads accidents are indispensable loss to our community. According to the research, one of the major causes of road accident is distracted driving. A distracted driver is the person who lacks their focus towards road and it can be due to many reasons like they might had a phone call, or they are eating or maybe they are too tired and feeling sleepy. Scientists are trying to develop several systems to prevent different types of accidents using alcohol sensors, automatic braking system and IR eye blink sensor. In our research we have tried to develop a system which can get rid of these types of accidents to a great extent. This system is like an advancement of eye blink sensor with high efficiency. With this alert system several distractions of the drivers can get rid which may causes for road accident.

Keywords – Advance Driver-Assistance Systems (ADAS), Collision Avoidance System, Distracted Driving, Internet of Things (IoT), Open Source Computer Vision (OpenCV),

1. INTRODUCTION

With the increase in quality of life and where having car is not a luxury thing. With the increase in number of vehicles on roads, the Advance Driver-Assistance Systems (ADAS) haven't been improved especially in India. As we know time is the most important factor of our lives so, we try to save as much as time we can and in that process to hurry up our tasks, multi-tasking is required. People use to try to multi-task everything, but in that scenario the focus on each task is also minimized. If the focus is not 100% then that task has some possibilities of failure. Same thing occurs on road, people use to eat, drink and talk over phone during driving and their focus on road gets minimized due to which accidents will occur. Figure 1 illustrates the scenario of distracted driving.

Figure 1 Eating and using phone while driving

Distraction is the major cause for roads accident, a person should be 100% focused and alert while driving. As we know mistakes are integral part of human lifestyle, and with that consideration in mind, scientists have developed many systems which can save people from accident even if they do mistakes, Collision avoidance system is a major example of these type of systems which is shown in Figure 2.

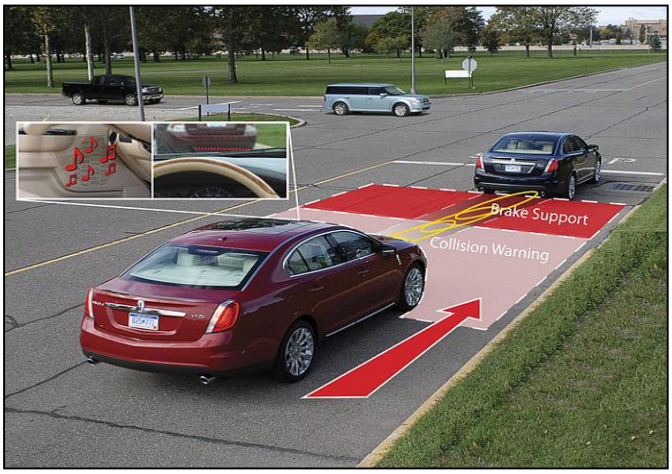

Figure 2 Collision avoidance system

According to a research in America, 16, 189 people are killed and 3, 27, 000 people are seriously injured because of drunk driving [1]. To prevent these modern smart car companies like Nissan has installed alcohol sensors in their car modules [2]. Apart from that, many projects and researches are going on to prevent road accident.

In our research we have taken drowsy driving as our main concern which is one of the major causes for distracted driving. According to research of NSF (National Sleep Foundation) an adult should sleep 7 - 9 hours daily [3]. Due to fast going life and compact schedules people hardly get 3-4 hours to sleep which is not enough and it had a verse effect on their day to day activities. Less sleep means brain is to in its peak energy state and due to which we will lack focus and will eventually become tired. Drowsiness is a consequence of less sleep and long working hours. Often people have to drive for long and if they didn't get adequate amount of sleep then they will feel drowsy while driving which will lower their focus on roads up to 60%. The American Automobile Association (AAA) found out that 16.5% of deadly road accidents, 12.5% of crashes is due to drowsy driving [4]. To tackle this problem, at first we studied about the symptoms of drowsiness and how we can track it as soon as it starts building. Here some of the symptoms of drowsy driver are explained below [5]:

- Lack of focus, or narrowing of attention
- Head nodding and inability in keeping the eyes open
- Poor judgment, slower reaction time
- Constant yawning or rubbing your eyes
- Drifting in the lane

Now our major concern was how to track these symptoms. In these symptoms we have taken inability in keeping eyes open and yawning/rubbing eyes as our tracking criteria.

There are two ways to track the development of drowsiness in a human body:

- By monitoring psychological changes and inner body changes by tracking brain signals, heart rate
- By monitoring external gestures like facial expression, nodding of head and opening and closing of eyes

The first way needs some advanced technologies which is being researched but with existing technologies it is not possible because sensing electrodes would have to be attached on the driver's body and it will be more distracting to the driver, with long time driving would result in perspiration on the sensors, and it will diminish the ability to monitor accurately [6].

This research involves controlling accident due to eye blinking and eye out of focus. We have taken eye as an important feature to detect the drowsiness of driver. Eye is the most symmetrical part of our body which can be easily tracked. In this research we have developed a mechanism on how by tracking eyes we can detect head movement and consciousness of the driver. Now let’s discuss about the outline of the device we have made to do all these stuffs. Here one camera is fixed in front of the driver to detect unconscious blinking and nodding of head which is shown in Figure 3.

Figure 3 Placement of Webcam

We have read physiological data for validation of this technology. We can incorporate it with a special instruction written in image processing that, if there is no pupil found for the certain period of pre-determined time i.e. time greater than the human eye blinking count (which is 15-16 times in a minute) then it will be considered as the driver is drowsy. We have also determined a set of operations which will be followed to help the driver to regain their focus on road.

2. STUDY OF EXISTING SYSTEM

Till today, the mechanism proposed to detect drowsy driving using eye blink sensor which is basically an infrared sensor (IR Sensor). This involves measure and controls the eye blink using IR sensor. The IR transmitter is used to transmit the infrared rays in our eye. The IR receiver is used to collect the reflected infrared rays from eye [7]. If the eye is closed means the output of IR receiver is high otherwise the IR receiver output is low. This is to know the eye is closing or opening position. This output gave a logic circuit to indicate the alarm. This mechanism involves controlling accident due to unconsciousness, through Eye blink count [8]. Here one eye blink sensor is fixed in vehicle where if anybody loses consciousness then indicates it through alarm. The section below is explained the disadvantage of the existing IR sensor based eye blink detection system.

2.1 Disadvantage

- Its efficiency is very less. By experimenting it by our team, we have found that it can detect only 3 eye-blinks in 10 eye-blinks which mean it has an efficiency of 30%
- It's largely dependent on positioning of these infrared sensors. We have tested that it should be placed in the middle of the eye to get reflected infrared ray in the right manner
- Moreover it can't deal with less conscious driving which means that the method doesn't have any calculation to determine the development of drowsiness of the driver

3. BACKGROUND CONCEPT OF OUR RESEARCH

We are deeply motivated with the research of Paul Viola and Michael Jones on object detection popularly known as Viola-Jones object detection framework [9] .We have taken a step further and tried to develop that algorithm and used it to design our system which can be used commercially. Let's discuss about object detection and rapid object detection framework. Object detection is a technology which includes computer vision and image processing capabilities, which is used to track and/or detect semantic objects of certain categories for which feature data has been inserted to the system [10]. The main reason behind using this principle in our system: that is robust and does real time object detection. Now let's discuss how this object detection framework works and what the sub modules of this framework are and how we used it in our system to meet our purpose.

Object detection framework comprises of 4 steps for feature extraction and classifier training. Features comprises of height, width, shades, depth of the object.

- Haar Feature Selection
- Creating an Integral Image
- Adaboost Training
- Cascading Classifiers

3.1 Haar feature selections

Haar features are generally common feature which is common in every object of a specific class. For example, in humans Haar feature would be like eye region is darker than the upper-cheeks, nose bridge region is brighter than the eyes (See Figure 4). Viola-Jones divided these features into 4 kinds of rectangular block features (See Figure 5). Each rectangular block consists of equal number of black and white sub-blocks.

Black sub-blocks represent the dark part of the object (showing depth) and white part shows the bright part of the object (showing elevation).

3.2 Integral Image

Viola-Jones divided a frame (where object is there) in 24*24 pixel sub-window and these rectangular Haar-features are matched with each pixels of that sub-window. In this process black sub-block value is taken as -1 and white sub-block value is taken as +1. Matching means are calculating the value of these blocks by summing up the number of black and white block's value to get a single value.

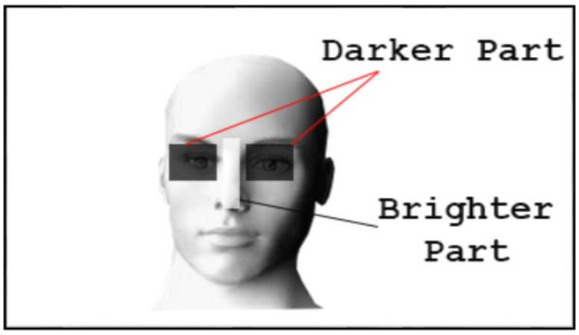

Figure 4 Bright and dark part of human face

3.3 Adaboost Training

Adaboost (Adaptive boost) is machine learning algorithm which is used with conjunction with other machine learning algorithm to increase their performance [11]. As after Integral image step, in each 24*24 pixel sub-window, there are more than 1, 60, 000 possible features [12] which are impossible to evaluate on real-time basis. Here comes the need of Adaboost, which combines "weak classifiers' and form "strong classifier".

3.4 Cascading Classifiers

The results of Adaboost is good but still it is not quick enough to detect the object at real-time. Strong classifiers are arranged in a cascading order based on their complexity. In this way a successive strong classifier needs to be trained on those features which pass through the preceding classifiers [13].

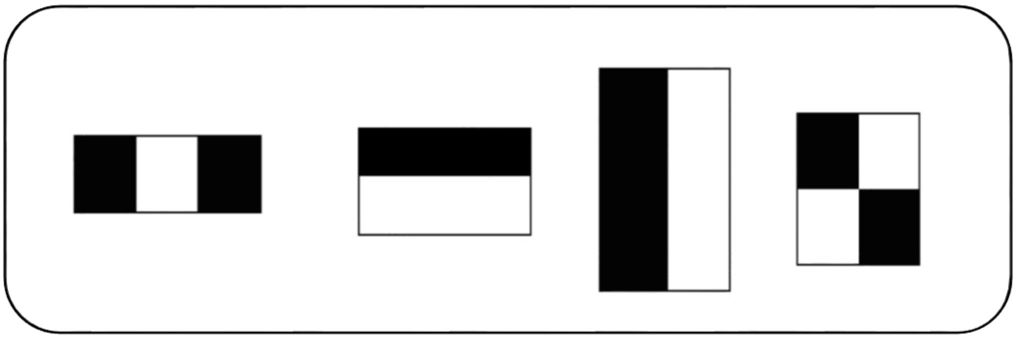

Figure 5 Four kinds of rectangular block features

4. DETAILED DESCRIPTION OF OUR SYSTEM

Our system consists of two major parts among them one is to detect the eye of the driver and the movement of the pupil and the second part is to do necessary action to help the driver in regaining focus on road.

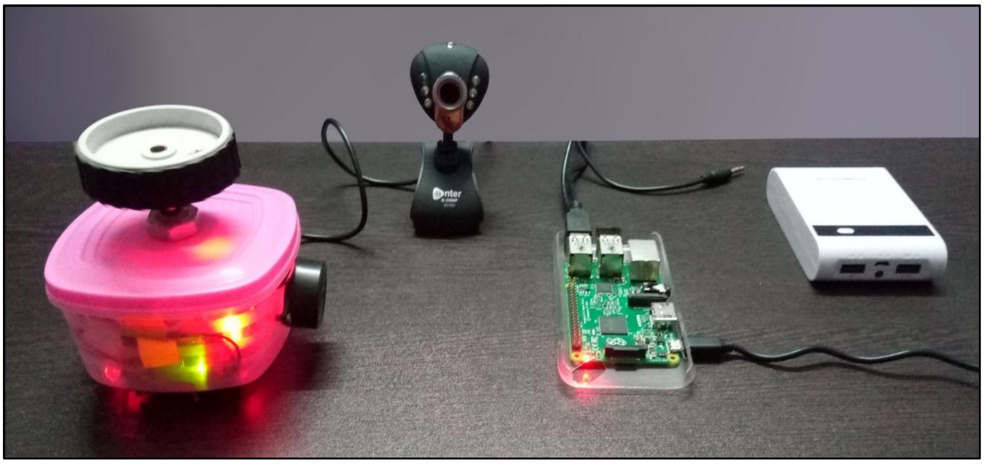

Figure 6 Prototype of our system

4.1 The Eye Blink detection systems

The system is developed to detect the eye blink of the driver. A webcam is used to capture the image of the driver. It is placed at a distance 50 cm from the driver so that it can capture the eyes of the driver. The distance limit varies from 40-60 cm. It is connected to a Raspberry Pi which is processed that data in real time and do necessary action. The camera will be in installed behind of the steering (See Figure 3).

The work of the camera is to capture video of the driver and send it to Raspberry Pi where our Eye blink detection program is running. Our eye-blink detection system will do image processing on each frames of the video in real-time and count the eye blinks (See Figure 6). We have used a camera which is able to capture 30 frames per second. In our program we have formed our own Haar feature-based cascade by taking 2000 positive images of eye and 1000 negative images which doesn't contain any eye image. Then we have transformed these images to vector form and by classifier training we have formed that Haar-cascade file. To consume that Haar cascade file we have formed a program with Python and openCV. According to the above stated principle each frame is going through all the 4 steps (Haar feature, integral image, Adaboost and Cascade) and in case if object is our program is returning true and if not then our program is sending a negative response to the actuator module. Figure 7 illustrates the detailed circuit diagram of our proposed system.

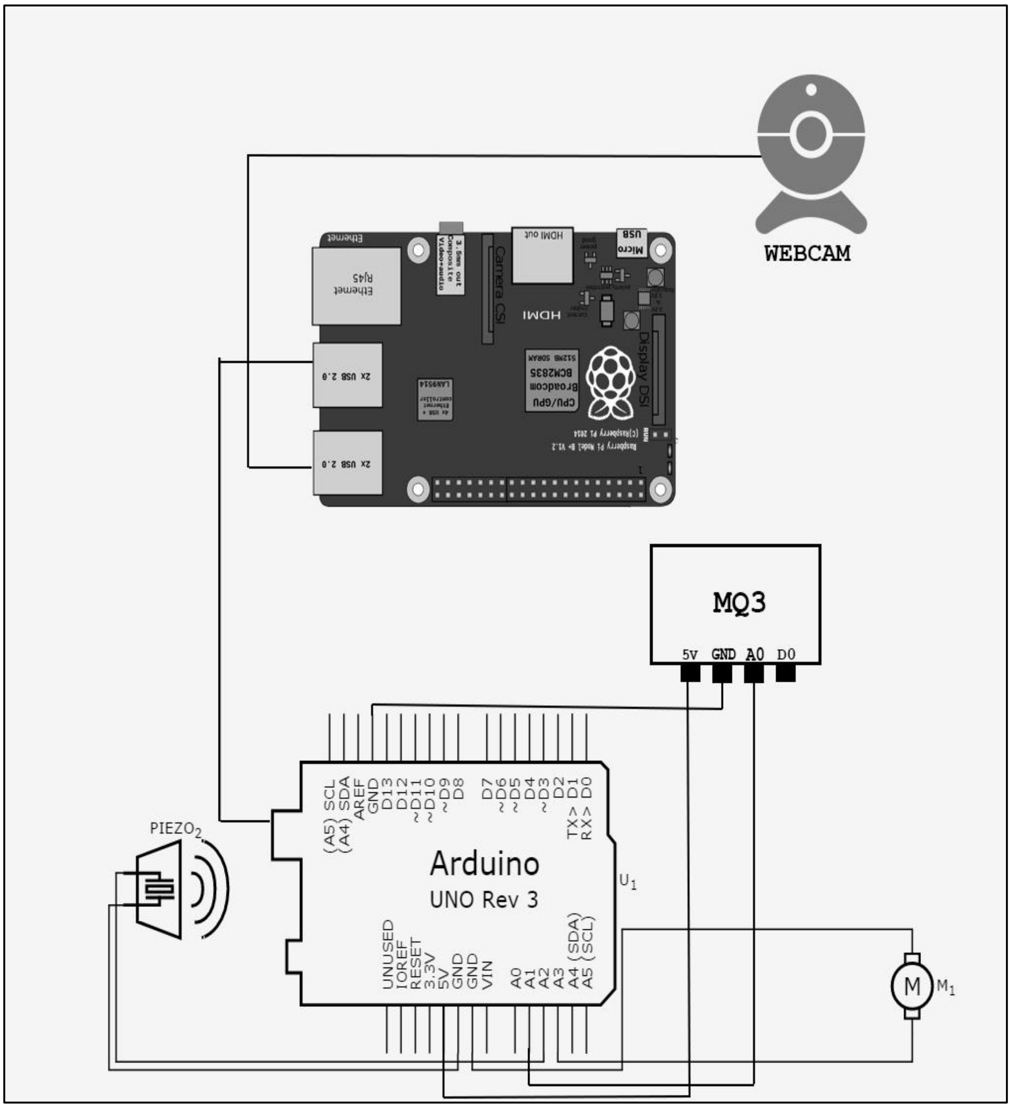

Figure 7 Circuit Diagram of Eye Blink module and Actuator module

To detect the eye blink we have created a Haar cascade file named haarcascade_eye.xml. We have used OpenCV (Open Source Computer Vision Library), which is an open source computer vision and machine learning software library [14]. The functions of the OpenCV are used to manipulate the image that is captured by the camera.

We first capture the frame using cv2. VideoCapture(0) and store it in a variable. It captures the image frame by frame. The argument is the device index here is camera. The size of the frame is set as 640x480 (See Figure 8). A time counter is started to as soon as the frame is created to count the time in minute. Use of this counter will be discussed later. The frame is converted to gray scale as the Haar cascade works better in a gray scale image. The cascade file is then loaded using cv2. CascadeClassifier (haarcascade_eye.xml) which tries to find the eye. A loop is used for continuous detection of the eyes. If the eye is detected then it draw rectangle around the eyes and prints the eye is opened. If it detect eye blink it prints that is eye blinked. Now are two possibilities when a person is sleepy. Either he is too much blinking the eyes than the normal rate or the eyes are closed for a continuous time. A normal human blinks 15-20 times per minute [15]. If the eye blink is greater than this rate then it can be said that the person is feeling sleepy. We use two counter variables to identify it. One is the minute counter that is mentioned above another is blink counter. The blink counter is increased whenever eye is blinked. Now if the value of the blink counter is greater than 21 in a minute then it prints the person is feeling sleepy. It sends the corresponding signal to the actuator to warn the driver.

For the second case if the eye is continuously closed for a fixed time it means the person is sleeping. Here is also a counter is used for the continuous detection. It sets to 0 whenever eye open is detected. We set the limit of continuous detection to 10.Whenever the limit crossed it send signal to the actuator to generate warning. Below the figure 8 shows the eye blinking scenario of our proposed system.

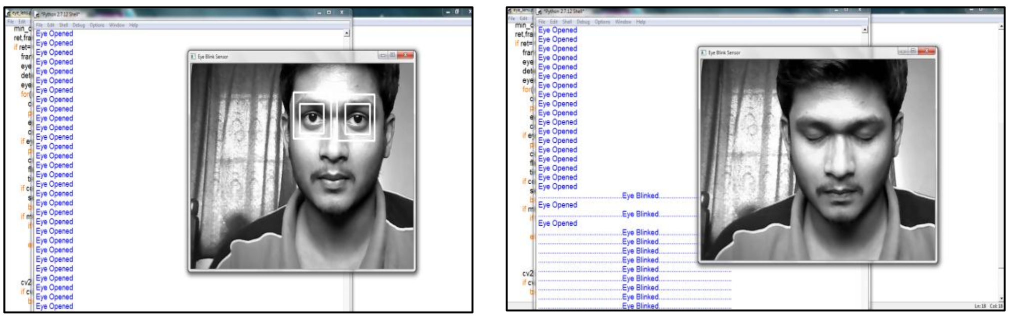

Figure 8 Eye Blink Detection and Response

4.2 Algorithm of our proposed system

```
1.Import CV,time,serial
2.START video_capture
3.SET width=640,height=480,count=0,flag=0
4.SET cap=Obj of Video_capture
5.ser=Obj of Serial
6.SET serial_baud_rate to 9600
7.OPEN serial port
8.SLEEP 2s
9.START LOOP While cap is TRUE
    9.1. eye_open=FALSE
    9.2. SET clock=START CLOCK+1
    9.3. min_check=clock%60
    9.4. ret,frame = READ cap
    9.5. SET frame = CONVERT IMAGE TO GRAYSCALE
    9.6. eye = CONSUME 'haarcascade_eye.xml'
    9.7. CascadeClassifier is a class for detection.cv2.CascadeClassifier() loads a classifier from
    9.8. a file which is sent through the parameter
    9.9. SET detected = DETECT frame
    9.10. detectMultiScale()  detects objects of different sizes in the input image.The detected
    9.11. objects are returned as a list of rectangles.
    9.12. eyeout = frame
    9.13. START LOOP WHEN OBJECT IS IN detected
        9.13.1. DRAW RECTANGLE
        9.13.2. rectangle() draws rectangle around the detected object
```

```
        9.13.3. PRINT Eye Opened
        9.13.4. SET eye_open=TRUE
        9.13.5. SET count=0
        9.13.6. IF eye_open = False THEN
            9.13.6.1. count=count+1
            9.13.6.2. flag=flag+1
            9.13.6.3. SLEEP 0.5s
        9.13.7. END IF
        9.13.8. IF count>10 THEN
            9.13.8.1. SERIAL_PORT=1
            9.13.8.2. BREAK
        9.13.9. END IF
        9.13.10. IF min_check=0.0 THEN
            9.13.10.1. IF flag<21 THEN
                9.13.10.1.2 SET flag=0
            9.13.10.2. ELSE
                9.13.10.2.1. PRINT you are sleepy
                9.13.10.2.2. SERIAL_PORT=2
            9.13.10.3 END IF
        9.13.11. END IF
    9.14. END LOOP
    9.15. IF KEY_PRESSED=0
        9.15.1 BREAK
    9.16. END IF
10.END LOOP
11.STOP Video_capture
12.STOP SERIAL_PORT
13.CLOSE PROGRAM
```

4.3 Actuator Module

The actuator module is used to control the car engine and to generate warning. Arduino is used to control the activities. It consists of a car wheel, display, and alarm and warning lights. This module gets command from the Eye Blink Detection System and act according to that. When the driver is in normal state it runs the car wheel and prints that the driver is driving. Now when the driver is not in normal state it get two types of input from the Eye Blink Detection System.

When it receives 2 as input it denotes that the driver is feeling sleepy. It generated the warning message “You are sleepy” and activates the alarm to wake up the driver and gradually decreases the speed of the wheel. It started blinking the warning lights to warn the neighbor cars so that they slow down the car or change direction to avoid accident (See Figure 9).

Figure 9 Actuator prototype with alarming system

When it receives 1 as input it denotes that the driver is sleeping. It generated the warning message “Wake Up” and activates the alarm to wake up the driver and gradually decreases the speed of the wheel. It turns on the warning lights to warn the neighbor cars so that they slow down the car or change direction to avoid accident.

5. CONCLUSION

There are several benefits of this system and lots of future scopes for distracted driving. This system has an efficiency of 80%, which means it can detect about 8 blinks in 10 actual blinks. This system is based on object tracking and machine learning and it can track the eye blink even if driver head is moving. It is feasible and cost effective; the actual system which will be made on this prototype will be cheap. Positioning of the system is not crucial. It can detect driver’s eyes even if you are not facing straight to the camera. In future we’ll mount head motion tracker in conjunction with eye blink detector and add up our previous alcohol detection module to get better results which will be a great help to our community [16].

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