Driver Behavior Monitoring through Sensors and Tracking the Accident using Wireless Technology

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ABSTRACT
Monitoring the driver behavior is one of the ways to prevent the fatal accidents and it is necessary to alert the driver when they are drowsy or in a distracted state. Distraction and drowsiness of the driver have been important factors for a large number of major accidents .They reduce the decision making capability and the perception level of the driver which negatively affect the ability of the driver to control the vehicle. A large number of serious or fatal accidents are occurred due to excessive or inappropriate speed of the vehicle and fatigue nature of the driver. With the new developed systems (sensors) there is a possibility of self controlling the vehicle when the driver was drunk or reckless or fatigue in order to reduce the major accidents. There is also a possibility of tracking the location of the accident, if occurs, through wireless access technology (GSM, GPS) so that proper measures are taken at a correct time.

General Terms
Driver Behavior Monitoring

Keywords
ARM, driver behavior, GPS, GSM, MEMS.

1. INTRODUCTION
In the developed world, Road fatalities are the major concern. At present time private vehicles are widely used daily by huge numbers of people. Regarding the increased use of private transport, the biggest problem is the rising number of fatalities. A consequence of accidents on the roads has been recognized as a serious problem. The main factors which are responsible for the most of the road accidents are the driver errors due to affected by fatigue, being drunk or reckless driving. Most of the traffic accidents occur due to a driver's diminished vigilance level. Recent Statistics show that 10% to 20% of the traffic accidents are occurred due to drivers with a diminished vigilance level. [1] Moreover, the accidents that occur in declined level of the driver vigilance are very serious when compared to other types of accidents, since drivers who are drowsy in the condition often do not take any actions which are avoidable prior to a collision.

According to the reports of National Highway Traffic Safety Administration (NHTSA) [2] while driving, falling asleep causes at least 1, 00,000 automobile crashes annually in the US and results in more than 40,000 non-fatal injuries. Due to this background, how to monitor the driver's vigilance level and how to avoid fatigue driving is necessary for prevention of the accident Intelligent transport systems(ITS) has been developed to solve several issues caused by the modern transportation environment. For the improvement in the intelligent transport systems (ITS), wireless communications &mobile computing focused on road safety applications.
Vehicle Adhoc networks (VANET) [3] safety applications are considered to be a vital step towards enhancing road safety and improving traffic efficiency. The most important ITS applications in the world have occurred in Europe, Japan and South America. There is a dynamic behavior model for inferring four types of driving behavior (normal, drunk, reckless and fatigue). This dynamic behavior model can capture the static and the temporal aspects related to the driver behavior, and thus it leads to accurate and robust detection of the behavior.

2. DRIVER'S BEHAVIOR OVERVIEW
The four categories of driving behavior are as follows

2.1 Normal behavior
The driver behavior is said to be normal when he concentrates on the driving task. This can be characterized by controlling the speed of the vehicle, avoiding of sudden acceleration, driving without alcohol intoxication.

2.2 Drunk behaviors
The behavior is said to be in drunk, when the driver was intoxicated by alcohol and is characterized by a set of observable actions like sudden acceleration, driving without controlling the speed.

2.3 Fatigue behavior
It stated that a driver driving after a period of 17 hours with no sleep behaves exactly as a driver who has 0.05% intoxication of alcohol. Based on this argument, fatigue driving was defined as driving that exhibits the same characteristics as drunk driving, but there is no alcohol intoxication in the blood of the driver.

2.4 Reckless behavior
It is the behavior of the driver who drives at high speed, with a high degree of acceleration and makes other traffic participants at risk. There is no alcohol intoxication and the driver's eyes are open, but the following behaviors such as driving with sudden acceleration, not maintaining the proper lane position and not controlling the vehicle's speed are exhibited.

3. LITERATURE SURVEY
Several methods were proposed by different researchers to monitor the behavior of driver. Some have attempted to measure the driver's state or the vehicle's behavior to detect fatigued and drunk drivers. Meanwhile, other researchers have

tried to monitor the driver, vehicle and the environment in order to detect the state of the driver. The main researches are summarized below.

3.1 Detection of fatigue condition of driver by video sensor module

A custom made webcam is placed on the dashboard of the driver seat to capture the image of the driver. The webcam is connected via USB port, with resolution up to 800×600 VGA 30 frames per second. Several infrared LEDs are placed on the right side and left side near to the camera to capture images of the driver more clearly during the night time [4].

In order to prevent interpretation of incorrect information, the data packet, which is received first validated by its length, channel number, and identification number before analysis take place. The video sensor is directly connected to the web camera by using USB port, whereas the biomedical sensor transmits the data packets wirelessly to the smart phone through the transceiver connected by RS232 serial port.

3.2 Monitoring drowsiness of the driver by visual features

To detect the drowsiness of the driver by visual features it is quite easy. Facial movements usually such as blinking of eyes, yawning frequently and nodding or swinging head are key elements among visual features which are used for detecting drowsiness of the driver [5]. Most of the research work focuses on eye behaviors in particular to monitor the alertness of the driver. A most reliable and valid method for monitoring a driver's alertness level is PERCLOS (Percent Eye Closure).

PERCLOS is the percentage of total time that the driver's eyelid is closed 80% (or more) over the pupil. When PERCLOS exceeds a given threshold the warning system generates a drowsiness warning immediately, so that the driver may alert. However, one limitation of PERCLOS is that sometimes a driver who is trying to stay awake is able to fall asleep with his eyes open.

To calculate PERCLOS, we have to extract the region of the eye, including the area of the pupil. However, there are some limitations while extracting those visual features. One of them is the problem of proper lighting. Drowsiness should be monitored under real conditions, i.e., throughout daytime and night, and regardless of whether the driver is wearing glasses or sunglasses.

Usually, web camera or a simple CCD is used during the daytimes, and an IR camera is used at night. In order to detect the eye of the driver who is wearing sunglasses, it is necessary to find a proper wavelength of Near IR (NIR) illumination. One possible wavelength is 850nm.

In a real automotive environment, there is a possibility of generating sunlight on the outer surface of the eyeglasses. To avoid the reflection effect, Jo ET al.used a NIR illuminator with a band pass filter which is narrow that restricts the incoming wavelength of light to 850nm. This is because the LED illuminator with a higher power is more powerful than the sunlight.

Another sign of driver drowsiness is yawning. It is detected by measuring both the rate and the certain amount of changes in the mouth contours of the driver. Head pose and head motion estimation movements such as nodding are also important to monitor driver alertness. In addition, driver's facial wrinkles appearing on the brows are excellent physical signs in order to detect drowsiness of the driver. Monitoring driver drowsiness by visual features provides more benefits when compared to non-visual features.

3.3 Detection of driver drowsiness by using Artificial Neural Networks

The George Washington University Virginia Campus Driving Simulator Laboratory, which is a part of the University's Center for Intelligent Systems Research, conducts behavior of driving and vehicle control experiments for making vehicle travel safer.

Through their Drowsy Driver Detection System, researchers track normal and drowsy steering behaviors by using artificial neural networks and later they classify normal and drowsy steering behaviors that mimic brain function.
In 1998 Azim Eskandarian, professor of engineering and applied science, started this project under a contract for the Turner-Fairbank Highway Research Center of the Federal Highway Administration (FHWA).
In the initial phase data which is gathered on sleep-deprived drivers by the FHWA was analyzed by using a driving simulator. They measured driver and vehicle variables like steering activity, speed, braking, lane control and acceleration. They also analyzed eye movement of driver in subsequent phases.

The data gathered in the simulator has been processed by the artificial neural networks. They created a framework to detect or predict whether the driver is drowsy or not. The fig 1 shows how the System works.

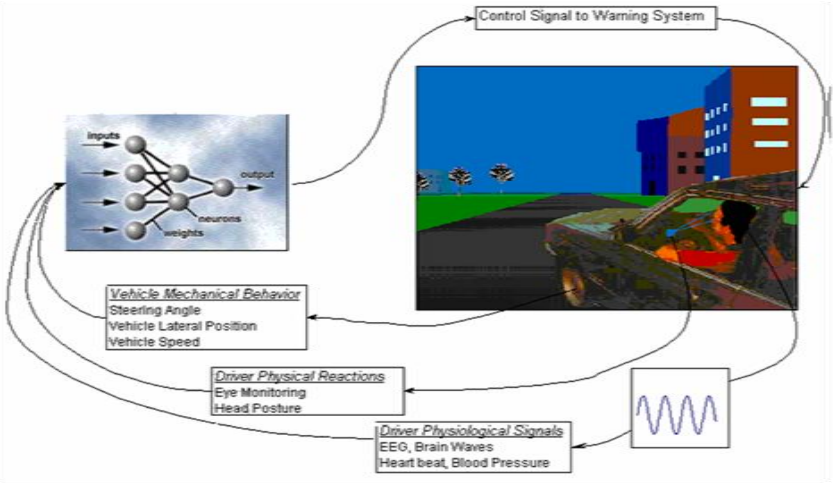

Fig.1. Approach for Drowsiness Detection and Driver Warning

In the second and third phase Eskandarian, his team and students gathered another data set in the Passenger Car Driving Simulator Lab [6]. They tried to study people driving in the morning and the evening. The same test was done by the Federal Motor Career Safety Administration of the Department of Transportation with truck drivers.

With these results of the tests Eskandarian and his team were able to further validate the detection system. From these three sets of data, the system achieved a percent of 86 to 91 success rates in the detection of drowsy driving patterns. With the eye monitoring in the second and third phases this detection accuracy increased by about 5 percent.

4. EMBEDDED SYSTEM DESIGN

The Embedded system design consisting of MEMS-Micro electro mechanical system, GSM-global subscriber module, GPS-global position system, alcohol detector, eye blink detector, gas leak detector, fire detector. Most of the researchers tried to monitor the behavior of the vehicle or the driver in isolation, while others have focused on monitoring a combination of the vehicle, the driver and the environment in order to detect the status of the driver so as to prevent road accidents.

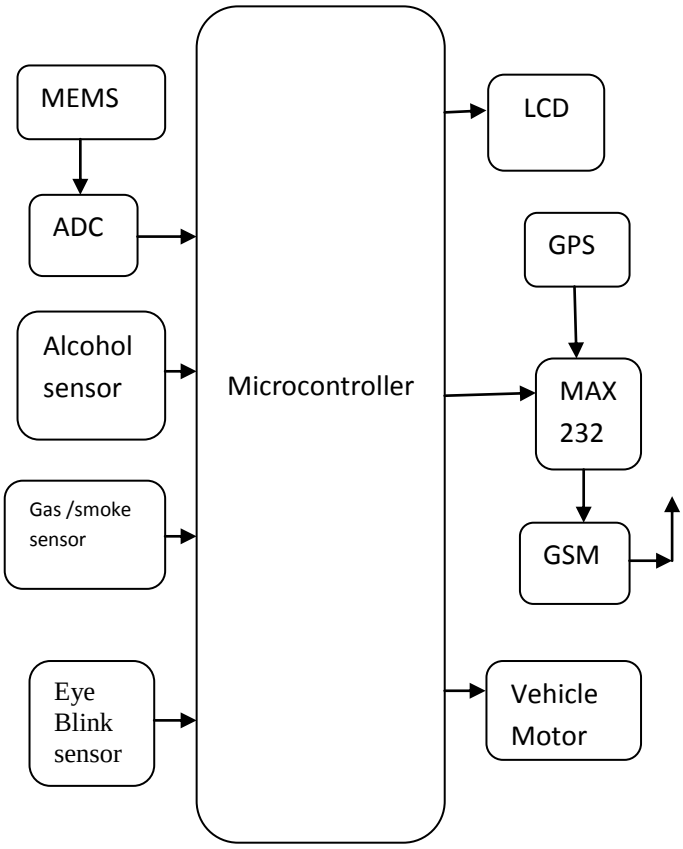

Fig.2 Embedded System Design

There is still no comprehensive system which can effectively monitor a driver's behavior, the state of the vehicle and changes of the environment.

Alerting other vehicles on the road by sending warning messages to the relevant vehicles in the vicinity, includes some corrective actions to avoid accidents.

5. MODULES

5.1 MEMS-Based accelerometers

The MEMS accelerometers can be divided into two important micro system architectures: piezo resistive and capacitive. Even though both of these two types of accelerometers

possess internal proof masses which are excited by acceleration, the differences of these two architectures lie in the transduction mechanism which is used to the movement correlation of the internal proof mass to accelerate.

The Capacitive accelerometers possess a differential capacitor whose balance is disrupted by the proof mass movement. Piezo resistive accelerometers commonly rely on inducing, which attach the proof mass to the sensor which is used for identification of the movement of the mass.

5.2 Alcohol sensor

For Alcohol detection the most commonly used semiconductor sensor is MQ303A. It has fast response to alcohol, very good sensitivity and it is suitable for portable alcohol detector.

The main features of alcohol sensor were long life, low cost and high sensitivity.

Fig.3 Alcohol sensor

5.3 Gas sensor

Detection of the gas leak is the process of identifying leaks of hazardous gas by means of several sensors. These sensors commonly possess an audible alarm in order to alert the people when a dangerous gas has been detected. The sensors that are used commonly today include , Ultrasonic gas detectors, Infrared Point Sensor, Semiconductor Sensors and Electrochemical gas detectors. These sensors are used for a very wide range of applications and can be found in refineries, industrial plants, vehicles, wastewater treatment facilities, and around the home.

Fig.4 Gas Sensor

5.4 Eye blink sensor

Eye blink sensor is Infra Red based. As per eye blink the variation across the eye will vary. The output is high if the eye is closed otherwise it is low. Eye blink sensor is used to predict whether the eye is in closed position or in open position. The resultant output is given to a logic circuit to indicate the alarm. It is mainly used to prevent the accidents.

5.5 Liquid Crystal Display (LCD)

A liquid crystal display (LCD) is a flat, thin display device which is made up of number of monochrome or color pixels which are arrayed in front of reflector or a light source .

The features of LCD are Energy efficient, cost effective, Space economy, reduction of radiation and lighter weight.

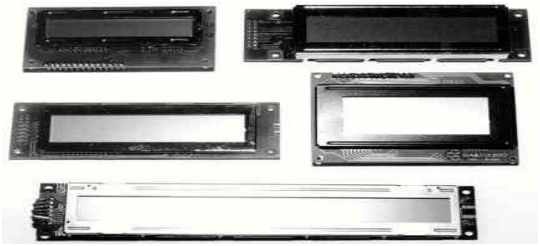

Fig 5.Shapes and Sizes

5.6 MAX 232

In many microcontrollers boards a MAX232 chip has been used. It is a dual RS232 transmitter / receiver which satisfy all RS232 specifications. It uses only +5V power supply. It has two onboard charge pump voltage converters. From a single 5V supply it generates +10V to -10V power supplies. It has four levels translators, two of which are RS232 receivers which convert RS232 input to 5V. Another two level translators are RS232 transmitters which converts TTL/CMOS input levels to +9V RS232 outputs. The Typical MAX232 circuit is shown below.

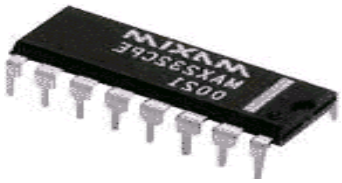

Fig 6.MAX 232

5.7 Global Positioning System (GPS)

The Global Positioning System (GPS) is a navigation system which is satellite based. It sends and receives radio signals. By Using GPS technology, one can determine the exact location, time, velocity, 24 hours a day, in any weather conditions & anywhere in the world.

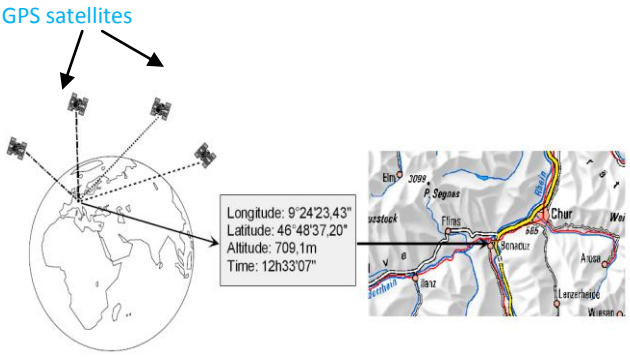

Fig 7.Basic function of GPS

GPS was mainly intended for most of the military applications, but in the early 1980s, the government made the system necessary for civilian use. GPS receivers are used for locating; positioning, surveying, navigating and determining the time [7].GPS are employed by both private individuals and companies.

5.8 GSM

One of the most leading digital systems is GSM. GSM uses narrow band Time Division Multiple Access (TDMA). Of all time GSM becomes the world's fastest growing communications technology. It is the leading global mobile standard.

GSM is an open, digital cellular technology, which is used for transmitting both data services and mobile voice .The operating frequency of GSM lies in between 900MHz and 1.8GHz bands .GSM is able to support data transfer speeds of up to 9.6 kbps. It also allows the transmission of basic data services such as SMS.

Fig 8.GSM module

GSM systems provide a number of useful features like Data networking, Call waiting, Call forwarding, Multi-party conferencing etc.

GSM carriers usually have roaming contracts with other GSM carriers and it typically covers all rural areas completely when compared to the competing CDMA carriers. GSM also has taken the advantage of using Subscriber Identity Module (SIM) cards. The SIM card acts as a digital identity, and it is tied to the mobile service carrier's network instead of to the handset. Due to this it allows for easy exchange from one mobile phone to another.

5.9 ARM LPC2148

"ARM" is the abbreviation of "Advanced RISC Machines". It is a widespread processor cores in the world. It is especially used in portable devices due to reasonable performance and low power consumption. ARM is a family of RISC architectures. The fig of ARMLPC2148 is shown in the fig9. The ASK 16/32-bit ARM7TDMI-S microcontroller training board is very specifically designed to help students to meet their required skills in the area of embedded systems. It is possible to design the kit in such way that all the important

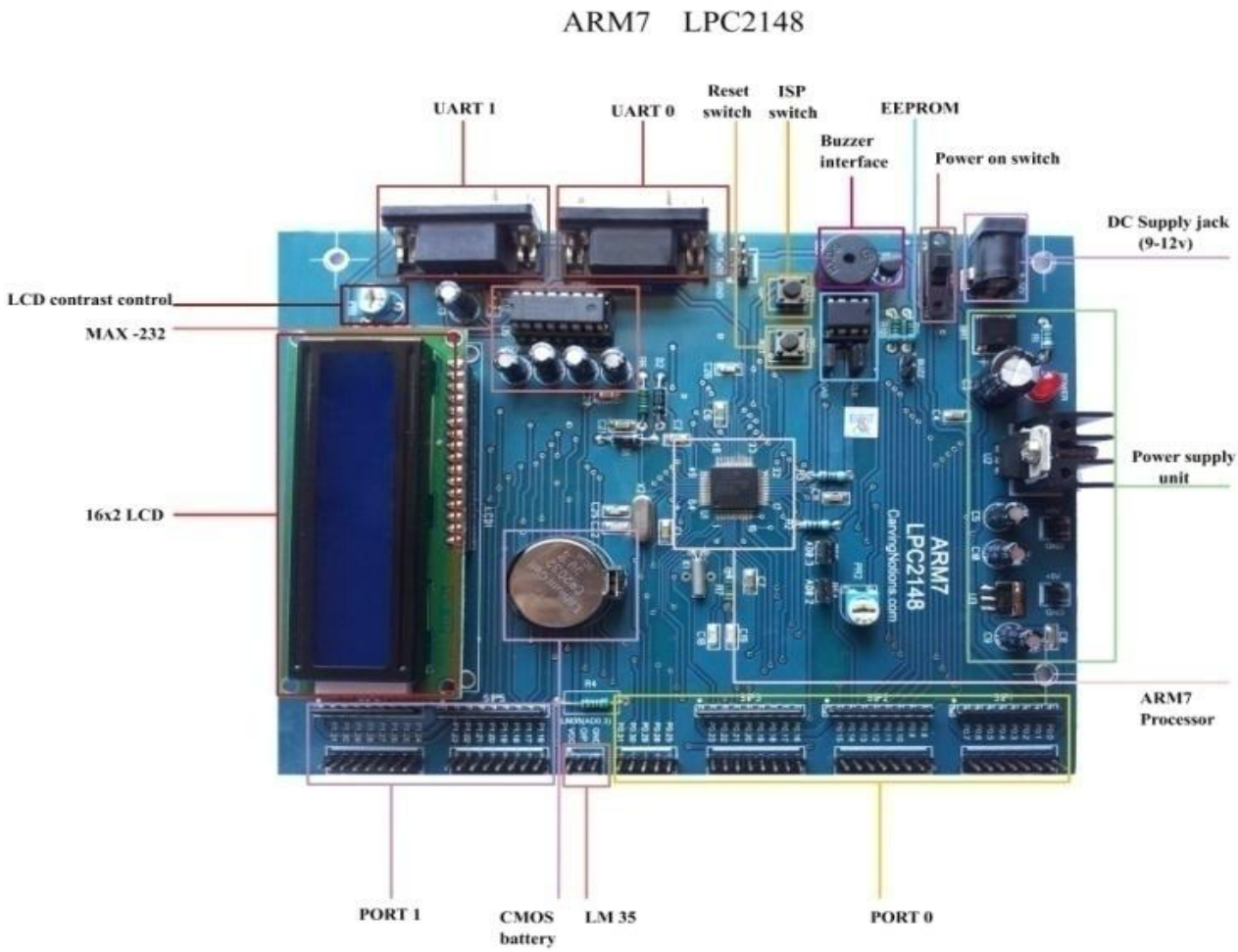

Fig.9.ARM LPC2148

Features of the microcontroller will be completely used by the students. The kit will supports in system programming (ISP) which is done by serial port [7].

ASK Board has advanced and new options that helps the user in implementing complex logic, which are used in the design of Embedded Systems. Pipeline techniques are successfully employed so that all parts of the memory and processing systems can perform continuously. Typically, when one instruction is being executed, its successor is decoded, and a third instruction is fetched from memory.

6. TRACKING THE LOCATION OF THE ACCIDENT

Nowadays accidents occur on all the places. Major accidents occur in highways because of the high speed of the vehicle. The main objective of Global Positioning System (GPS) is to detect the accident if occurred and informs the respective authority [8].

The GPS tracker will track the accident from at least three orbiting GPS satellites. The GPS tracker will transmit that related information to a server (computer), and it will display it on a web-based portal which is in-line with mapping software.

The information system of accident will get activated and the message will transmit immediately to the respective authority whenever an accident occurs. This process is done by GSM. In case of any accident, the vibration of vibration sensor increases beyond the limit and information is sent to GSM module. The GSM then sends message to the right person.

7. WORKING OPERATION

Different sensors (alcohol, gas, eye blink) are used to sense the alcoholic nature of the driver, any leakage of gas, the eye-lid movement of the driver. The output of different sensors is given to the microcontroller. The output of the microcontroller is displayed on the LCD. If any gas leakage occurs or when the driver is intoxicated with alcohol or if the driver blinks his eyes, immediately the motor of the vehicle will stop.

If the accident occurs by vibration of rotating machinery of the vehicle, immediately the exact location of the accident is identified by an authority person through Global positioning system(GPS)and message is sent via Global system for mobile Communications (GSM).

8. RESULTS

Table 1. Conditions and their corresponding resultant

S.no	Conditions	Result which is displayed on the LCD
1.	Driver in sleep condition	Driver in Sleep
2.	Driver in alcoholic condition	Alcohol detected
3.	Leakage of gas/smoke	Smoke detected
4.	Occurrence of accident	Accident detected
5.	Information to the authority person by using GSM	Message sent

The results for the above conditions are shown in the following figures.

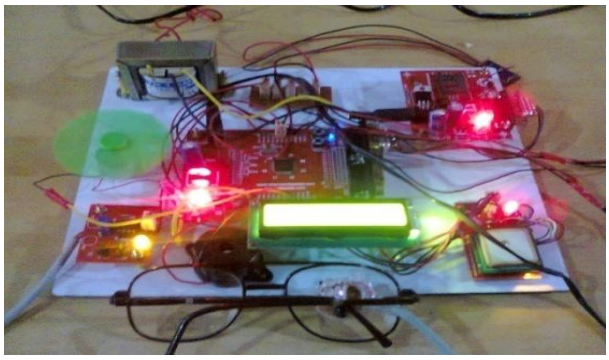

Fig.10 Research experiment picture

Fig.11 When the driver was in sleepy condition

Fig.12 When the driver was intoxicated with alcohol

Fig.13 When there is a leakage of gas/smoke

Fig.14 When the accident is detected by GPS

Fig.15 Message is sent to mobiles through GSM

9. CONCLUSION

Detecting and monitoring the driver behavior is vital to ensure road safety by alerting the driver and other vehicles on the road mainly in cases of abnormal driving behaviors. Behavior of the driver is affected by many factors that are related to the vehicle, the driver and the environment .It is important to capture the static and the dynamic aspects of behavior and take into account the contextual information that relates to behavior of the driver. Nowadays, different driving support systems assistant the driver in reaching his destination safely. In many cases, these systems capture sensory data and present them to the driver. These systems actually process the data captured by the sensors. They act quantitatively relatively to the processed data. The growth of sensor technology and network based information technology has expanded the reach of wire-less sensor networks into numerous areas such as remote control, health care, monitoring of wildlife habitat, detection of military explosive, intelligent home monitoring and environment observation and forecasting system.

10. ACKNOWLEDGEMENT

We are very grateful to the editor and the reviewers for their valuable comments and suggestions to help improving this work.

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