ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

# Intelligent Vehicular Communication System for Safe Driving using CAN Bus

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## Abstract

Modern vehicles are developed with many sensors and Embedded control units (ECU). CAN (Controller Area Network) bus play a significant role in handling the entire communication between the sensors and ECU.This paper proposes a system in which, the CAN-bus signals are acquired and analyzed to recognize driver's drowsiness as well as driving sub-tasks. This paper contains the algorithms that are used for detection of drowsiness. The system is based on a real-time monitoring system. The objective is on improving the safety of the driver without being obtrusive and the eye blink of the driver is detected. If the driver's eyes remain closed for more than a specified period of time, then driver is said to be drowsy and an alarm is sounded. The programming for this system is done in OpenCV software which contains Haarcascade library for the detection of facial features.

**Keywords**: CAN bus, Face detection, Drowsiness detection, OpenCV, Alarm.

## Introduction

The CAN-bus signals are acquired and analyzed by controller to recognize driving sub-tasks, maneuvers and routes. As this system accessed driver's attention and an overall system which acquires, analyses and warns the driver in real-time while the driver is driving the vehicle can be designed to achieve improved overall safety.

Increasing stress levels in drivers, along with their ability to multi task with entertainment systems cause the drivers to deviate their attention from the primary task of driving. With the rapid advancements in technology, along with the development of entertainment systems, much emphasis is being given to occupant safety. Modern vehicles are designed with many sensors and ECUs (Embedded Control Units) and CAN-bus (Controller Area Network) plays a important role in handling the entire communication between the sensors, ECUs and actuators. Most of the mechanical links are replaced by intelligent processing units (ECU) or controllers which take in signals from the sensors and provide measurements for proper functioning of engine and vehicle functionalities along with several active safety systems such as Anti-lock Brake System and Electronic Stability program. Current active safety systems utilize the vehicle dynamics which using signals on CAN-bus but are unaware of multi tasks and driver status, and do not adapt to the changing mental and physical conditions of the driver. The long-term history and trends in the CAN-bus signals contains important information on driving patterns and driver characteristics in real time [1].

## Proposed Theory and Practices

Driver behavior signals are made by using Hidden Markov Models (HMM) in two different and complementary approaches. The first approach considers isolated maneuver recognition with model concatenation to construct a generic route (bottom-to-top), whereas the second approach models the entire route as a 'phrase' and refines the HMM to discover maneuvers and parses the route using finer discovered maneuvers (top-to-bottom). By applying these two approaches, a hierarchical framework to model driver behavior signals is proposed. It is believed that using the proposed approach, driver identification and distraction detection problems can be addressed in a more systematic and mathematically sound manner [2].

Most of the accidents on the roads are caused by driver faults, inattention and low performance. Therefore, future active safety systems are required to be aware of the driver status to be able to have preventative features. This problem study gives a system structure depending on multi-channel signal processing for three modules: Driver Identification, Route Recognition and Distraction Detection. The novelty lies in personalizing the route recognition and distraction detection systems according to particular driver with the help of driver

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identification system. The driver ID system also uses multiple modalities to verify the identity of the driver; therefore it can be applied to future smart cars working as car-keys. In overall, system is able to identify the driver, recognize the maneuver being performed at a particular time and able to detect driver distraction with reasonable accuracy [3].

The last decade has witnessed the introduction of several driver assistance and active safety systems in modern vehicles. Considering only systems that depend on computer vision, several independent applications have emerged such as lane tracking, road/traffic sign recognition, and pedestrian/vehicle detection. Although these methods can assist the driver for lane keeping, navigation, and collision avoidance with vehicles/pedestrians, conflict warnings of individual systems may expose the driver to greater risk due to information overload, especially in cluttered city driving conditions. As a solution to this problem, these individual systems can be combined to form an overall higher level of knowledge on traffic scenarios in real time. The integration of these computer vision modules for a 'context-aware' vehicle is desired to resolve conflicts between sub-systems as well as simplifying in-vehicle computer vision system design with a low cost approach. In this study, the video database is a subset of the UTDrive Corpus, which contains driver monitoring video, road scene video, driver audio capture and CAN-Bus modalities for vehicle dynamics. [4].

UTDrive is part of an on-going international collaboration to collect and research rich multi-modal data recorded for modeling behavior while the driver is interacting with speech-activated systems or performing other secondary tasks. A simultaneous second goal is to better understand speech characteristics of the driver undergoing additional cognitive load since dialog systems are generally not formulated for high task-stress environment (e.g., driving a vehicle). The corpus consists of audio, video, brake/gas pedal pressure, forward distance, GPS information, and CAN-Bus information [5].

## Related Technology

The block diagram shown in Figure 1 below describes Dynamic flow of the system where a new image is extracted Pre-processed, processed and post processed to determine whether the state of drowsiness is reached. If this state is reached then an alert is given to the driver and the process continues until all frames are processed.[6]

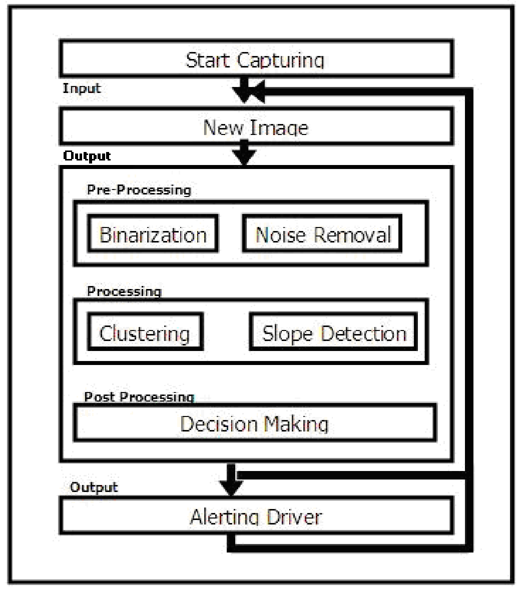


**Figure 1: Block Diagram of drowsy detection and alarming system**

The system uses a completely software approach & has been broken down into three phases:
1. Pre-processing
2. Processing
3. Post-processing

The processing phase forms the major part of the system & this is where the algorithm to detect the state of the eyes has been implemented.

**1. Pre-processing**

In this part the images acquired from the infra red night vision camera are converted into binary images using a specific threshold. Also the image is enhanced by isolating independent pixels.

**2. Processing**

The binary image is then input to the clustering algorithm wherein clusters are found out within the binary image. Depending on the illumination from the camera at that instant of time & the skin color of the person there will be different number of clusters that will be found each time. Clusters are nothing but the areas of the face which are turned on after applying a specific threshold. Once the clusters are detected the centers of each of the clusters is found out & distance is calculated. We have tested the algorithm on the samples of a number of different people & found out the approximate distance within which the two pupils lie. To detect the eyes the distance is checked between the clusters & if ever the clusters are found to be within that range then the eyes are detected. One problem with this algorithm is that the same distance can be there

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between a different set of clusters which are really not the eyes.

To accurately detect the eyes the slope detection algorithm is used to calculate the slope between each of the clusters & it discards the clusters till finally the eyes are detected.

1) If ever the eyes are found then the driver is alert & there is no

Need of raising an alarm.

2) But if the eyes are not found or are closed for a period of 3 seconds continuously then it is safe to assume that the alertness level has dropped down to certain level & the driver is dozing. In such a case the driver is alerted by raising an alarm.

**3. Post Processing**

Depending on the state of the eyes found in the previous stage an appropriate decision is made & then displayed on screen.

The block diagram in figure 2 shows implementing an automated security system to vehicles that provides high security to driver. An eye blink sensor is continuously monitors the number of times the eye blinks, if the count of eye blinks decreases that means the driver is sleepy at that time buzzer will on and then turn off the vehicle's ignition .This paper involves measuring the eye blinks using IR sensor. There are two sections in IR sensor.[7]

a) The IR transmitter is used to transmit the infrared rays in our eye. b) The IR receiver is used to receive the reflected infrared rays of eye. If the eye is closed then the output of IR receiver is high otherwise the IR receiver output is low. This to know the eye closing or opening position.

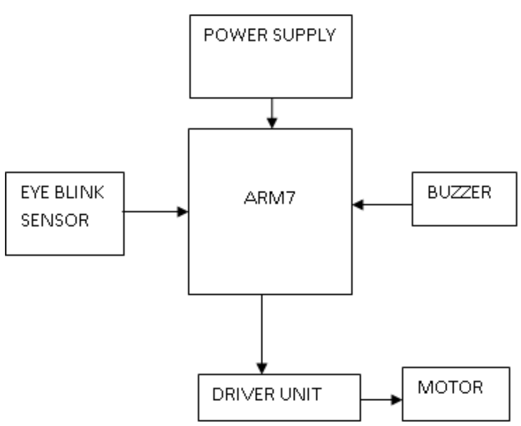


**Figure 2: Block Diagram of Driver Drowsiness Detection System.**

1. In the transmitter section, 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 ARM7 Microcontroller.

2. The ARM7 processor uses this information to compare with the normal eye blink programmed in the chip and if any abnormal situation arises, the vehicle is stopped with an buzzer indication, 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.

3. In the Receiver side 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 then vehicle is stopped immediately.

## Proposed Work

To overcome drawbacks of above methods given in III chapter new intelligent vehicular system is proposed. In this paper, data from various sensors will be collected by using CAN-Bus[8]. The system block diagram is shown in figure 3.

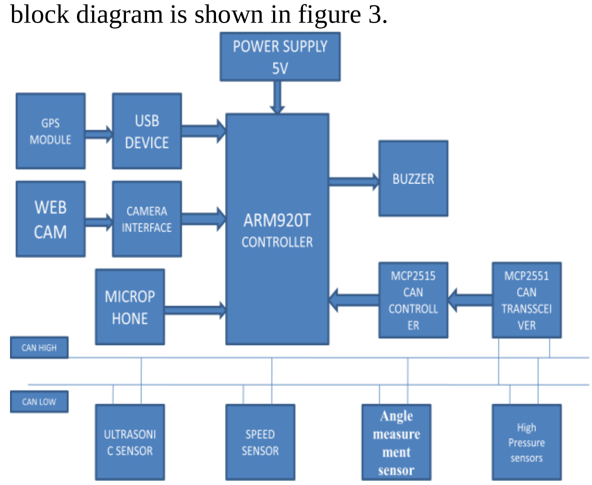


**Figure 3: Block diagram of intelligent vehicular system**

This paper proposes following work,

1. One camera, facing the driver to monitor his actions and Drowsiness Detection.
2. Optical /Ultrasonic distance sensor to obtain the forward distance between the vehicles in the traffic flow.
3. GPS for location tracking.
4. Vehicle speed, steering wheel angle.
5. Brake pedal pressure sensors to collect information related to pressure patterns in car-following and braking.

As per above proposed work this paper mainly focuses on driver safety techniques. The main objective of this system is drowsiness detection by using OpenCV. However Matlab had some limitations. The processing capacities required by

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Scientific Journal Impact Factor: 3.449
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Matlab were very high. Also there were some problems with speed in real time processing. Matlab was capable of processing only 4-5 frames per second. On a system with a low RAM this was even lower. As we all know an eye blink is a matter of milliseconds. Also a drivers head movements can be pretty fast. Though the Matlab program designed by us detected an eye blink, the performance was found severely wanting.

In this detection the eye blink of the driver is detected. If the drivers eyes remain closed for more than a certain period of time, the driver is said to be drowsy and an alarm is sounded. The programming for this is done in OpenCV using the Haarcascade library for the detection of facial features.

OpenCV is an open source computer vision library. It is designed for computational efficiency and with a strong focus on real time applications. It helps to build sophisticated vision applications quickly and easily. OpenCV satisfied the low processing power and high speed requirements of our application. OpenCV was designed for image processing. Every function and data structure has been designed with an Image Processing application in mind. Meanwhile, Matlab, is quite generic.

Drowsiness of a person can be measured by the extended period of time for which his/her eyes are in closed state. In our system, primary attention is given to the faster detection and processing of data. The number of frames for which eyes are closed is monitored. If the number of frames exceeds a certain value, then a warning message is generated on the display showing that the driver is feeling drowsy.

First the image is acquired by the webcam for processing. Then we use the Haar cascade file face.xml to search and detect the faces in each individual frame. If no face is detected then another frame is acquired. If a face is detected, then a region of interest in marked within the face. This region of interest contains the eyes. Defining a region of interest significantly reduces the computational requirements of the system. After that the eyes are detected from the region of interest by using Haarcascade_eye.xml[10].

Ultrasonic distance measurement sensors are used in traffic flow control. In traffic if vehicle comes very closer to any object then this sensor detects and warns driver on display. GPS location tracking is used to locate vehicle and help driver to find route[11].

Speed, angle and Break pedal pressure sensor is used to display on CCDT timeline. This data is collected by using CAN-Bus in high and low signals which goes to the ARM9 through CAN transceiver. For the analysis of large-size multi-sensor driving data, a color code scheme is used, visually marking each event and task labels with certain colors and projecting them as two parallel time-lines. An example of the timeline is shown in Fig. 3.9 with the legend of the Color Coding for Driving Timeline (CCDT) [12]. Using CCDT, it is possible to observe the multi tasking activities of a driver. This visualization tool is used extensively in further analysis stages for generating the distraction/work-load hypotheses considering the overlaps between task and events.


**Figure 4: Color-Coded Driving Timeline**

## Conclusion

This paper provides intelligent vehicullar communication system which enhance the performanceof previous techniques based on driver centric.It displays in real time basis which continuosly communicate with driver and alert his from any fatigue. Further the implementation system using arm micro-controller is the future scope of study.

## Acknowledgment

The authors are thankful to the Department of Electronics, Shivaji University, KBP College of Engineering, Satara India for providing research facilities and their faculty for being the constant source of inspiration. The authors would like to thank Prof.Mrs.Thorat R.A.of Institute of KBP Satara, for their valuable support during the preparation of this paper.

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