EEG Based Driver Drowsiness Detection

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Abstract- *Human lethargy suggests a physiological state of decreased mental or physical execution coming about from inadequate rest, long commitment periods or tiring work hours. The limit of a man to stay caution and settle on decisions rapidly reduces in the midst of the drowsiness plight. This circumstance shows a possibly issue in drivers. Drowsy driving remains a considerable contributing factor to accidents. So it is critical to identify the sleepiness and to create programmed indicators of this stage, with a specific end goal to avoid and diminish the radical number of mishaps and accidents caused hence. The purpose of this work is to develop a modified technique to recognize the state of drowsiness in EEG records using wavelet analysis.*

Keywords- Electroencephalography(EEG), Drowsiness, Wavelet Analysis, Sleep, Driver, DWT

I. INTRODUCTION

Drowsiness is transient phase from the state of alertness to sleep. Drowsiness moderates response time, diminishes mindfulness, and weakens judgment. Driver can't focus on primary duty of driving which may enhance the likelihood of crash and accident. With the ever-growing traffic conditions, this problem will further worsen. Drowsiness remains a long-standing road safety issue and the improvement of enhanced strategies to quantify it has advanced gradually. Moving towards more exact prediction of drowsiness has been a enduring point inside the field and it remains an issue of huge significance to research and industry.
The improvement of innovations for identifying or avoiding drowsiness in the driver is a noteworthy challenge in the field of accident prevention systems. There are different symptoms that suggest to the drivers to quit driving and take a rest such as tired eyes, difficulty in keeping head up, restlessness, yawning, floating from path, hazy vision, rubbing eyes, and so forth. In any case, dodging these signs could prompt a genuine or harmful mischance while driving. Designing EEG experiments for studying the brain diverse driver's drowsiness identification measurements have been proposed in the writing. The reported systems so far rely upon various estimations including subjective measure, vehicle-based measure, conduct measure, and physiological measure. Regardless, no perfect prepared system for driver's drowsiness acknowledgment exists, so each proposed system has repressions to the extent cost, feasibility, flexibility, or valuable use.

The utilization of neuroimaging systems, for example, EEG can help the specialists to test for drivers in a simulated exploratory condition. In this way, the simulated condition helps the inventors to control the costs, proficiency, wellbeing, and simple to gather information. The utilization of EEG signals can record the particular example that progressions with the sluggish state or loss of sharpness. In this manner, in future an EEG-based caution framework might be presented by the car organizations for indicating the sleepy drivers either by sound caution or direct controlling of the vehicle.

Drowsiness discovery can be separated into three principle classes[1] : (1) Vehicle based (2) Behavioural based (3) Physiological based. A brief review on these measures will give knowledge on the current systems, issues related with them and the improvements that need to be done to make a robust arrangement.

II. LITERATURE REVIEW

Numerous analysts have worked as of late on systems for driver inattention identification, concentrated predominantly in sleepiness, with an expansive scope of strategies. Few among them have been listed as following :

Vehicle based measures : Various measurements, including deviations from path position, movement of steering wheel, pressure on the acceleration pedal, and so forth are continually observed and any adjustment in these that crosses a predetermined limit demonstrates an essentially expanded likelihood that the driver is drowsy.

- Steering Wheel Movement [2][3]: It is one of the vehicle based measure for identifying the level of alertness of the driver utilizing steering angle sensor attached to the steering column. If the driver becomes drowsy on the steering wheel the numbers of micro-corrections are reduced compared to normal drivers. The researches normally considered only the 0.5 to 5 degree steering wheel movements to dispense with the impact of path changes.

- Standard Deviation Lateral Position [4][5]: The standard deviation of the lateral position referred to as pointer of the nature of driving conduct and driver execution. It has been discovered that here is a close by relationship between drowsiness and standard deviation of the lateral position. How well subjects keep up their path position can reflect by estimating the standard deviation of lateral position. It is a test can give helpful solid data to discover the driver drowsiness. It is estimated in centimeters, utilizing the gadget called electro-optical settled on the back of the vehicle that continuously records horizontal position with respect to path line outline. A few earlier specialists have utilized standard deviation of lateral position as a superior execution measure to discover the accidents. The researchers also concluded that, meanwhile the drivers change their activities in response to the road environmental conditions, it is essential to consider discrete variances while calculating the horizontal position of the vehicle for analysing driver sleepiness.

Behavioral Measures : [6]The drowsy driver behaviour like head posture, frequently yawning, eye closure and eye blinking and so on are seen to identify the driver drowsiness with the help of camera and caution the driver if any one of these signs is indicated in the driver. To measuring abnormal behaviour of the driver, different behavioural approaches are utilized, one such is eye blinking and PERCLOS[7]. Some investigators also used facial activities including inner brow rise, outer brow rise[8]. To overcome the limitation of vision based approach in night, an infrared LED lights are utilized. Unique characterization strategies such as neural network classifier, fuzzy classifier, support vector machine, and liner discriminant analysis used to gauge the driver drowsiness.

Physiological measures : Physiological measures have every now and again been valuable. Physiological signs are more reasonable to finding the driver sleepiness. The physiological measure is an immediate measure and it keeps away from numerous street mishaps due to driver drowsiness. Electro-cardiogram (ECG), electro-myogram (EMG), electro-encephalogram (EEG) and electro-oculogram (EoG), heart rate(HR) and eye developments are conceivable measures for physiological signals.[9][10][11]

Commonly utilized physiological flag to quantify driver drowsiness is Electro-encephalogram (EEG), EEG have distinctive recurrence groups like delta band theta band to gauge the tiredness of the driver. Eye development is one of the measures used to distinguish the driver sluggishness and the distinctive parameters utilized by EOG are eye blinking duration and blinking frequency. Brain and eye measures are sometime combined to measure the drowsiness explained in paper by Renner and Mehring.

Hybrid Measures : [1] Each system utilized for identifying drowsiness has its own advantages and points of confinement. Dependability and precision is progressively when at least two strategies are used in combination to recognize the driver sleepiness that is called hybrid measures. It is a combination of behavioural, subjective and physiological features to detect the driver drowsiness. Loss of driver sharpness is quite often gone before by psycho-physiological and these changes are the reason that it is possible to detect onset of drowsiness associated with loss of alertness in drivers. The fundamental thought behind vehicle-based detection is to monitor the driver unobtrusively by methods of an on-board system that can identify when the driver is impaired by drowsiness. The idea includes detecting different driver-related variables (such as physiological measures) and driving-related variables (driving performance measures), computing measures from these factors on-line, and afterward utilizing the measures independently or in a consolidated way to distinguish when drowsiness is occurring. Measures are consolidated in light of the fact that no single unobtrusive operational measure seems sufficient in dependably detecting drowsiness. Another aspect is the great inter-individual variability in driver and driving conduct, which an eventual automated system must have the capacity to deal with.

III. METHODOLOGY

Literature reports that EEG information gives the the best descriptors of sleep. EEG indicators are the sign of brain interest in a high degree organism. The brain is comprised of neurons which impart by means of electrical driving forces. It is comparable to a system with hubs relating to different activity centers, and meshes comparing to different pathways.

The voltage estimated is extremely small (up to the order of microvolts) and is liable to artifacts and disturbances. These alerts are non-stationary in nature. This implies they have diverse recurrence parts existing at various interims of time. The five essential recurrence groups in a normal EEG sign are characterised as : [12]

- Delta – (0.5 – 4) Hz
- Theta – (four – 8) Hz
- Alpha – (eight – 12) Hz
- Beta – (12 – 30) Hz
- Gamma – >30 Hz

EEG signals straightforwardly measure the neuronal changes taking place because of drowsiness or cognitive fatigue and may be quantitatively analysed using computational techniques to determine useful statistics for evaluation of mind states.

The objectives of this research is to build up a drowsiness detecting system by way of manner of analysing the electro-encephalographic (EEG) signals in a software program.

These signals are recorded via a multi-channel electrode gadget. The number of channels used to record the EEG signals assumes a noteworthy part. More data is received when numerous channels are utilized. Any muscle development impacts the EEG recording which interprets to artifacts. Therefore, noise from the recording is removed by way of subtracting the noisy signals from the unique EEG recording. The filtered signals are analysed with the usage of a time-frequency technique called the Discrete Wavelet Transform (DWT).

Specific goal of this work is to detect drowsiness and therefore we intend to apply records from a publicly available Sleep-EDF database at Physionet or the live data recorded from any EEG capturing equipment. The EEG signals gathered would be examined by DWT that utilizes an eighth order Debauchies' wavelet and five level decomposition is applied to segregate the signal into five sub-groups, to be specific, delta (0.5 – 4 Hz), theta (4 – 8 Hz), alpha (8 – 12 Hz), beta (12 – 30 Hz) and gamma (> 30 Hz). The Fast Fourier Transform (FFT) of the EEG recordings was calculated after sure pre-processing. The spectral analysis of every of the subsequent five sub-groups has been computed. The drowsiness is detected using frequency domain analysis.

IV. EXPERIMENTAL RESULTS

Multiresolution analysis by the wavelet rework is an effective technique to take a look at the numerous different parts of a non-stationary signals. This approach utilizes a mother wavelet as a way to measure the similarity between the premise function and the signal in phrases of the frequency content material. The discrete wavelet remodel is useful for assessment and reconstruction of signals. In this study, the discrete wavelet remodel coefficients are acquired by picking the eighth order of Debauchies' wavelet family.

The following are the screenshots taken after application of above stated methodology to figure out from the used data, if the person is normal or in the state of drowsiness. The Fig 1 shows plotting of EEG data when loaded, then the Fig 2 shows the graph plotted after the wavelets are decomposed and reconstructed with the prominent five frequency bands. The third graph shows the nature of the wavelets after they have been subjected to the Fast Fourier Transform (FFT). The first subject is that of drowsy person and his EEG dataset are loaded into software to carry out the analysis. The results are as follows :

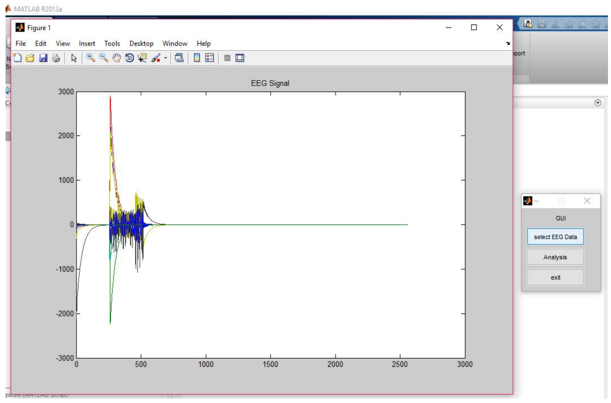


Fig. 1 EEG loaded dataset of a Drowsy person.

Fig. 2 EEG signals of Drowsy person subjected to decomposition and reconstruction.

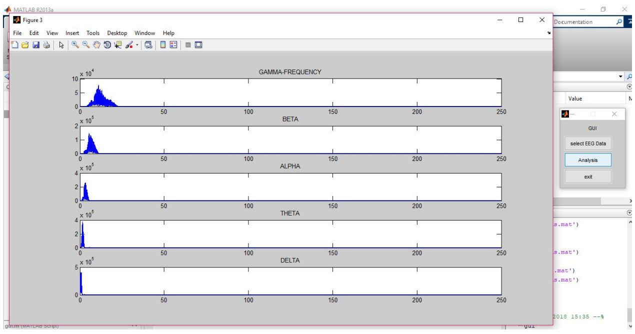
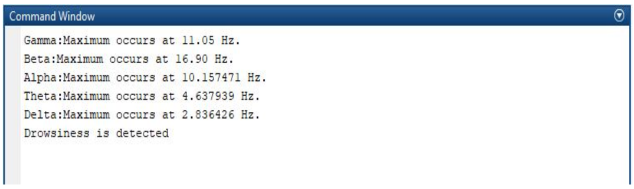


Fig. 3 EEG signals of Drowsy person after application of FFT.


Command Window

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Gamma:Maximum occurs at 11.05 Hz.
Beta:Maximum occurs at 16.90 Hz.
Alpha:Maximum occurs at 10.157471 Hz.
Theta:Maximum occurs at 4.637939 Hz.
Delta:Maximum occurs at 2.836426 Hz.
Drowsiness is detected
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Fig. 4 Detection of the Drowsy state of the person based on the frequency band values.

The primary phase of sleep is described by theta waves, which are slower in frequency and more prominent in amplitude which occur when the subject enters the stage 1 of sleep. During drowsiness, the principal recognizable change is progressive loss of the successive muscle and movement artifacts and diminishment of eye blinks. The EEG contains synchronous frequencies of theta (4– 7 Hz) might be seen with slower exercises getting to be noticeable at some point of drowsiness.

This gives a strong choice making device for a actual-time drowsiness detection system.

Now the results of a Normal and awake person and his EEG dataset are loaded into software to carry out the analysis. The screenshots are as follows :

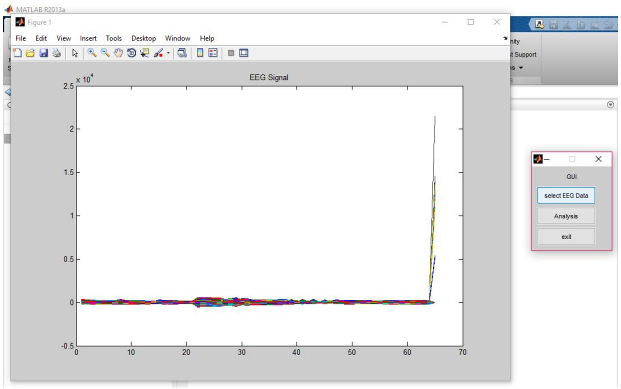

Fig. 5 EEG loaded dataset of a Normal person.

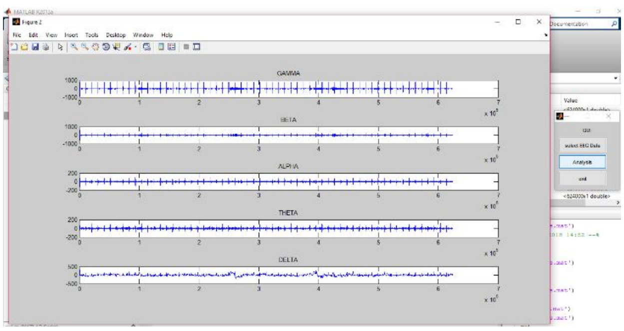

Fig. 6 EEG signals of Normal person subjected to decomposition and reconstruction.

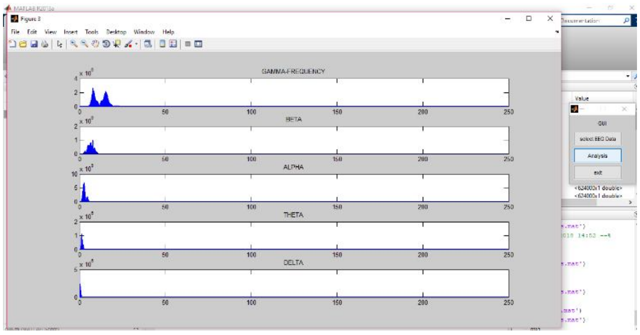

Fig. 7 EEG signals of Normal person after application of FFT.

Fig. 8 Detection of the Normal state of the person based on the frequency band values.

V. CONCLUSION AND FUTURE SCOPE

This studies pursuits to develop a framework for drowsy driving identification or detection of drowsiness with the aid of studying EEG signals of the driver. The Electroencephalogram (EEG) is the physiological signal most commonly used to measure drowsiness. There are numerous algorithms accessible for Drowsiness Detection. But as EEG-based approach can use a shorter shifting-averaged window to track second-to-second changes in the subject execution, the DWT method for drowsiness detection using EEG signal is proposed. This method is implemented through the use of MATLAB software program. The wavelet transform is a powerful toolbox to investigate the time as well as frequency additives embedded in such non-stationary signals. The obtained EEG signal is processed and analysed and from the power spectrum, it is observed that the individual contrasts in EEG progression going with loss of alertness to that of the normal individual.

From the outcomes it is conceivable to keep drivers from causing mishaps because of drowsy driving since this strategy manages biological signals to distinguish the drowsiness of the driver. The above findings help identify the drowsy drivers and possibly save numerous lives while driving which otherwise could have led to cause accidents.

This method can be extended to construct a portable embedded device for a real time driver's alertness monitoring system.

Furthermore, our results conclude that it is possible to estimate the drowsy driving performance, expressed as deviation within the theta band frequencies which generally demonstrate a high state when the subjects are cognizant and relaxed, while the movement supposedly is reducing if the subject tends to nod off or during the onset of drowsiness. Our findings presume that all these are useful for further studies.

For future work, we will concentrate more on the investigation of other EEG features that can be utilized for driver drowsiness identification.

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