A Microcontroller Based Car-Safety System: Implementing Drowsiness Detection And Vehicle-Vehicle Distance Detection In Parallel.

Pragyaditya Das., S. Pragadeesh

Abstract: Accidents due to drowsiness can be controlled and prevented with the help of eye blink sensor using IR rays. It consists of IR transmitter and an IR receiver. The transmitter transmits IR rays into the eye. If the eye is shut, then the output is high. If the eye is open, then the output is low. This output is interfaced with an alarm inside and outside the vehicle. This module can be connected to the braking system of the vehicle and can be used to reduce the speed of the vehicle. The alarm inside the vehicle will go on for a period of time until the driver is back to his senses. If the driver is unable to take control of the vehicle after that stipulated amount of time, then the alarm outside the vehicle will go on to warn and tell others to help the driver.

Keywords: Eye blink sensor, Drowsiness, IR sensor, Distance Sensor, Microcontroller Based Implementation, Software Implementation, Design Procedure.

1 Introduction:

Accidents are caused yearlong due to various factors such as drunk driving, texting while driving, speeding, distractions, sleeping on the wheel, etc.

2 Fatigue statistics

Ideally, each individual needs between seven and eight hours of good quality sleep each night. Those with less build up sleep debt, or sleep deficit. At worst, drivers with sleep debt risk nodding off, yet fatigue can impair reaction time and decision making when behind the wheel which increases the risk of being involved in an accident. If a driver falls asleep for just four seconds while traveling at a speed of 100 km/h the vehicle will have gone 111 meters without a driver in control. Those groups of drivers considered at greatest risk of being involved in a fatigue-related accident are:

1. Heavy vehicle drivers
2. Drivers with sleep disorders
1. Young Drivers.

3 Basic model of the system:

The block diagram of the system consists of:

1) Eye blink sensor (IR): To sense the duration and frequency of eye blinks.
2) 8051 microcontroller.
3) Buzzer (Piezo).
4) LM358 comparator.
5) Distance sensor.

- *Pragyaditya Das., S. Pragadeesh*
- *Under-Graduate, Department Of Instrumentation And Control Engineering National Institute Of Technology, Trichy. Email: pragyaditya.das94@gmail.com*
- *Under-Graduate, Department Of Instrumentation And Control Engineering National Institute Of Technology, Trichy. Email: praga.nitt@gmail.com*

3.1 Eye blink sensor module:

Here we use the CNY 70 IR transmitter. It is a reflective sensor that includes infrared emitter and phototransistor in a lead package which blocks visible light[1]. One main condition is that the IR transmitter and receiver should be in a straight line for optimum performance. The transmitter transmits IR rays into the eye of the driver. Depending on whether the eye is closed or open, there will be high output for closed eye and low output for open eye. The transmitted signal is captured by the IR receiver. This receiver is connected to the comparator. The comparator is an op amp where the reference voltage is given to inverting input terminal and the output of receiver is given to non-inverting terminal. When the IR transmitter passes the rays to the receiver, the receiver is conducting due to the fact that non inverting input voltage is less than inverting input voltage. Now the output of comparator is GND, so output is given to microcontroller.

3.2 Distance sensor:

The distance sensor module can sense if any vehicles are too close to the driver's vehicle and alerts the driver so he can take action to change the direction of his vehicle[3]. We can use around 10- 12 sensors distributed evenly on the front bumper. This is the method of Distributed sensing using an Array of Sensor. The output to the microcontroller will be the statistical mean of the output of all the Sensors[4]. These sensors are connected to port 2 on 8051. If there is any intrusion detected by sensor, then the corresponding pin of port 2 goes high. Pin 2.7 of 8051 is made output pin. It can also be connected to the braking system to stop the vehicle. The sensors are evenly distributed on the left and right side. The sensors on the left are connected to port 0 and the sensors on the right side are connected to port 1. If at least one of the left sensors is activated, then the corresponding pin goes high, then output pin 0.2 is activated and if it is a right sensor which is activated, then pin 1.7 goes high. Here we use the sensor QRD1114.

3.3 Buzzer:

The "Piezoelectric sound components" introduced herein operate on an innovative principle utilizing natural oscillation of piezoelectric ceramics. These buzzers are offered in lightweight compact sizes from the smallest diameter of 12mm to large Peizo electric sounders. We will be using two buzzers in our system. Buzzer 1, will be interfaced with the Eye-Blink Sensor to alert the driver when he starts feeling sleepy and the Buzzer 2 will be interfaced with the Distance Detector that will alert the driver if the vehicle is closer than the permissible distance from another vehicle.

4 Function:

The project involves preventing accidents due to drowsiness in vehicles by using eye blink sensor. The IR transmitter transmits infrared rays into the eyes. The ray reflected from the eye is picked up by the receiver which is in a straight line to the transmitter. Depending on the output of receiver, we get to know whether the eye is in an open or closed position[2]. Another extra feature is the alarm system. There are two alarms. One inside the vehicle to alert the driver and another outside to alert the people in the vicinity of the vehicle. If the eye is in a closed position, then the output is high. This output activates the corresponding pin in the microcontroller and sets off an alarm. The alarm continues to ring until the driver takes necessary steps to take control of the vehicle. If after a stipulated amount of time, the driver is unable to take control of the vehicle, then the microcontroller which is linked to the braking system, slows down the vehicle. An external alarm goes off indicating people to help the driver in the vehicle.

5 Related Works:

Driver drowsiness resulting in reduced vehicle control is one of the major causes of road accidents. Driving performance deteriorates with increased drowsiness with resulting crashes constituting 20%-23% of all vehicle accidents. The National Highway Traffic Safety Administration (NHTSA) conservatively estimates that 100 000 reported crashes are caused by drowsy drivers each year. These crashes result in more than 1500 fatalities, 71 000 injuries, and an estimated $12.5 billion in diminished productivity and property loss. Many efforts have been made recently to develop on-board detection of driver drowsiness.

6 Drowsiness Features:

The drowsiness features are characterized by the blinking frequency of the eye by the driver.

State	Output	Risk
Awake	Conscious	Normal
Drowsy	Less conscious	Risky
Sleep	Out of conscious	Extreme risk

7 Implementation:

7.1 Software Implementation for Simulation:

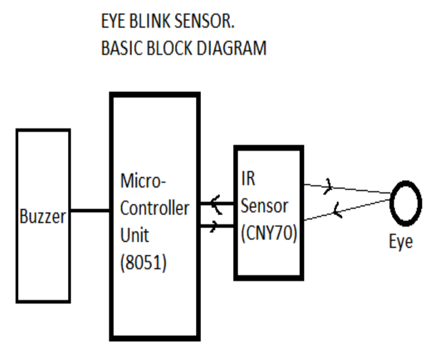
We will use Python with OpenCV to implement this concept using the Laptop Webcam. The algorithm for the program to work is as follows:

1) Define a region of interest. We define it using the cheek bones and the eye- brows.
2) See for a sharp contrast and sense it. Our eye is white (Sharp Contrast) with respect to the skin color.
3) Sense each blink.
4) Set a maximum time for each blink. Exceeding which will generate an alarm.

7.2 Hardware Implementation (First Prototype Building)

7.2.1 For Eye Blink Sensor :

All the blocks of the Eye-Blink Detection System is put together and the design is tested. We interfaced the CNY70 along with the 8051 Microcontroller and the Buzzer. The basic block diagram of the entire set-up for detecting the eye blink rate and alerting the driver when the blink rate is more than a pre-defined threshold value, indicating that the driver is sleepy or drowsy. Here is the block diagram of our setup:



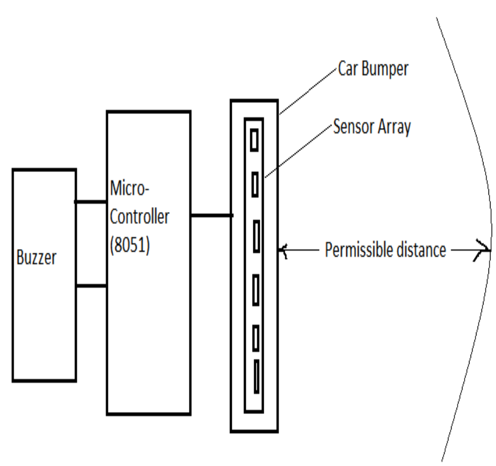
The Sensor Output to the Microcontroller Goes High when the eye is open (Reflecting).

The output goes low when the eyes are closed (not reflecting).

7.2.2 For Distance Sensor:

We will be interfacing a the QRD1114 along with the 8051 Microcontroller and the buzzer. The Distance Sensor Array will give a high when the vehicle is closer to another vehicle more than a threshold value. The Basic Block Diagram is as follows :

Distance Sensing System



The Buzzer Goes ON when the distance between two vehicles is less than the permissible distnace

8 Mathematics:

Some basic mathematical analysis was necessary for some calculations and optimization requirements. We have made some assumptions for the preliminary mathematical analysis. They are as follows:

- **a.** We assume that the Driver is not wearing an Reflectors/Spectacles/Contact Lenses.
- **b.** We assume that the ambient light doesn't effect the Eye-Blink Sensor.

Now, we will set the variables of our model.

Let the rate at which the eye blinks be = m blinks/minute.

Let the rate at which the CNY70 sensor sends the IR signal be = n pulses/second.

Let the distance between the Vehicle and other vehicle at the front be = d meters.

Let the voltage output of the CNY70 be = R (when eye open).

= C (when eye close).

Let the voltage output of QRD114 be = S (when the vehicle maintains a safe distance).

= U (when the vehicle is not maintain a safe distance).

Let the voltage of the Microcontroller to the Buzzer

= A (Eye open OR Safe Distance).

= B (Otherwise).

Now, A = f (R, S, m, d). [considering n to be a constant pulse]. ----------------------------(1).

Till the time the number of blinks per minute is not more than 16 [6]. The value of R will always be on, that means, the buzzer won't go ON. Similar is for the distance sensor.

Therefore, the output voltages are a function of the eye blink rate and the distance between the vehicle.

Thus,

m = g (R,C) [note that m has two states] --------(2).

d = h (S,U) [note that d also have two states] --(3).

Now, equation (1) reduces to :

A = f(m, d) --(4).

Again, we should also consider the fact that both m and d should independently trigger the microcontroller. Both the sets are completely disjoint. Thus, equation (4) can be written as,

A = f(m) + f(d) + f(m,d) + f(d,m) [keeping in mind an arbitrary precedence of output signals]---(5).

9 Application:

- I. The prime purpose is to provide safety measures.
- II. It is used for Automatic parking.
- III. It can be used in wireless technology.
- IV. The eye blink module of this project can be separately used for RFID detection in global industries.
- V. v.It can be used in image processing application by replacing sensor by camera module.

10 Advantages:

- I. Intelligent and Safe Transportation
- II. Accidents due to drowsiness can be avoided.
- III. Drunken driving also prevented by using alcohol detector.
- IV. Safe parking with no damage or distraction to nearer vehicles.

11 Conclusion:

Nowadays, people have become more prone to accident. So, we as an engineer need to take some action against this and provide the desired solution. For the safety of the human being some automation is made. The purpose of such a model is to advance a system to detect fatigue symptoms in drivers and control the speed of vehicle to avoid accidents. Advanced technology offers some hope avoid these up to some extent. This project involves measure and controls eye blink using IR sensor. We can automatically park the vehicle by first using Automatic braking system, which will slow down the vehicle and simultaneously will turn on the parking lights of the vehicle and will detect the parking space and will automatically park the vehicle preventing from accident.

13 Reference:

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