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AN IMPROVED MECHANICAL DESIGN FOR EXPOSED MOTORIST MONITORING SYSTEM USING MEMS

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ABSTRACT

Due to the swift rise of vehicles on roads, the probability of accidents is mounting precipitously. Crashes caused by loss of vigilance in vehicle drivers pose a severe danger to people, not only to drivers themselves but also often to the common civic. In this paper, we propose a hybrid mechanical system that uses different sensors for early detection of perilous driving and sleep deprivation. Alcohol sensor detects the drunken state from breath of the driver and drivers fatigue is determined using flexi force sensor. Mobile baseband sensor is used for detecting and avoiding any mobile phone usage during driving. Accident detection module comprises Micro Electro Mechanical System (MEMS) accelerometer for sensing and detecting collisions and Global Positioning System (GPS) receiver for providing information about the location. Global System for Mobile communication (GSM) modem is used for sending the collected information from different sensors in case of abnormality in driving state.

Key Words: Collision detection, Mechanical Design, Biosensors, Microcontrollers

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1. INTRODUCTION

Road traffic injuries are a major but ignored worldwide public healthiness problem, requiring intensive efforts for effective and viable prevention. Among all the systems that people have to deal with on a day-to-day basis, road transport is the most complex and the most hazardous. There are many types of diversions that can lead to weakened driving, but in recent times there has been a noticeable increase around the world in the use of mobile phones by drivers that is fetching a growing concern for road safety. Sudden text messaging also results in significantly abridged driving performance, with young drivers at particular risk of the effects of distraction resulting from this use. Drivers using a mobile phone are approximately four times more likely to be involved in a crash than when a driver does not use a phone [22]. Driver drowsiness, compounded by the high workloads and stress of the ever-increasing complexity of car and traffic environments, is also a major cause of severe accidents.

2. PRECEDING RESEARCH

Using remotely located CCD cameras equipped with IR illuminators, video images of the driver are acquired. Various visual cues characterizing the level of alertness of the driver are combined to infer the fatigue level of the driver. These visual cues characterize eye lid movement, gaze, head movement and facial expression [2].Physiological parameters such as Electrocardiogram (ECG), Electroencephalogram (EEG), Electrooculogram (EOG), Galvanic skin resistance and body temperature, pulse and oxygen saturation in the blood are measured and the drowsiness of the driver is detected based upon the variations in the above parameters [6]. Gas sensors such as MQ-3 gas sensor detect the alcohol content in the driver’s breath and send the level to the controller unit. If the level exceeds the limit, ignition off will take place [3]. Sweat sensors [4] which are placed on the driver seat are used to detect the drunken condition of the driver. To characterize a driver’s level of vigilance some visual behaviors are monitored. Parameters such as Percent eye closure (PERCLOS), eye closure duration, blink frequency, nodding frequency and fixed gaze. These parameters are combined using a fuzzy classifier to infer the inattentiveness of the driver [5]. The techniques for face detection in color images are plagued by poor performance in the presence of scale variation, variation in skin colors, complex backgrounds, etc. In case of physiological sensors the installation of physiological sensors and electrodes on driver’s body makes the driver uncomfortable during driving session, whereas the use of sweat sensors lead to misreading, inaccurate testing and circuit complexity is very high and the use of Fuzzy interference system (FIS) makes the system complicated and it is hard to implement.

In order to overcome these drawbacks we have provided a mechanical design which integrates the vehicle control system and driver control system as the major reasons for accidents are driver’s behavior. The system ensures the complete hands free usage of mobile phone while driving by auto reply SMS. The system detects the driver’s drowsiness without any privacy invasion using appropriate indirect monitoring system. The continuous monitoring of the alcohol content in driver’s breathe will be uncomfortable for the driver. So system controls the ignition of the vehicle based on the alcohol content. It uses ARM microcontroller for low power consumption, better efficiency and future enhancement.

3. EXPERIMENTAL RESULTS & DISCUSSION

The heart of our system is Microcontroller which accesses the data from various modules such as Mobile baseband monitor, Alcohol sensor, Drowsiness detector, GPS receiver, MEMS accelerometer and GSM modem. An alarm unit is connected to the system which will indicate the drowsiness detection and incoming call intimation. The system is designed as shown in figure 1.

3.1. MPU unit

The various modules in the system are integrated and controlled by ARM7 microcontroller. It has greater performance efficiency, without increasing the frequency or power requirements. Its low power consumption enables longer battery life. It also provides easier programmability and debugging and smaller memory requirements for programming. It has wide choice of development tools. Additionally it has support for modem control with maximum UART data bit rate of 4.5Mbps and built in ADC and PWM ports. Any activity in driver’s mobile phone such as attending incoming calls, making outgoing calls and SMS texting will be actively monitored using the built in Mobile Baseband Sensor circuit and if it finds any activity while the vehicle is running, it will be slowed down to a halt by applying the brakes automatically.

The driver can regain the vehicle control by simply pressing the brake pedal sensor. The system has a built in alcohol testing feature which would instruct the driver to blow air into the sensor unit and checks the alcohol content present in the drivers breathe. If the value has crossed a certain limit the vehicle ignition will be locked which prevents a drunken driver from starting the vehicle. An Alcohol Sensor unit is integrated into the system for this purpose. The output voltage of the sensor varies according to the gas contents in the driver's breathe. The output voltage decreases linearly for CO_2 (normal breathe) and remains constantly at a higher value for the alcohol.

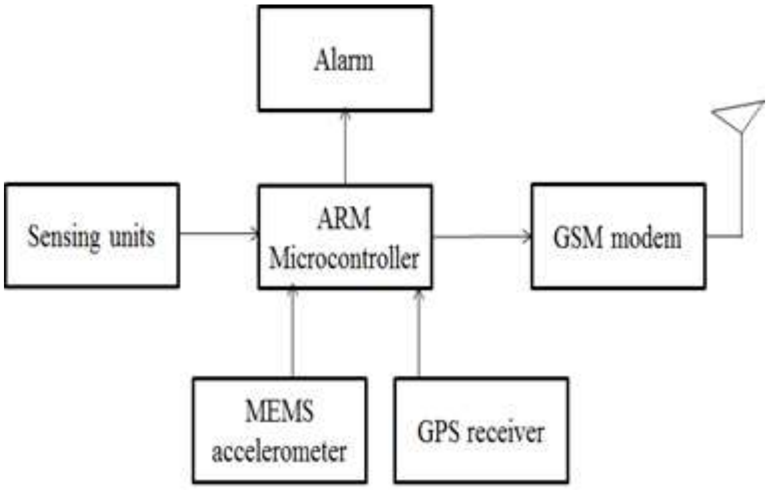

Figure 1. Proposed Mechatronics

3.2. Drowsiness Detector

The system uses an indirect monitoring system for drowsiness detection. This unit consists of a flexi force sensor which senses the grip on the steering wheel while driving. The sensor used is standard force and load sensors model A401. The output voltage of the sensor varies according to the force applied by the driver on the steering wheel column (SWC), which is then amplified using an op-amp circuit for observation. The sensor is driven by the driver voltage which acts as the reference.When the driver is drowsy the force on the SWC tends to reduce which results in increase in the output voltage which triggers the two stages of alarm and any ignorance of the alarm will make the vehicle to halt.

3.3. MEMS Accelerometer & Mechanical Alert System

Generally accelerometer provides tilt compensated direction information. Here it is used to detect any event of accident. This system uses a combination of 3-axis accelerometer and 3-axis magnetometer SOM (System on Module), capable of measuring angular rates around one or more axes, these gyroscopes represent a fitting complement to MEMS accelerometers. So that it is conceivable to track and to capture whole movements in a three-dimensional space. This also includes a digital compass, used as direction sensor. GPS receiver calculates location using Triangulation method. This system uses a 66 Channel GPS receiver interfaced via NMEA (National Marine Electronics Association) Protocol .It has Up to 10Hz update rate and 57600 bps UART interface additionally a built-in micro battery to preserve system data for rapid satellite acquisition. The system uses a GSM modem with a quad band module so that it can operate any of the 4 bands. The alarm unit consists of buzzer, matrix keypad, LCD display. The alarm unit is used to alert the driver as a preventive measure, in case of detection of drowsiness or to intimate the incoming call in addition the key pad is used to input user settings. Additionally the system has the Accelerator Pedal Sensor and Brake Pedal Sensor along with a DC Motor controlled wheel to demonstrate a running vehicle and a driver circuit to interface the microcontroller with the vehicle's motor. The program for the system is written in Embedded C language using the development tool LPC Express IDE.

4. EXPERIMENTAL RESULTS & DISCUSSION

Results obtained are explained with the simple flow diagram in figure 3 shown below. We have developed a prototype model in which we have tested the cognitive output provided by the medical devices against a DC motor connected with a wheel. The power supply section of the system which consists of transformer of output 12 voltage and current of 750mA, which is then trailed by the bridge rectifier circuitry of diodes (1N4007). At the output of this, we get pulsating DC voltage of 5.75 volts. The design of regulator is shown in figure 2. This 5 volt supply is provided to the many components of the system such as LCD display, Touch screen, Alcohol sensor, Flexi force sensor, buzzer, and. The fixed regulator circuitry followed by constant voltage regulator (LM1117) which provides 3.3 volt to the controller, MEMS accelerometer, GSM modem and GPS receiver.

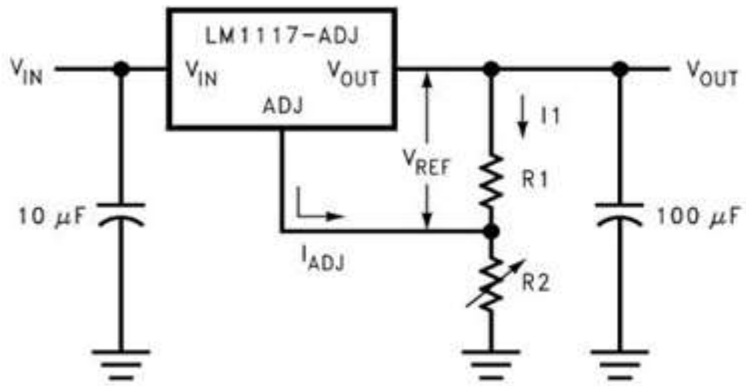

Figure 2. Circuit diagram of voltage regulator

LPCXpresso IDE is an extremely incorporated software development environment for NXP's LPC Microcontrollers, which comprises the entire tools essential to develop high quality Software solutions in a timely and cost effective fashion. A simple layout is shown in figure 5. LPCXpresso supports the full embedded product design cycle by stirring beyond chip Evaluation boards and assist growth on external target boards.The last figure shows the prototype model of the system. Prior to driving when the driver blows air in the alcohol sensor unit, the system determines the alcohol content in the driver's breathing as shown in Figure4. If the alcohol content is within the threshold level, the ignition of the vehicle starts else the ignition does not take place. To start the vehicle, initially the alcohol level in driver's breathe is sensed and level of alcohol should be greater than 100. If the alcohol level is found to be greater than 100, it is confirmed that the driver is not drunken. Figure 6 shows that the alcohol level is below the threshold and the ignition stops. When the alcohol content is not found in driver's breathe it will display that there is no alcohol content and also the value found as shown in figure 6 .

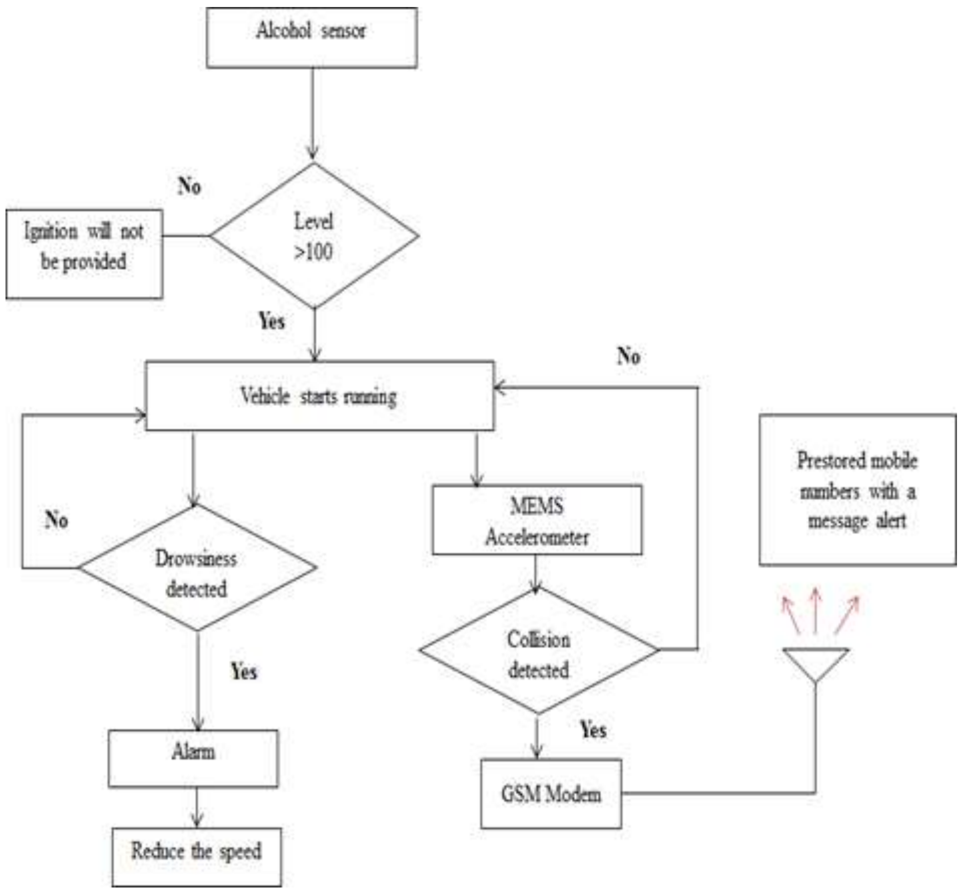

Figure 3. Flow diagram of the proposed model

An analog output Flexi Force Pressure Sensor measures the steering-wheel grip force and the warning is issued with Buzzer and LED Lights. If the driver ignores this warning and continues to drive then the system will apply brakes automatically to slow down and halt the vehicle. Here the brake pedal sensor will be activated and it will reduce the speed of the running DC motor and additionally the prototype model developed can also be set for periodic wake-up call using a Keypad buttons and the dashboard Graphics LCD. The result shown in figure 8 depicts the method of deducing drowsiness at the wheel. When the user firmly holds the flexi force sensor it shows the heart force as shown in figure 7.When the driver is drowsy, and doesn't hold the steering firmly, the flexi force sensor triggers an alarm. This is indicated by unit force value as shown in figure . When the driver feels drowsy, periodically repeating alarm can be set and the numbers of alarms set are shown in figure4 . The speed of a DC motor depends on the given input current. An assembly is constructed using magnet and reed switch. A small piece of magnet placed on the DC motor's rotor spindle. The magnet rotates at the same speed as the DC motor shaft.. When the magnet starts to rotate the each reed switch produces square pulses. This is the magnetic motor speed encoder. By measuring the period between consecutivepulses the speed of a motor is calculated. The function of an MEMS accelerometer is to measure the acceleration of object that it's attached on. It is interfaced to the Microcontroller through Inter Integrated circuit protocol. When acceleration is applied to the sensor the proof mass displaces from its nominal position, causing an imbalance in the capacitive half-bridge. This imbalance is measured using charge integration in response to a voltage pulse applied to the sense capacitor. At steady state the nominal value of the capacitors are few pF and when acceleration is applied the maximum variation of the capacitive load is in pF range. To detect the collision in our prototype model designed we need to just shake MEMS device.

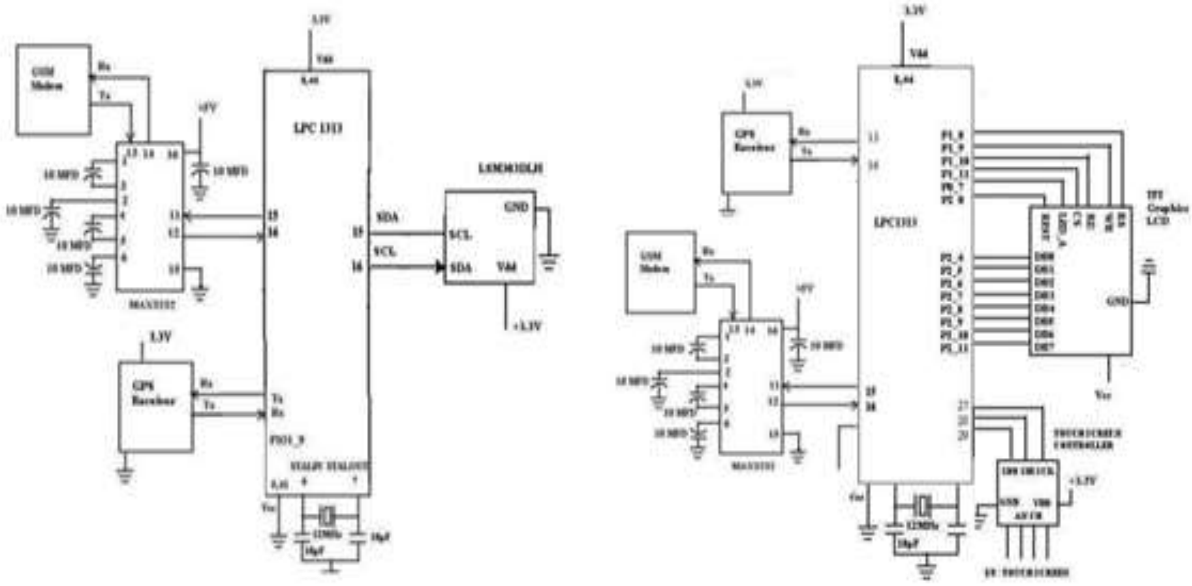

Figure.4 Overall Circuit diagram

Once Vibration is detected the latitude and longitude positions obtained from the GPS device will be sent to the nearby emergency centers through GSM modem.When the driver feels panic, if he press a switch, panic alert along with the location of the vehicle is sent to a pre stored number as shown in figure 8 and during the event of any accident the accident alert along with the location of the vehicle is sent to a pre stored number as shown in figure 8. When the driver receives any call during driving; an auto reply SMS is sent to the calling number that the driver is in driving and the calling number is displayed on the LED as shown in figure 9 The system also detects any incoming text messages in the mobile phone and invokes the auto reply SMS.The PCD8544 is a short power LCD controller/driver, intended to drive a graphic display of 48 rows and 84 columns. All essential functions for the display are delivered in a particular chip, comprising on-chip generation of LCD supply and bias voltages, subsequent in a minimum of external components and low power consumption. The PCD8544 boundaries to microcontrollers through a serial bus interface.

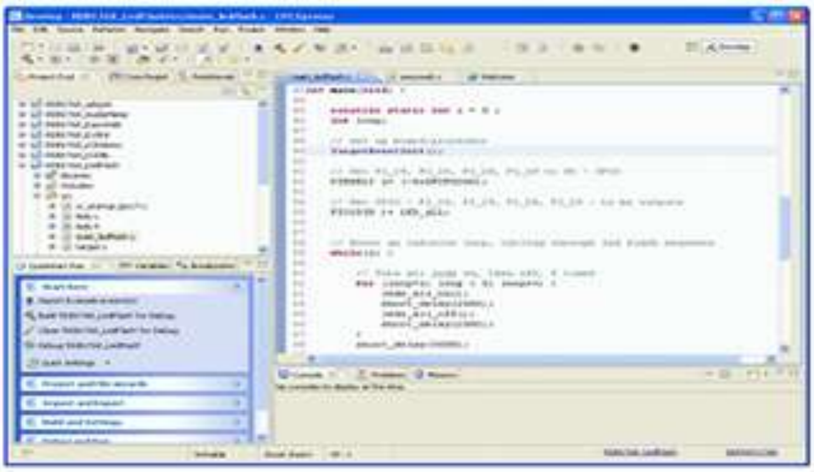

Figure 5 LPCXpresso IDE development tool

Figure.6 Outputs of alcohol sensing unit

Figure.7 Outputs of drowsiness detection unit

Figure.8 Panic and accident alert outputs

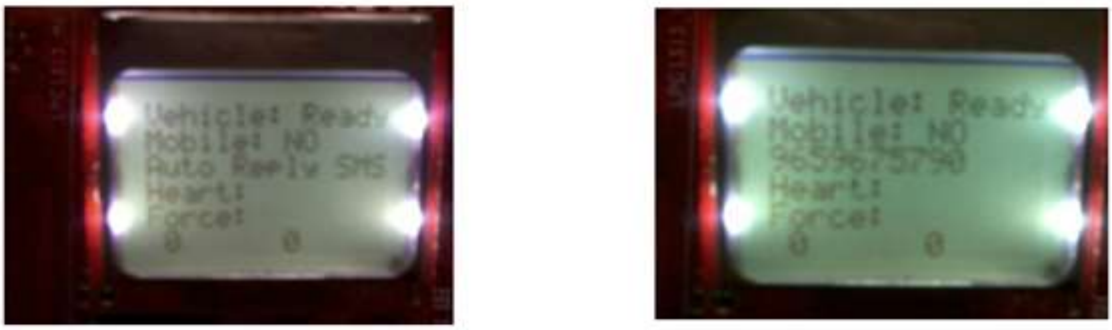

Figure.9 Output results of mobile alert system

4. CONCLUSIONS

We have designed a prototype model of mmechanical smart driver alert system by combining different sensing units. Our system efficiently prevents the ajor causes of road accidents caused by drunken drive, driver's fatigue and mobile phone usage while driving. If the system is implemented in all vehicles, road accidents can be considerably reduced. Collision reduction can be added to the system which will provide a better safety assistance system

Table 1 Precise analysis of the proposed driver alert system

Tested Area	**Gender**	**No of Samples**		**Precise (P)**	
		Aggregate	**Precise**	**Obtained value**	**% (P)**
Urban	Men	15	13	0.8666	86.66
	Women	12	10	0.8333	83.33
Rural	Men	15	14	0.9333	93.33
	Women	12	11	0.9167	91.67

REFERENCES

[1] Boon-Giin Lee and Wan-Young Chung, Driver Alertness Monitoring Using Fusion of Facial Features and Bio-Signals, IEEE Sensors Journal (2012), pp.2415-2422.

[2] P.Busek, J.Vankova, J.Opavsky et al. Spectral analysis of heart rate variability in sleep, Physiological research (2005), pp. 369-376. Hossein Seifoory, DavoodTaherkhani, BehnsmArzhang, Zahra Eftekhari, Hamid Memari,An Accurate Morphological Drowsy Detection, International Proceedings of Computer Science and Technology, 2011,51-54.

[3] P.Caffier , U. Erdmann and P.Ullsperger, The spontaneous eye-blink as sleepiness indicator in patients with obstructive sleep apnoea syndrome - a pilot study, Sleep Medicine (2005),pp. 155-162.

[4] Ayush Mathur, Driver Alcohol detection system, International Journal of Scientific and Engineering research (2013), pp. 1340-1342.

[5] M. Chau and M.Betke Blink Detection with USB cameras (2005),http://www.cs.bu.edu/techreports/pdf/2005-012-blink-detection.pdf.

[6] Chin-Teng Lin, Ruei-Cheng Wu, Sheng-Fu Liang, EEG-Based Drowsiness Estimation for Safety Driving Using Independent Component Analysis, IEEE transactions on circuits and systems (2005), pp.2726-2738.

[7] SK.Lal , A.Craig, P.Boord etal. Development of an algorithm for an EEG-based driver fatigue countermeasure. Journal of Safety Research (2003), pp.321-8.

[8] B.Lee , S.Jung, W.Chung, Real-time physiological and vision monitoring of vehicle driver for non-intrusive drowsiness detection, IET journal of Communications (2011), pp.2461 – 2469.

[9] 9. Lin, Chin Teng, Chang et al. , A Real-Time Wireless Brain–Computer Interface System for Drowsiness Detection, IEEE Transactions on Biomedical Circuits and Systems (2010), pp: 214-222.

[10] Lin, Yingzi, Leng et al, An Intelligent Noninvasive Sensor for Driver Pulse Wave Measurement, IEEE Sensors Journal (2007), pp. 790–799.

[11] T.Morris, P.Blenkhorn, F.Zaidi, Blink detection for real-time eye tracking, Journal of Network and Computer Applications (2002), pp. 129-143.

[12] T.Nakano, K.Sugiyama , M.Mizuno etal ., Blink Measurement by Image Processing and Application to Warning of Driver’s Drowsiness in Automobiles, IEEE Intelligent Vehicles (1998), pp.285-290.

[13] C.Papadelis, C.Kourtidou, C.Papadeli , P.D.Bamidis etal. Indicators of sleepiness in an ambulatory EEG study of night driving. Proc. IEEE International Conference on Engineering in Medicine & Biological Society (2006), pp. 6201-4.

[14] J.Qiang, Z.Zhiwei, P.Lan, Real-time nonintrusive monitoring and prediction of driver fatigue, IEEE Transactions on Vehicular Technology (2004), pp.1052-1058.

[15] Shahina Begum, Mobyen Uddin Ahmed, Reno Filla, Mental State Monitoring System for the Professional Drivers Based on Heart Rate Variability Analysis and Case-based Reasoning, Proc. Federated Conference on Computer Science and Information Systems (2011), pp. 35–42.

[16] M.A.Sotelo, L.M. Bergasa , R.Barea et al, Real time System for monitoring driver vigilance , proc. IEEE Transactions on Intelligent Transportation Systems (2006), pp. 63-77.

[17] E.D.Ubeyli, D.Cvetkovic, I.Cosic, AR spectral analysis technique for human PPG, ECG and EEG signals, Journal of Medical Systems (2008), pp. 201-6.

[18] N.M.Vaishnavi and R.R.Santhosh, Performance Evaluation of Statistical Approach for Drowsiness Detection for Driver’s with and without Spectacles, Proc.2nd International conference on Computing, Communication and Networking Technologies (2010), pp.1-5.

[19] Youn Sung Kima, Hyun Jae Baekb, and Jung Soo Kim etal. “Helmet based physiological Monitoring System”, European Journal of Applied Physiology, pp. 365-372, 2009.