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Automation in Cars to Alert Drivers

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Abstract - *In recent years driver drowsiness has become one of the major causes of road accidents. Under sleeping conditions, the driver is not able to respond effectively since his attention is decreased and he has a reduced decision-making capability. Usually, there is no one who can see a driver falling asleep prior to a crash. A very effective and an intelligent system built into vehicles can minimize the accident death toll. Here we are using a face recognition system, based on image processing in a real time environment. The system used in a running environment of a vehicle, wherein the driver in the vehicle is alerted of his drowsiness, thus reducing the rate of accidents. This system gives high accuracy rate and low error detection with a quick processing of input data. Along with these features it is also cost efficient and easily implementable and installable in every type of vehicle, thus minimizing number of accidents caused by driver's drowsiness.*

Key Words: Image processing, Raspberry Pi, GSM Module, Machine Learning, Steering Wheel Movement, Lane Departure Warning System.

1. INTRODUCTION

A driver's drowsiness is one of the major causes of traffic accidents. Car accidents can also be caused due to fatigue which is due to sleep deprivation. Under sleeping conditions, the driver is unable to respond effectively since his attention is decreased and he has a reduced decision-making capability. Every year about 421000 people injured in crashes those have involved a driver who was distracted in some way. 78% of all distracted drivers are distracted because they have been texting while driving [5]. A warning system based on an automatic detection of the human drowsy state, would help to prevent car collisions. The method we use to detect signs of drowsiness and warn the car driver before driving condition becomes dangerous is the driver's facial expression. Eye closure rate is one of the most reliable measures for an immediate detection of drowsiness. Eye blink has become a known indicator for drowsiness. Opening or closing of the eye is determined by the exposed length of the pupil. The eye is considered closed when 80% or more of the pupil is covered. The technology that's being implemented is Face Recognition System which uses sensor cameras, infrared illuminators. The movement of the face is tracked. The system detects drowsiness by analysing eye closures and head poses to determine fatigue and distraction. When the system detects signs of drowsiness or distraction in the driver, it sends a voice message or an alarm asking the drivers to stop the car and take rest.

2. RELATED WORKS

A driver who falls asleep behind the wheels loses the control of the vehicle. In order to prevent accidents, the state of driver's drowsiness should be monitored. The following measures are widely used for monitoring drowsiness:

2.1 Steering Wheel Movement (SWM):

There is a number of metrics inculcated today including deviations from lane position, pressure on the acceleration pedal, movement of the steering wheel, etc. This is done by placing sensors on various components of the vehicle; the signal sent by these sensors are then analyzed to determine the drowsiness level. The steering wheel movement is measured using steering angle sensor (SAS) which is located in a sensor cluster in the steering column [6]. Cars companies like Nissan, Mercedes have adopted SWMs but these work in very limited situations as they work only at particular environments and also the nature of the road.

2.2 Lane Departure Warning System:

LDWS is another measure which warns the driver when the vehicle begins to move out of its lane [7]. The position of the lane is tracked by using an external camera. This measure is dependent on factors like road marking, lane division and lighting condition. This system uses the principle of Hough transform and Canny edge detector to detect lane lines from real time camera images fed from the external camera. Major automakers like BMW, Audi, Nissan, Ford, and many more have integrated different forms of lane assistance systems in their new car models. However, vehicle-based measures like Steering Wheel Movement and Lane Departure Warning Systems are not specific to drowsiness. Deviation of lane position and irregular steering movement can also be caused by driving under influence of alcohol or drugs.

2.3 Physiological Measures:

Electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and electro-oculogram (EOG) are the physiological signals used to detect drowsiness. EOG signal are used to identify driver drowsiness through eye movement by measuring EOG signal using electric potential difference between the cornea and the retina which generates an electric field that reflects orientation of the eyes [8]. Heart Rate Variability is a physiological phenomenon measured by variation in beat-to-beat interval in the heart rate. The heart rate which varies through different stages of drowsiness can be determined easily by ECG signal [9]. EEG is a method to record electrical activity of the brain [10]. It is measured in various frequency bands- delta, theta, beta and the alpha band. Decrease in the alpha frequency band and increase in the theta frequency band indicates drowsiness. Though the signals produced by these measures are accurate, these systems are intrusive in nature [4].

3. PROPOSED DESIGN

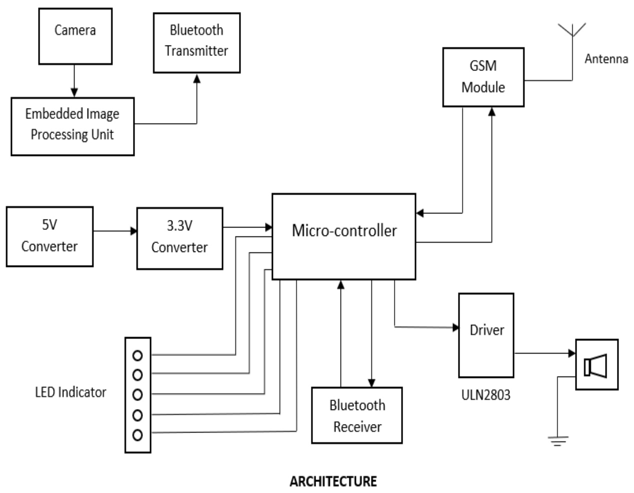

Fig 1: Block Diagram

A drowsy person displays various characteristic facial movements like rapid and constant blinking, nodding, swinging their head, eyelid closure at irregular interval. The system we propose includes continuous monitoring of facial features of the driver, and alerting him primarily by using alarm buzzer, and can alert any others by the means of SMS through GSM communication. Apart from that the system monitors the car battery voltage continuously and gives an alert to the driver upon any abnormality in the battery. Fig 1 shows the block diagram of architectural design of the model. The Image Processing Unit used in the system works on modern Machine Learning Algorithms, that monitors the facial features of a human being. Different facial features such as eyes, nose, mouth and eyebrows can be easily monitored by the algorithms used in the system. The image processing unit is being deployed in a Linux environment, which runs on an Arm processor. The application for monitoring the facial features runs as a Docker, independent of other processes. Upon detecting any unusual behavior in the driver's face, who is being monitored, the system will raise a Flag which in turn gives signal to the STM32 Microcontroller. The Microcontroller issues proper command to the GSM module, which in turn sends SMS to the specified persons. At the same time, the driver also will be alerted using the alarm buzzer placed along with system.

4. IMPLEMENTATION

The system can be implemented on any 4-wheeler automotive on its dash board. The camera should be continuously facing the driver and upon any abnormality in the driver's facial features, the system will activate the Alarm Buzzer and the GSM module to alert the driver as well as the concerned persons through SMS. Parallel to the operation, the system continuously monitors the accelerator signal of the vehicle, tapped directly from the ECU of the vehicle and also it monitors the car battery continuously. The concerned people can be alerted through SMS regarding the Battery status whereas the accelerator status can be taken for monitoring the driver's drowsiness. Fig 2 shows the block diagram of the software process.

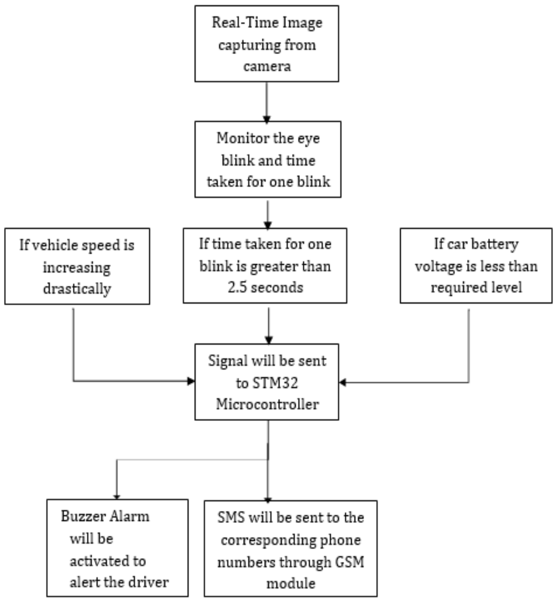

Fig 2: Flow Diagram

4.1 Power Supply:

The power will be taken from car battery which is 12 V rated, which will be converted to 5v, 3.3v and 4V respectively. 5V supply is for image processing board and other peripherals (max current will be around 1.2A). 3.3V for microcontroller and other circuits (max current will be around 500mA) and 4V for GSM module.

4.2 The Image Processing Unit:

The image processing unit runs on a Linux environment as Docker application on an Arm processor. The application is coded in python scripting language and uses modern Machine Learning library called NumPy. The application extracts the features out of the face and classifies according to the machine learning concepts.

4.3 The Microcontroller Unit:

This unit consists of STM32 Microcontroller, which controls peripheral devices such as the GSM module, Bluetooth transmitter and receiver, Alarm Buzzer and Car battery monitoring module. Microcontroller is programmed in Embedded C language and it's a Hardware Abstract Layer (HAL) code. The driver program flashed inside the microcontroller controls all the devices connected to it.

4.4 GSM Module:

SIMCom presents an ultra-compact and reliable wireless module-SIM800. SIM800 supports Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. It features Bluetooth and Embedded AT. SIM800 GSM modules have inbuilt Bluetooth stack compliant with 3.0+EDR & FM radio support, and the interface is accessible using AT commands. SIM800 modem operates from 3.4V to 4.4V supply range.

4.5 Accelerator monitoring module:

The IAM-20680 used here is a 6-axis Motion Tracking device for automotive applications that combines a 3-axis gyroscope and a 3-axis accelerometer in a small 3x3x0.75mm (16-pin LGA) package. It also features a 512-byte FIFO that can lower the traffic on the serial bus interface and reduce power consumption by allowing the system processor to burst read sensor data and then go into a low-power mode.

4.6 RS485:

The RS485 is used for high speed serial data communication. The MAX13487 is +5V, half-duplex, ±15kV ESD-protected RS-485/RS-422-compatible transceivers feature one driver and one receiver. The MAX13487 feature Maxim's proprietary Auto Direction control.

5. CONCLUSION AND FUTURE ENHANCEMENT

The main interest of this study is to find a system that could detect typical signs of drowsiness and warn a car driver before it's too late. In this matter, a lot of research have already been done but although many detection devices are available on the market today, the validity of most of them needs to be confirmed. Usually, there is no one who can see a driver falling asleep prior to a crash. It is much more difficult to identify a drowsy driving than drunk driving. In this paper, we have proposed a system that gives high accuracy rate and low error detection with a quick processing of input data. Along with these features it is also cost efficient and easily implementable and installable in every type of vehicle. The system can be further improved by combining with physiological sensors for more information such as heart rate variation during drowsiness.

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