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A Novel Signal Processing Based Driver Drowsiness Detection System

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Abstract

Drowsiness is a major cause of vehicle collisions and it most of the cases it may cause traffic accidents. This condition necessitates the need to develop a drowsiness detection system. Generally, the degree of sleep may be assessed by the number of eye blinks, yawning, gripping power on the steering wheel, and so on. These methods simply compute the actions of the driver. Henceforth, this research work proposes a Brain Computer Interface (BCI) technology to evaluate the mental state of brain by utilizing the EEG signals. Brain signal analysis is the main process involved in this project. Depending on the mental state of the drivers, the neurons pattern differs. Different electric brain signals will be produced in every neurons pattern. The attention level of brain signal varies from general state when the driver is sleeping mentally with eyes open. Various frequency and amplitude of EEG based brain signal are collected by using a brain wave sensor and the attention level is analyzed by using a level splitter section to which the brain signals are made into packets and transmitted through a medium. Level splitter section (LSS) figures out the driver's state and provides a drowsiness alarm and retains the vehicle in a self-controlled mode until the driver wakes up. Additionally, this research work will provide an alert to the users and control the vehicle by employing the proposed model.

Keywords: Brain Computer Interface, EEG signal, level splitter section (LSE), RMSE, accuracy.

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1. Introduction

As the population grows, so does the number of cars on the road, reducing available resources. According to current research, the number of accidents in cities and bustling towns is higher owing to high population density and pollution. [1]. Drunk and drive, juvenile driving, rash driving, Racing in highways, Concentration losing situations are some of the causes for accidents to take place in current era. Driver's mental and physical sickness, tired feeling and sluggishness are one such condition for accident [2, 3].

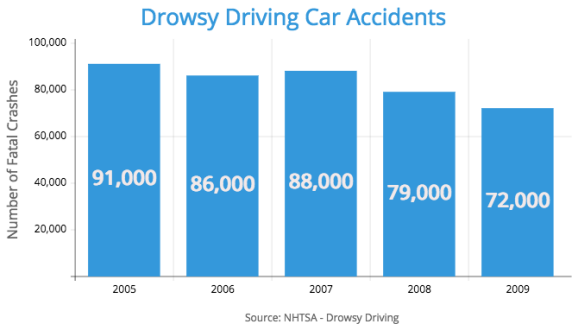

Figure 1. Percentage of drowsy driving car accidents

Large size vehicle drivers, who encounter drowsiness while driving in highways causes serious accidents as it is a place, where small error lead to big troubles. Driver's mental state can be recorded by various methods. The time when the driver feels drowsy is also monitored [4]. As we observe, all those methods use physical factor as one of the determining factors where yawning, eyelid closure, heartbeat rate and all other related parameters are evaluated. There are some shortcomings, since monitoring can't be done by using physical factors.

The EEG (Electroencephalogram) used here is new to this platform but it is highly accurate and steady. Feature extraction and classification methods for identifying drowsiness are used by several EEG related systems [5, 6]. This paper shows major gap that is the channel selection

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method is not clearly specified. Researchers are going for proper detection of channel for accurate detection of drowsiness. Here another issue is that there is no public dataset, each technique is comprised on bits of dataset. Accidents that are caused by drowsiness, collisions and consuming alcohol can be avoided by implementing the steps taken by this system. Several techniques are used to identify drivers fatigue such as correlation procedures, facial pixel and eye ball tracking, eye identification, image processing, facial expressions etc. Drivers activities are examined by the proposed model and accidents that are caused by the feebleness of the driver are avoided. The prototype comprises of distinct components that are interconnected to the ARM 7 microcontroller [7].

Figure 2. Brainwave sensor

The processor inputs are brainwave sensor, ultrasonic sensor and gas sensor. The outputs are LED, Buzzer and Motor. The necessary specification is in line to the input 5 volts DC from 230 volts AC power line. In 2014, 73,000 collisions, 42,000 accidents and 800 demises resulted due to drowsy driving. However, these counts are underrated, and up to 6,000 mortal crashes are resulting every year due to feeble drivers. The battery life is increased because of less power

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consumption and greater performance efficiency of the vital component ARM 7 processor which enables many works to be done without rise in the frequency [8].

2. Literature Survey

Ref. No	Problem	Solution	Remarks
[9]	To develop a system that recognizes driver's languor utilizing image, signal and data set inputs.	Driver tracking data from EEG model, Gyroscope model and Vision model are utilized. Prophecy for cost and accuracy are done.	This appliance can be used in manufacturing units owing to accuracy.
[10]	To develop a device to determine driver's sluggishness utilizing facial image, YawdDD and NthuDD data set.	Indoctrination and verifications are done by experimenting the Multi-task ConNN model accuracy and loss. The sluggishness was assessed when the PERCLOS threshold (fPERCLOS) >0.24.	Owning a single conNN Model, the system is quick and dynamic.
[11]	Design a system to find Drivers alertness associated data utilizing neural network algorithms and signals as input.	Examining and correlating drivers physical characteristics, visual behavior (languor, sluggishness)and Vehicle dynamics.	Multiple sources of information determines driver's unusual behaviours.
[12]	To discern driver's fatigue by brain computer interface with fNIRS signals.	Evaluating fatigue by channel wise instance. 2-class feature spaces map for DNN and CNN.	This system found at the time of fatigue, 13 different brain channels act effectively.
[13]	To create a model for Driver's safety (supervising and alerting) utilizing EOG signals.	Eleven measurements are used for obtaining the characteristics of EOG signals.	This model creates a driver's tracking system at lesser price.

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[14]	To design a system for frequently examining driver's activity and providing appropriate reactions with EEG signals.	Analysing the efficiency of SPLLD with other approaches are done.	Enhanced interpretation are produced by this powerful and non-linear device.
[15]	Recognizing driver's lethargy using differential phase synchronization with EEG signals.	The regression estimation are calculated using RMSE, CC and MAPE. Observation graph reveals percentage growth in RMSE, CC and MAPE with MTDNN method over the existing procedures.	It expressed a 15.48% lesser RMSE, a 26.15% lesser MAPE and a 10.03% greater CC than SVR is MTDNN method.
[16]	Prediction of driver's feebleness by Differential Entropy from EEG signals utilizing SEED-VIG dataset.	Scheduled method for VIGNet is correlated with previous technique, calculated in terms of Classification (Accuracy=0.96±0.03, Precision = 0.97±0.12) and Regression(RMSE= 0.04±0.01).	On correlating with other similar methods this network shows great achievement on public open SEED-VIG with less state parameters.
[17]	To design an advanced helmet containing implanted EEG and brain wave sensors for driver's safety.	The condition of driver is calculated by the Arduino reading in microvolts which are transformed to signal frequency (Hz) utilizing SSD.	In fourth coming model, online alerting in real time will be initiated.
[18]	Evaluating driver sluggishness level by observing the EEG signal utilizing FWET algorithm.	Drowsiness index was compute utilizing sixteen healthy subjects. RMSE, CC are the evaluation metrics to compute error and correlation between the anticipated and ground truth DIs.	FWET never requires labelled or unlabelled assessment info from different users.

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[19]	To develop an online driver drowsiness tracking system utilizing EEG signals.	RMSC and Correlation Co-efficient are utilized to analyse the performance graphs	Over the network it is tough to check the RMSE metric So, in forth coming years offline surveying of RMSC provides intensified result.
[20]	To Evaluate the languor state utilizing scrutiny of EEG signals.	The EEG power spectrum for the alpha band is inspect for 12 samples from the Physio net sleep-EDF directory. Languor state by the system and the user is examine for every individual.	Acquired 80% as comprehensive languor identification level.
[21]	Recognising the driver fatigue utilizing Electroencephalography .	Twenty-two subjects were utilized to calculate inter and intra hemisphere integrities. The P-value, frequency band and alertness level was attained by combined t-test.	Computational intricacy must be minimize to carry out this process in real time.
[22]	To determine feebleness of the driver utilizing EEG sensor	Depending on three waveform parametric quantities (Amplitude, Frequency, and Duration of synchronization) evaluation was done.	The modular technique makes the system adaptable to several other application
[23]	To analyze the mental state of an individual by analysing the EEG signals of brain.	Using a forehead single dry electrode that collects EEG based brain signals, the amplitude and frequency is analysed.	It is made up of non-invasive sensor that won't hurt the user.
[24]	Detecting driver's drowsiness by utilizing	This experiment utilizes 8 right-handed users.	Needs limited processing time

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	a multimodal approach by merging EEG and EOG signal.	The proposed technique out performs 8 existing methods in terms of validate accuracy and standard variance.	and easy to be carried out in the BCI online systems.
[25]	To develop a system for estimating driver's Sluggishness utilizing facial characteristics and EEG signals.	An indication is sent when the driver's eyes stay closed beyond the threshold period and frequency of brain wave is less than 4 Hz.	An Exceptionally cozy gadget should be fabricated in prospective years.

3. Proposed System

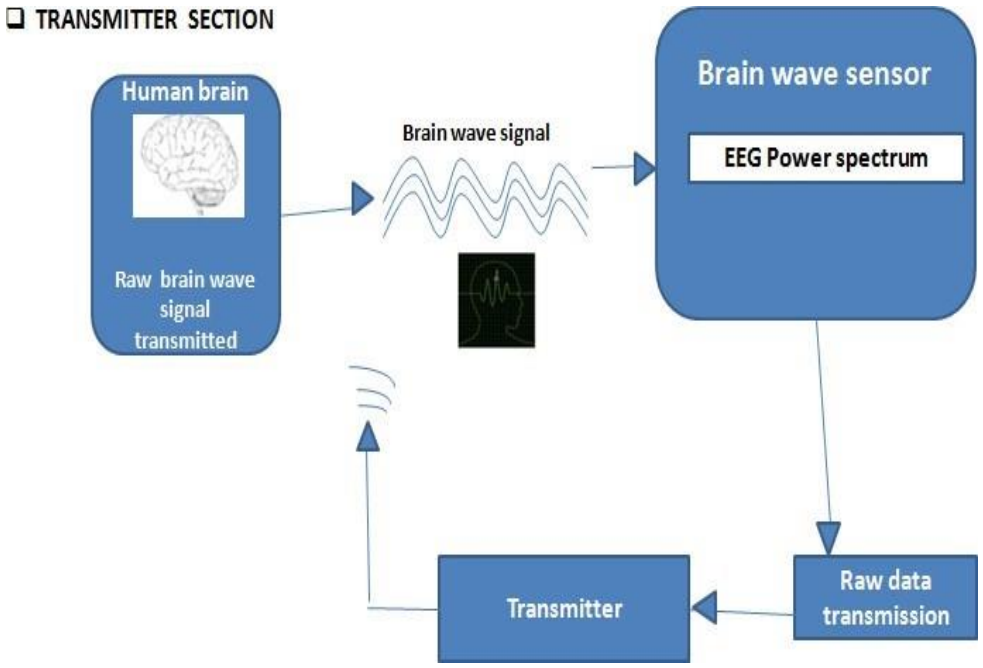

Figure 3. Transmitting section

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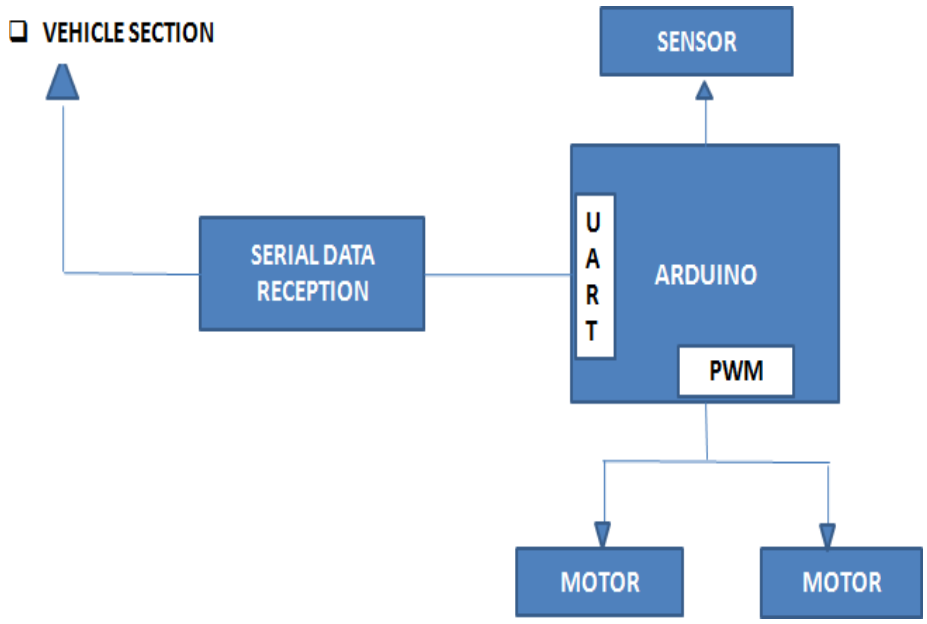

Figure 4. Receiving section

The drivers brain wave signals are recorded by the system and exhibit the wave shape, amount of alcohol consumed and the distance between the vehicles are determined.

Sensors: To identify sleepiness, closeness and intoxicant consumption, the model is integrated with Brain wave sensor, Ultrasonic sensor and Gas sensors.

Brainwave Sensor: The brain waves vary from one individual to the next, also from elders to children depending on amplitude and frequencies when they differ from one level to another such as alertness and sleep.

Based on the various frequency levels from minimum to maximum, there are specific bands such as alpha (α), theta (θ), beta (β), delta (δ), and gamma (γ). Alpha and beta waves are mainly recognized with reference to our feasible brainwave sensor. The activity of the brain is analyzed by Brainwave sensor which uses Bluetooth to transmit info to the system. This deals with the

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realistic variation that goes through the brain. The Mind wave Mobile sensor from Neurosky, an EEG headset is one of the splendid inventions with regard to brain-computer interface. It includes a headset, an ear-clip and a sensor arm. The headset reference and ground electrodes are on the ear clip, while the EEG electrode is on the sensors arm, resting on the forehead above the eye. Feature extraction is the very commonly utilized and the blocks referring this system of extraction and classification is shown below.

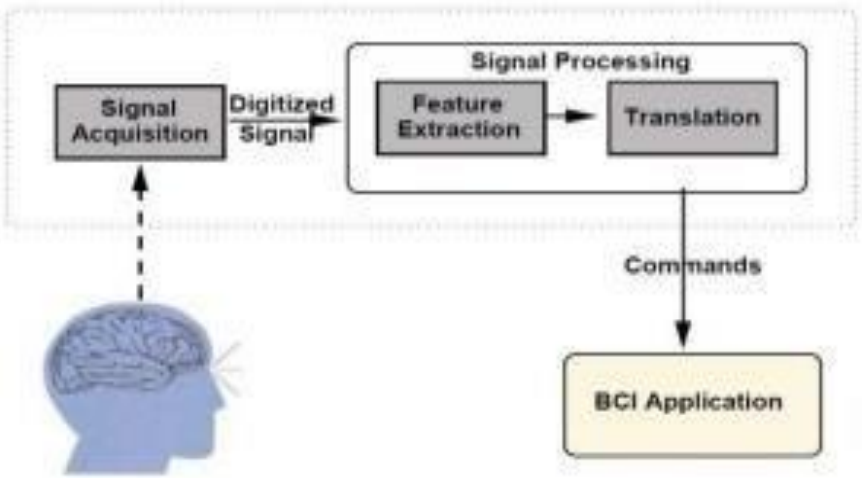

Figure 5. Block diagram of the feature extraction system

Accidents are one of the causes for the economic loss in a nation. The economy of a nation is also improved by this factor. Henceforth it is good to avoid even a single step towards accident. So, alerting drivers about the upcoming- risk by detecting drowsiness is necessary. In order to regulate the drowsiness level, EEG is used in both Brain-Computer interface and cognitive neuroscience area. Spectrally, the brain waves are examined. The vital process of this project is to identify and implement an automatic approach depending on the artificial neuronal network (ANN) using only in EEG channel and with the help of Fast Fourier transform (FFT) this was examined on 10 persons with 9 features. The paper results with classification accuracy rate of 86%

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and 84% of drowsiness, embedded implantation is adapted in this method. A scientist from China, Chin-Teng briefs that the present BCI system are generally big and need to pass the EEG signal to the system for further processing. His paper notifies the driver when he feels drowsy by examining the mental state of the driver. Embedded signal processing module and wireless physiological signal acquisition module are attained in this model. The power consumption and volume of the proposed system is low. Hence, this the advantageous part of this model. Certain papers developed and implemented Drowsiness Recognition Algorithm. Below are some further survey of scientists regarding the drowsiness detection using brain-monitor interface.

4. Experimental Results

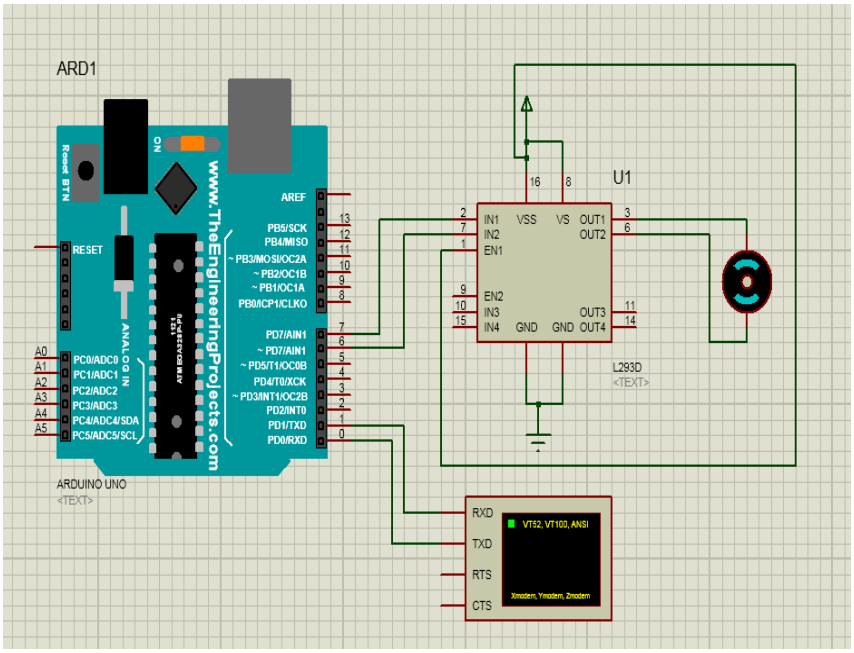

Figure 6. Circuit layout

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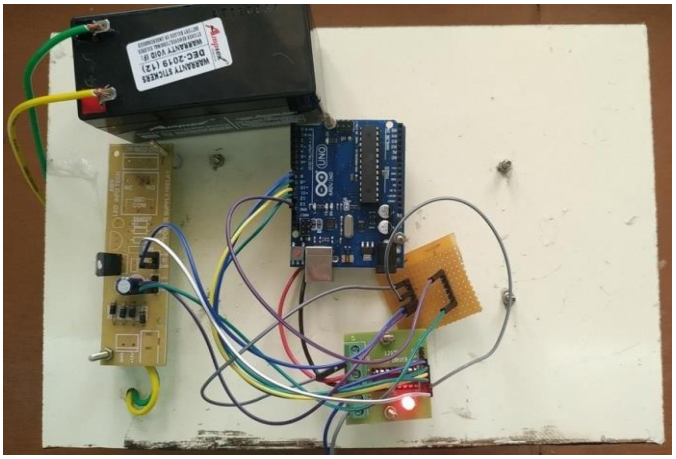

Figure 7. Receiver section [On Position]

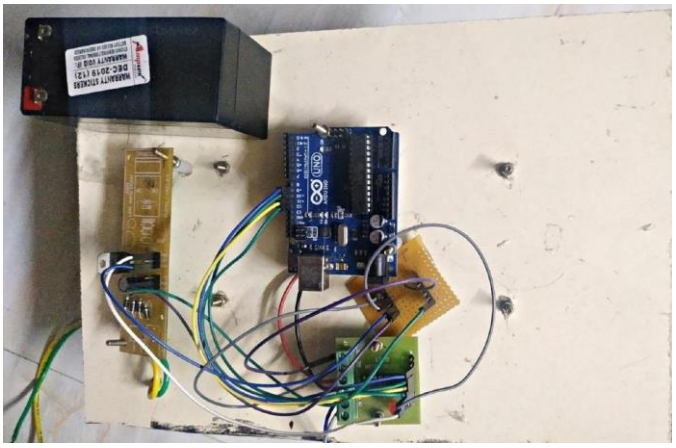

Figure 8. Receiver section [Off Position]

5. Conclusion

The proposed technique outperforms the existing methods by not only detecting driver's drowsiness based on physical actions but also by analyzing and evaluating the mental state of the driver. The Brain Computer Interface (BCI) technique evaluates the brains mental state by utilizing

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the EEG signals. The billions of neurons in the brain generates a specific neuron pattern. Henceforth, with the help of the neuron pattern, one can determine the mental state of the driver. Evaluation metrics such as accuracy, precision, RMSE, correlation coefficient are utilized in this technique. Varied frequencies and amplitude of the EEG signals are accumulated and the alertness range is evaluated by utilizing a level splitter. If there are any issues, it renders a drowsiness alert and following which the cab goes into self-controlled mode until the driver is back to normal. Thereby, this technique helps to prevent the occurrence of accidents.

6. Future enhancement and application

The development of non-invasive BCI devices based on an EEG is an exemplary of future mainstream availability of BCI technique. To manage actions of a prosthetic limb or for thought-to-text transcription BCI technology can be utilized. There are many scope in the following platforms: Automobile, Robotic, Home, Monitoring device, Remote control applications.

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