EEG Based Drowsiness Detection Using Mobile Device for Intelligent Vehicular System

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***Abstract*—Drowsiness of driver is one of the causes for accidents. Here is proposal for drowsiness detection and alert using mobile phones. In this system driver has to wear USB EEG headset which is connected to mobile device. EEG will capture live brain signals and send to mobile device. Mobile device has a application installed in it which classifies these live signals and capture sleep /drowsiness related signals. Also, if mobile device finds a drowsiness signals it will activate alert in it this enables the driver to wake up or be alert. This proposal involves development of mobile application which classifies the live sleep signals from brain and activates the alert in it**

***Index Terms*—EEG, mobile device, sleep**

I. Introduction

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). EEG will record the signals as waves or wavy lines on to display or paper.

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. This paper discuss about how EEG can be used to implement drowsiness detection in intelligent transportation system for example, cars, airplanes, helicopters etc to monitor drowsiness status of the driver /pilot (called as subject in this paper) and alert them being sleep(figure 1).

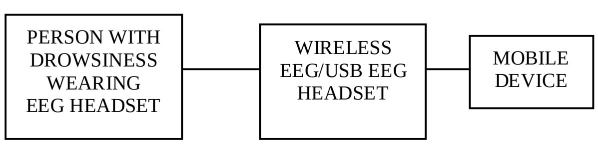

Figure 1. Block diagram for EEG based drowsiness alter system

Driver is the main part of vehicle system and driver condition is related to traffic safety such as driver's emotion state, fatigue state, drunken state etc. Study says accuracy of these states will be reflected very efficiently in EEG. So, now a days in intelligent transportation systems which mainly has network and information, if driver's EEG information can be gathered in Real-time and transportation system is synchronized to this then driver can be alerted and necessary measures can be taken against accidents due to sleep state of driver.

In this paper, combining the mobile device and EEG measuring instrument, the experiments of drowsiness driving will be designed. EEG signals were measured when they were in normal, dworsiness, sleep state.

II. LITERATURE SURVEY

Drowsiness detection is a challenging task on live signals. Many techniques have been proposed on this. One of the method is using Mahalanobis Distance [1][3]which transforms a given multinormal distribution into the simple standard (spherical) multinormal distribution. It also helps in studying the distributions and conditions of independence of quadratic forms in multivariate normal variables. Freuqency bands are separated using DFT or FFT to an EEG Signal [2]. After this, the magnitude values are stored for each band. The lower cut of frequency and upper cut of frequency is defined depends upon the frequency range of each band only the signals between the upper band and lower band of EEG remain as it is and others magnitudes are zero padded., for plotting graphical results for each band like Delta, Alpha, Beta and Theta for calculation of percentage power in each bands. The lower bands and upper bands are defined depend upon the frequency range of each band. This detection system can be fully hardware controlled using mirco controller [3][4].

III. METHOD

EEG signals are divided into the following frequency bands-

1. Delta (δ)

Frequency: 0.5 to 4 Hz
Occurrence: This occur only once in every 2 or 3 seconds. These occur in deep sleep, in premature babies and in very serious organic brain diseases. These can occur strictly in the cortex independently by the activities in the lower regions of brain.

2. Theta (θ)

Frequency: 4 to 8 Hz

Occurrence: these are recorded from the parietal and temporal regions of the scalp of children. These also occur during emotional stress in some adults particularly during disappointment and frustration.

3. Alpha (α)

Frequency: 8 to 13 Hz

Occurrence: they found in normal persons when they are awake in quite, resting state. They occur normally occipital region.During sleep, these disappear .these have amplitude of 20-200 µV with mean of 50 µV.

4. Beta (β)

Frequency: 13 to 30 Hz (At intense mental activity, the frequency increases up to 50 Hz)

Occurrence: These are recorded from the parietal and frontal regions of the scalp. These are divided into two types as beta I which is inhibited by the cerebral activity and beta II which is excited by the mental activity, like tension. Analysis of different frequency band is done in numerical form and in graphical form

A. Different Stages Of Sleep Pattern

EEG signals are analyzed to find different sleep stages which depends on the power in each band. Different stages sleeps are as follows:

- **Stage 1 Sleep –**

In this stage, Subject will be in light sleep and easy to rouse. The EEG shows low voltage and mixed frequency with the highest amplitude of 2-7 Hz range. It can include sharp waves whose amplitude can reach about 200 µV.

- **Stage 2 Sleep**

In this stage, subject will be in deeper level of sleep. There will be more generation of theta waves with bursts of rapid brain activity. Waves can occur in the frequency range of 12-
14 Hz.

- **Stage 3 Sleep**

Delta waves increases by 20 to 50%. Subject involves in deeper sleep.This contains waves with 2Hz or slower and amplitude above 75 µV.

- **Stage 4 Sleep**

It has same attributes as stage 3. The waves has 2 Hz and amplitudes greater than 75 µV. Subject will be is deep sleep with generation of 50% of delta waves . It will be difficult to rouse a subject. This stage is called as confusion. This further involves bedwetting, sleep walking, sleep talking and night terror.

Sometimes, a subject who will be in sound sleep breaks into unsynchronized high frequency EEG and then return back to normal sleep frequency pattern. This is also called Rapid Eye Movement (REM).

EEG waves in theta (4-7 HZ) and alpha (8-11 Hz) shows the changes in brain activity and are used to design alter system for drivers.

A. EEG dataset Collection

For experiment purpose, dataset can be used from physonet website. EEG waves will be avaible in .edf (European data format). In, this paper, this .edf files will be converted into .wav file which is compatible with MATLAB. This waveform will be given to alert module which involves segmentation and classification of drowsiness signal (figure 2). After classification, drowsiness signal will be sampled and stored in the sample dictionary. One more dictionary called as base dictionary will be built which stores pre-captured drowsiness EEG pattern of the subject(s). The samples from sampled dictionary will be compared with base dictionary. If the samples match then the alert will be enabled.

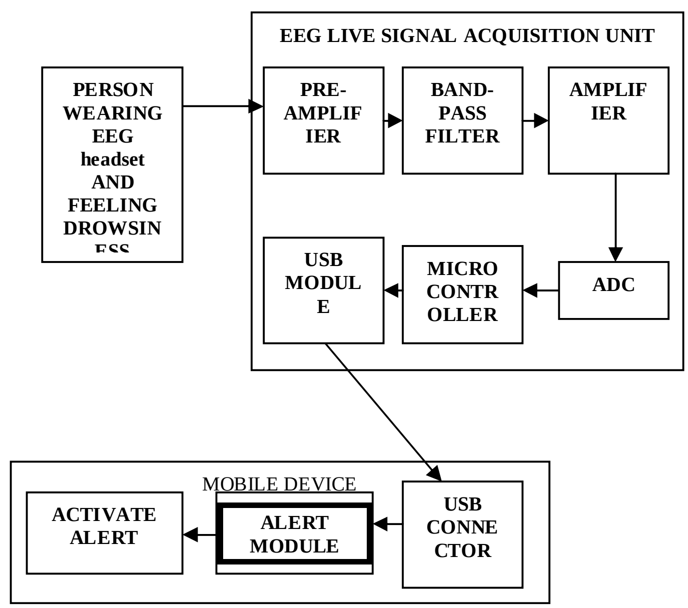

Figure 2. ALERT MODULE

B. Alert Module

Alert Module discussed in this paper has the following steps.

Step 1: Preprocessing

Step 2: Classification

Step 3: Comparison

Step 1: Preprocessing

This step involves capturing EEG signals and storing in .Edf format and later converts into MATLAB compatible .wav format.

Step 2: Classification

Signals have to be captured during the transition from wake stage to sleepiness stage which lasts only for few minutes. Analysis of these signals is one of the challenging tasks. After classifying, noise should be removed by filtering. Sampling is done and samples are stored in the sample dictionary.

Step 4: Comparison

A sample from sample dictionary is compared with pre captured and stored in base dictionary. If match is found then subject is in drowsiness condition as a result suitable alert will be given.

C. Requirements

Hardware:

- EEG Headset (real time implementation)
- Mobile Device with following features-
    - 4-16 Gb RAM per processor
    - 64-bit processors

Software:

Windows Operating System
EEGLAB v12 - MobiLaB toolkit
MATLAB 7.6 or later signal processing tool box

IV. PROPOSED RESULT

The obtained dataset will be converted into .wav format. These dataset contains EEG signals formats. Using classification technique drowsiness signal will be extracted and compared with pre-captured and stored wave pattern.if match is found alert will be activated otherwise it continue handle next available dataset.

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