An IoT based Accident Prevention and Car Security System for Vehicles

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***Abstract*— Fatal Road accidents can be easily avoided by understanding the psychological state of drivers. Drowsy driving is one of the main reasons of road accidents. Here is proposal for EEG based drowsiness detection which will alert the driver by alarming and put the vehicle in semiautomatic parking mode by controlling fuel supply. At the same time, it reports nearby police station by SMS which contains necessary information to take essential steps locating the vehicle In this system driver has to wear USB EEG headset. EEG will capture live brain signals and by measuring the slow wave to fast wave ratios of EEG activities, driver's drowsiness will be detected. Arduino Uno with GPS and GSM modules will be used to track vehicle, notify remotely and control servomotor to stop fuel supply.**

Another important aspect is security of the vehicle when it is parked at an unfamiliar location . The human movement is detected using the PIR sensor and the Tilt sensor will trigger Arduino if the vehicle is being towed. The limit switch will provide the condition of the door which is open or closed. Thus the system triggers an alarm detecting the presence of the person or towing vehicle or opening the door in a specific interval of time and the GSM call to user gets activated

Keywords*— *Internet Of Things (IOT); Arduino uno; road accident prevention; semiautomatic parking; drowsiness; GPS; GSM; EEG; PIR Sensor; Tilt Sensor; Limit Switch.

I. INTRODUCTION

Road accident has been one of the main reasons of deaths and injuries. There is a fatal car accident about every 25 seconds [1]. Road accident annually cost USD $518 billion worldwide, kills almost 1.3 million people, wounds or makes disabled other 50 million [2]. Unfortunately, low and middle-income countries are the main victims of these fatalities, about 90% of total deaths and injuries occur there [3]. In Bangladesh, over 12000 people die and other 35000 people get severely injured annually [4]. The economic loss is estimated to be about 2-3% of national GDP of this country [5].

There are a number of reasons behind the road accidents, most of which are related to drivers [6-7]. Driver's fatigue or drowsiness has been proved to be the vital factor of road accidents [8]. When drivers get drowsy, they loss vigilance, abilities of perception and overall control over the vehicle [9-10].

Number of vehicles is increased exponentially. In market various vehicle security systems are available but this security systems can be hacked easily. They are not capable for providing real time analysis of the scenario. Sirens which are been used can be easily disabled. So real time analysis is mandatory for advanced security purpose [11].

Tiny electrical signals are produced by brain cells when they pass message to each other. Electrodes which are placed on brain scalp of subject (person) will pick up these signals and send them to machine called as Electroencephalograph (EEG). [12]. EEG will record the signals as waves or wavy lines on to display or paper. The first human EEG recording obtained by Hans Berger in 1924.This pattern of electric activity produced on EEG can be used for various applications like sleep detection, drowsiness detection, and sleep disorders like insomnia, studying brain activities of coma patients and to diagnose many other conditions which affect the brain.

In this paper, proposed EEG based system will continuously monitor driver's brain signal to detect drowsiness. If drowsiness is detected once, our system will activate a microcontroller module which will enables the buzzer to awaken the driver. It will put the vehicle on semi-automatic parking mode by controlling the oil flow. Also, it will report the nearby police station using GSM and GPS technologies so that the concerned authority can take necessary steps to prevent road accidents.

II. RELATED WORKS

Drowsiness detection is a challenging task on live signals. Previously many systems were implemented to check the driver's attention drowsiness detection and inattention monitoring [13].

Aishwarya et al. [14] utilize visual features such as eye blink, gaze, head movements of drivers to detect their drowsiness. They use IR sensor to monitor eye movement that ignore normal eye blinking. For monitoring head movement, they use Accelerometer ADXL330 which measures 3-axis detection. If drowsiness detected they sent data to the authority through GPS and GSM module. This system has several limitations, since they used IR sensor at day light it will not give proper reading. When drowsiness is detected this system slow the vehicle but still moving that may be caused accident.

Khunpisuth et al. [15] use Computer vision and image processing techniques. The authors detected the drowsiness level of drivers by checking for head tilting and eye blinking rate. They used Pi Camera that is processed by Raspberry Pi 3. They measure with different perspective such as Different Light Condition, Different Skin Color, Wearing Glasses, Geometrical Rotation. These techniques have some serious limitations. Since the physical parameters what these techniques are based on, may be different for different drivers and different driving

conditions, these techniques sometimes incorrectly detect drowsiness which can be misleading. For example, if a driver talks while driving, it could be misdirected as yawning. For detecting actual drowsiness, more effective techniques have been a crucial need. In our proposed system rather, we will use EEG so such kind of limitations doesn't exist here.

III. SYSTEM DESCRIPTION

The overall functional block diagram is illustrated in Fig. 1.

A. Brain signals and their Acquisation:

Electrical activity of human brain which is measured by electroencephalogram (EEG), directly corresponds to the physiological and mental status of human. These activities exhibit rhythmic patterns called brain waves which are classified into five different bands (delta, theta, alpha, beta, gamma) based on their frequency and amplitude of oscillation [16].*:*

1. Gamma (γ)

Frequency: Above 22 Hz

Occurrence: These waves are related to very excited and disordered or restless mental condition and not 'normal' for driving.

2. Beta (β)

Frequency: 13 Hz to 22 Hz.

Occurrence: When a person experiences beta waves as dominant, he remains highly alert, more focused, high state of wakefulness and vigilant.

3. Alpha (α)

Frequency: 8 to 13 Hz

Occurrence: most relaxed and stable brain states. A person while having dominant alpha waves remains balanced, calm with complete awareness of surroundings.

4. Theta (θ)

Frequency: 4 to 8 Hz

Occurrence: Consciousness or vigilance is seen to be significantly declined and drowsiness or light sleep is observed when theta waves are dominant.

5. Delta (δ)

Frequency: 0.5 to 4 Hz

Occurrence: the slowest brain waves and are experienced during deep sleep. During fatigue or drowsiness, delta and theta waves become dominantly stable, alpha waves decreases marginally and beta waves decline significantly. Different algorithms such as θ/β, α/β, (θ+α)/(α+β), (θ+α)/β and (θ+ δ)/(α+β) have been used to determine the drowsiness. Among them, (θ+ δ)/(α+β) and (θ+α)/β ratios are observed to rise more sharply during drowsiness [17].

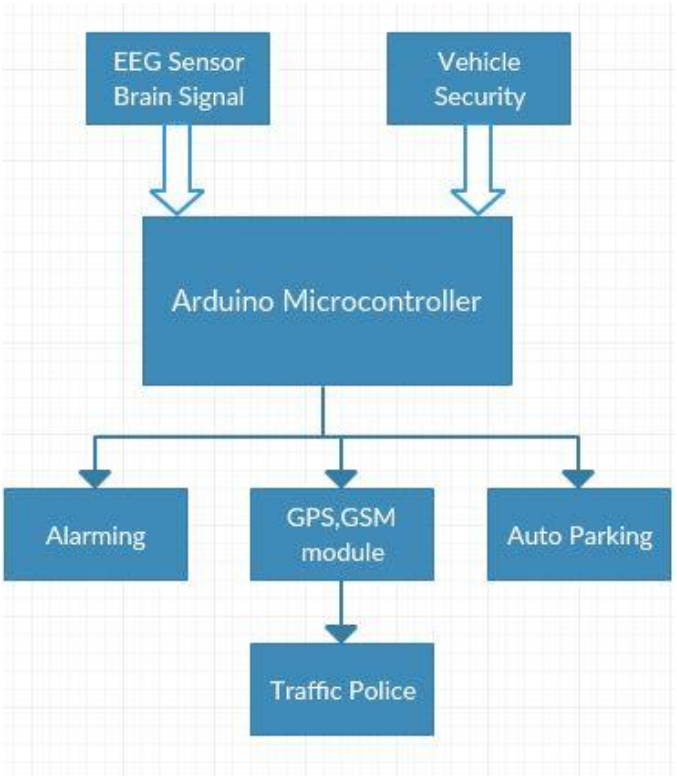

Fig. 1. System Architecture.

B. Signal Processing:

The signal processing unit is an embedded signal processing chip. In this work, we will use MATLAB R2016a v9.0 under Windows 64-bit platform. We will load a large number of signals in workspace, filtered with a 6th order Butterworth filter to remove different artifacts and noises. Then, we will perform spectral analysis of those signals by Fast Fourier Transform(fft) algorithm to resolve the signals and to determine the dominant frequency component for each epoch. Finally, we will calculate (θ+δ)/(α+β) ratio of brain signals for a number of subjects over a certain period of time.

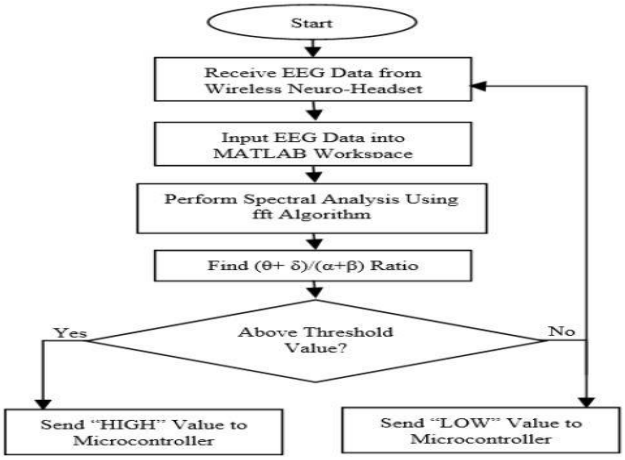

Fig. 2. Flow chart of drowsiness detection algorithm

C. Microcontroller unit:

If the brain states correspond to alert or vigilant, $(\theta+\delta)/(\alpha+\beta)$ ratio is less than threshold level or the fast waves are dominant, it will keep going and the rest of the system remain idle. But when drowsiness will be detected, microcontroller will be enabled and worked as showed in algorithm of Fig 3. It will trigger the buzzer to alert driver, put vehicle auto parking mood by controlling fuel supply and activate GPS, GSM module to send the message and location to near police station or owner of the vehicle. Need to use Arduino Uno as microcontroller device and Arduino IDE for programming platform.

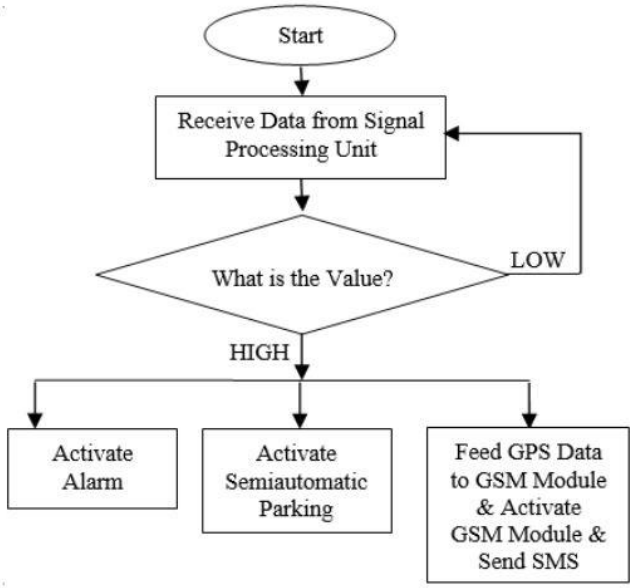

Fig. 3. Flow chart of controlling and reporting system

D. Alarming unit:

The buzzer system is an immediate safety for the vehicle until police locate the vehicle. It will be connected with the Arduino as output device. When the buzzer rings, it awakes the driver and the driver is then bound to park the vehicle to the nearest suitable place if it is made mandatory traffic rule.

E. Semi Auto-Parking:

This sub module will enable immediately after the drowsiness is detected. We will design vehicles speed control system by controlling the fuel supply to the engine as shown in the Fig. 4. Usually, driver supplies fuel to the engine by pressing accelerator through a pipe line. In our semiauto parking system, we will use a valve attached to the pipe line which could rotate clockwise or anti-clockwise. The movement of valve will be controlled by a servo motor. When drowsy condition of driver will be detected, the microcontroller will send a signal to the servo motor and then it will move in such a direction that the valve connected to it blocked the pipe line. In this way fuel supply to the engine will be controlled and it would make the driver to park the vehicle in a nearest suitable place.

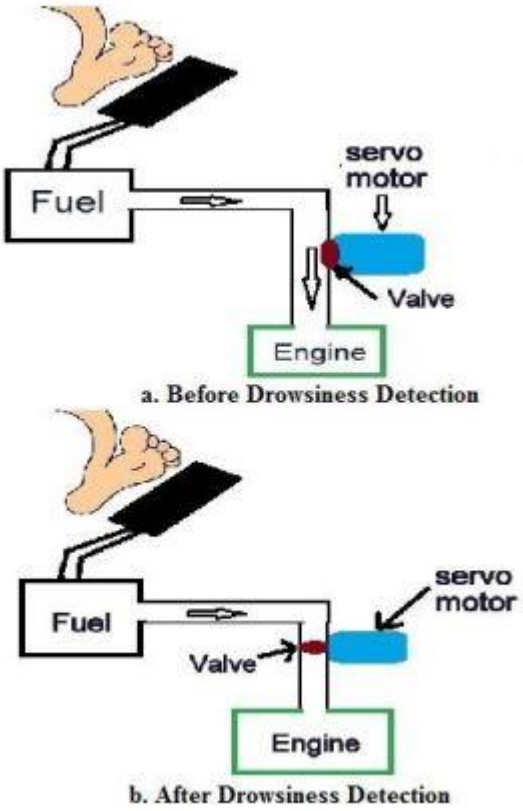

Fig. 4. Semi Auto-Parking Mechanism

F. Vehicle security:

In This model Fig. 5 Car security against external threat will be achieved by using Limit Switch for Car door opening detection, PIR sensor will be used for Intruder's presence and Tilt sensor will be used for Towing of car.

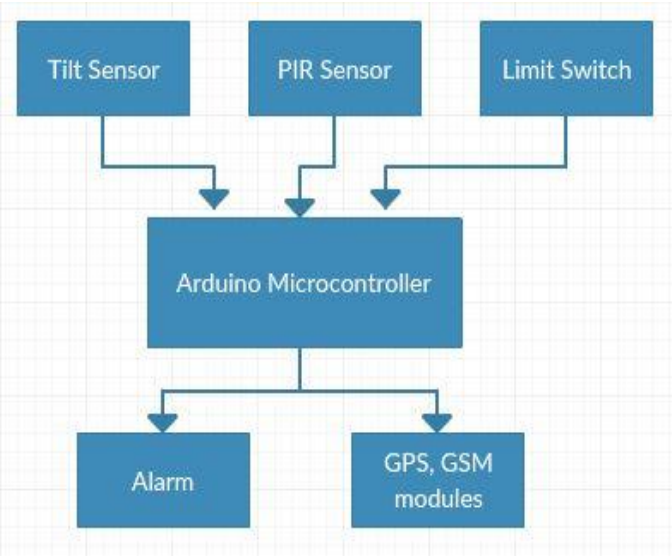

Fig. 5. Block model for Vehicle security

1. **Limit Switch:** Switch operated by the presence of the object which is the motion of the machine part is known as limit switch. [18] Safety interlocking will be done by limit switch. There will be an actuator which is linked with mechanical contacts. When any object comes in contact with this actuator the device breaks the electrical connection. In this way the limit switch will provide the condition of door which is opened or closed

Fig.: Limit Switch

2. **PIR Sensor:** PIR sensor will be used to detect motion (change). The output of PIR sensor goes high when the sensor detects any variations in its proximity. When the controller receives signal GSM call program will be initiated.

Fig.: PIR Sensor

3. **Tilt sensor:** Tilt sensors are used to detect the inclination or the orientation. The purpose of using tilt sensor in this project is to detect whether car is being towed. The car towing will be detected and informed to the car owner to avoid theft of vehicle or damage in case of towing.

Fig. Tilt Sensor

G. Requirements:

Hardware:

1. **EEG Headset**
2. **Arduino Uno**
3. **Servo motor**
4. **PIR Sensor**
5. **Tilt Sensor**
6. **Limit Switch**
7. **Buzzer**
8. **GPS, GSM module**
9. **Connecting wires**

Software:

1. **Windows Operating System(64 bit)**
2. **MATLAB R2016a v9.0**
3. **Arduino IDE**
4. **Police Station No list**

IV. PROPOSED RESULT

The obtained dataset will be converted $(\theta+\delta)/(\alpha+\beta)$ ratio. If it is less than threshold level or the fast waves are dominant, it will keep going and the rest of the system will remain idle. But when drowsiness is detected, microcontroller will be enabled. If the car is towed or any motion is detected or any objects come in contact then buzzer will be activated.

IV. CONCLUSION

In this paper, we discussed the latest technology that can help to reduce road accidents caused by driver drowsiness. An EEG based driver monitoring system ensures secure travelling will provide the complete Protection by using brain sensors arrangement. The GPS module used to indicate the location and GSM module to communicate the location information to the authorized person to guarantee the effective working of designed system.

VI. REFERENCES

[1] Association for Safe International Road Travel (ASIRT) , Road Crash Statistics. http://asirt. org/ initiatives/ informing-roadusers/road-safety-facts/road-crash-statistics, 2016.

[2] Global Status Report on Road Safety, World Health Organization (WHO), 2015. Available: http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/

[3] "World report on road traffic injury prevention," WHO, Geneva, 2004. Available: http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/ [23 May, 2016]

[4] Md. Mazharul Hoque, Zobair Ibn Awal, Sabreena Anowar, Shahnewaz Hasanat-E Rabbi, S. M. Sohel Mahmud, "Road Safety Research Needs and the Role of Accident Research Centre (ARC)", Proceedings of the National Symposium on Engineering and Technological Education (NSET), BUET, pp.95-100, 29 December, 2007.

[5] Hoque M. M.,Mahmud S. M. S., Paul S., "The Cost of Road Traffic Accidents in Bangladesh", 10th Pacific Regional

Science Conference Organization (PRSCO) Summer Institute 2008, Bangladesh Regional Science Association (BRSA), pp. 88, 15-17 May, 2008
[6] Jonathan Mosedale, Andrew Purdy, Eddie Clarkson, "Contributory factors to road accidents", Available: http://www.mvs.net/safety.html [23 May, 2016]
[7] "National Motor Vehicle Crash Causation Survey", U.S. Department of Transportation, National Highway Traffic Safety Administration, July, 2008. Available : www-nrd.nhtsa.dot.gov/Pubs/811059.PDF [23 May,2016]
[8] "Driver Fatigue and Road Accidents", The Royal Society for the Prevention of Accidents (RoSPA), Available: http://www.rospa.com/roadsafety/advice/drivers/fatigue/roadaccidents/, June, 2011.[23 May, 2016]
[9] Jennie Connor, Gary Whitlock, Robyn Norton, Rod Jackson, "The role of driver sleepiness in car crashes: a systematic review of epidemiological studies," Accident Analysis & Prevention, vol. 33, no. 1, pp. 31-41, January 2001.
[10] Al-Khateeb, G.G., "Analysis of Accident Data and Evaluation of Leading Causes for Traffic Accidents in Jordan," Jordan J Civ Eng, vol. 4, no. 2, pp.76-94, 2010
[11] Warankar, Sayali, et al. "Arduino based Car Security System." (2017).
[12]TP, D., & Reddy, V. EEG Based Drowsiness Detection Using Mobile Device for Intelligent Vehicular System.
[13] S. Kaplan, M. A. Guvensan, A. G. Yavuz and Y. Karalurt, "Driver Behavior Analysis for Safe Driving: A Survey," IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 6, pp. 3017-3032, Dec.2015
[14] Aishwarya, S. R., Ashish Rai, Prasanth MA Charitha, and S. C. Savitha. "An IoT based accident prevention and tracking system for night drivers." International Journal of Innovative Research in Computer and Communication Engineering 3, no. 4 (2015): 3493-99.
[15] Khunpisuth, O., Chotchinasri, T., Koschakosai, V., & Hnoohom, N. (2016, November). Driver Drowsiness Detection Using Eye-Closeness Detection. In Signal-Image Technology & Internet-Based Systems (SITIS), 2016 12th International Conference on (pp. 661-668). IEEE.
[16] PL Nunez, Ramesh Srinivasan. Electric fields of the brain: the neurophysics of EEG, Oxford University Press, USA, 2006
[17] Hossan, Alamgir, et al. "A smart system for driver's fatigue detection, remote notification and semi-automatic parking of vehicles to prevent road accidents." Medical Engineering, Health Informatics and Technology (MediTec), 2016 International Conference on. IEEE, 2016.
[18]Paperoncarsecurityissue:http://www.panisch.com/wpcontent/uploads/2012/06/Security_Issues_in_Modern_Automotive_Cars.pdf