Brain Computer Interface for Sleep Apnea Detection

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Abstract **- A brain-computer interface (BCI) is interface method that someone to deliver instructions and messages to a automated gadget, via way of means of using person mind activity. An electroencephalogram (EEG), mounted BCI became related with a synthetic gadget to command a home automation application. It provides an alternative to built-in interface and control. It is a digital surroundings shape that enters the body's everyday prepared pathways, which might be neuromuscular output passage.**

Sleep apnea is personification of sickness which occurs during sleep, which impacts the human fitness via way of means of blockage in respiratory for positive period of time. The prognosis is critical that's viable via way of means of the perceiving of apnea episodes the use of electroencephalogram (EEG) reports. EEG is an adjustable decomposition for the identifying of apnea events using EEG signals. EEG plays an essential role in identifying the sleep apnea by recognizing and producing the brain neurons activities. The EEG sign dataset is filtered, the purified EEG sign is subjected for sub-band separation and 5 frequency bands inclusive of Gamma, Beta, Alpha, Theta, and Delta. It employs residences inclusive of entropy, variance, and electricity which might be computed for every frequency band received from the decomposed EEG signals.

Index Terms -Brain Computer Interface, Electroencephalogram sensor, Sleep Apnea, Entropy, Sub-Band.

I. INTRODUCTION

Sleep Apnoea is a obstruction which causes delay or disorganization in usual respiration. The permanent monotonous sleep apnoea occurrence are in charge for health- connected problems such as unhappiness, diabetes, and cardiovascular disease. The designation of sleep apnoea needs a methodical for the observation of apnoea incidents. Sleep specialists usually conduct manual sleep phase attain by visually examining the patient's neurophysiologic signals assortment at sleep workshop[1],[2]. Here, generally, a very laborious, tiresome and hardworking task. The constraint of manual sleep phase attain have escalated the request to evolve machine-driven(Automated) Sleep Stage Classification (ASSC) systems [3]. Sleep phase classification refers to distinctive the varied phases of sleep and may be a crucial step in a shot to assist doctor within the designation and medical care of connected sleep obstruction.

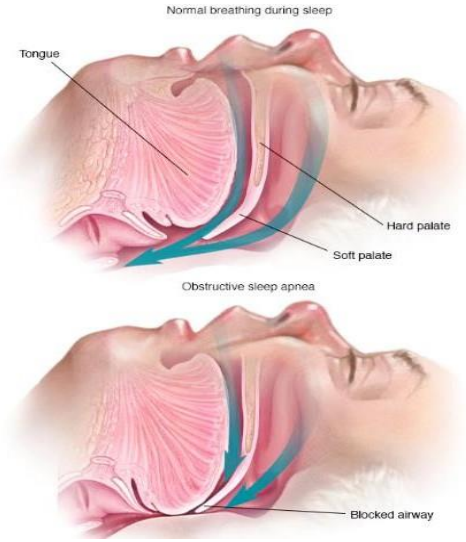

Fig 1. Sleep Apnoea

A brain-computer interface (BCI) is a new transmission withinside the center of human brain and a CPU. Sleep apnea is universal sleep-associated altitude sickness characterized through monotonous prevalence of absolute or partial termination of airflow required to bodily blockage of higher airway. An apnea episode is defined as the complete pause in the airflow through upper airway for at least 10 s during sleep. Based at the respiratory efforts gift all through the apnea episodes, the activities of apnea are similarly classified as central, obstructive, and mixed.

A hypopnea occasion is characterised with the aid of using a discount in oronasal airflow with the aid of using 25% or 50% at the side of a blood oxygen desaturation of 4%. It is a maximum not unusual place respiratory disease in the course of sleep which impacts on adults [4]. It turned into summarized primarily based totally on to be

had populace research that the obstructive sleep apnoea influences about 3–7 to men and 2–5% to women.

II. PROBLEM STATEMENT

Sleep apnoea is common, many people go undiagnosed for the disorder. It is approximated that up to 80% of people with sleep apnoea don't get the disorder treated. Some of these people may have light indications of sleep apnoea and don't realize many of the symptoms as being a sleep disorder. And others may not understand the resolved nature that untreated sleep apnoea can have on their lives.

The analysis of sleep apnoea calls for an methodical device for figuring out of apnoea events. Traditionally, the polysomnography is utilized by a fitness expert for the figuring out of apnoea episodes. In polysomnography, the physiological alerts which includes electrocardiogram (ECG), electroencephalogram (EEG), and electromyogram (EMG) are required to be analysed with the aid of using the specialists for apnoea detection. These physiological alerts encompass composite nature and their genuine functions in widespread expressions are uncertain. The polysomnography is likewise complicated with the aid of using the reports: speedy enlargement of the variety of recording channels, variable sampling frequency and extra channels processing[5]. These conditions results in fake apnoea detection device. An automatic apnoea detection device is wanted for sleep apnoea analysis.

III. SCOPE AND OBJECTIVES

The main aim is adjustable decomposition for identifying of Sleep Apnoea using Electro-encephalogram(EEG) sensor. An EEG primarily based brain- Computer interface changed into related with a Virtual Reality gadget to manipulate a clever domestic application. It is subjected to give healthier sleep apnoea detection results as differentiated to the state-of-the-art methods.

Sleep Apnoea has to be diagnosed to avoid serious problems where repetitive events cause to death or stroke. This technique introduces technique to offer a dependable com puterized answer for the detection of apnoea events, which may be beneficial in medical settings for the analysis of sleep apnoea disorder. Brain Computer Interface is a technique for recording brain waves. EEG is used as Brain Computer- Interface, EEG does this the use of electrodes that are positioned at head. Measuring electric interest from the mind is beneficial due to the fact the mind makes use of electric impulse to function electric indicators journey alongside mind cells (neurons)[6].The fundamental manner that facts is processed via way of means of the mind is via way of means of very complicated connections (networks) of neurons speaking with every different the use of electricity.

IV. IMPORATNCE OF THE PROJECT

Different mind states are the end result of various styles of neural interplay. These styles result in waves characterised through distinctive amplitudes and frequencies. This neural interplay is finished with more than one neurons. Every interplay among neurons creates a minuscule electric discharge.This challenge handling indicator s from the mind. Different mind states are the end result of various styles of neural interplay. Sleep experts behavior bodily sleep level scoring via way of means of pictorial inspecting the patient's neurophysiological alerts gathered at sleep labs. This is, generally, a completely hard, monotonous and extended task.

The regulations of guide sleep level scoring have expanded the call for for growing Automatic Sleep Stage Classification (ASSC) systems. Sleep level class refers to detecting the exclusive ranges of sleep and is a hard step so as to help physicians withinside the prognosis and remedy of comparable sleep disorders. The improvements and demanding situations in numerous present Electroencephalogram (EEG) signal-primarily based totally techniques used for sleep level identity at every phase; along with pre- processing, characteristic extraction and class; in a try to locate the studies gaps and probably introduce an affordable solution. Many of the previous and cutting- edge associated research use more than one EEG channels, and are primarily based totally on 30 s or 20 s epoch lengths which have an effect on the feasibility and velocity of ASSC for real-time applications. This gift a terrific paperback and dependent approach that may be carried out in an embedded hardware tool to stumble on sleep ranges the use of new statistical capabilities carried out to single-channel EEG alerts [7]. Clinical verification now exists for the remediation of a one of a kind kinds of sleep problems with EEG biofeedback training, together with the ones sleep troubles which can be ascribable to neurological immaturity of childhood, or correlated with attentional troubles: bedwetting, sleep strolling and talking, night time terrors, anxiety- associated problems falling asleep, and insomnia. Among grownup sleep problems, many proof exists for remediation of insomnia and sleep apnoea.

Many of the occasions helped with EEG biofeedback are correspond to issues of sleep. This consists of tension and depression, epilepsy, hyperactivity and interest deficit disorder, persistent pain, closed head injury, and Tourette Syndrome. Even while inefficient sleep isn't the motive for referral for biofeedback, it's far stated as an trouble in the course of the consumption interview [8]. We trust that

the essential mechanism of efficacy of EEG schooling is that it normalizes self-tracking of physiological arousal, and the useful results of the schooling on sleep may be defined withinside the comparable manner. When self- tracking is deficient, this need to be obvious while arousal degree is least tightly regulated, i.e. in the course of sleep in general, and in the course of transitions among sleep degrees in particular.

V. SYSTEM ARCHITECTURE

We have used an EEG headset known as Neuro-sky Mobile. The headset is Bluetooth successful and transmits brainwave records with negligible latency. The EEG records is transmitted to a processor which makes use of neural networks to decide purpose of notion and sends the command.

1. *EEG Module*: Consists of the BCI headset and is liable for detecting the P300 waves and sending the serial facts to the processing unit. Any open supply headset may be used so long as the latency and accuracy are confined to affordable amounts.

2. *Control Module:* The software-primarily based totally processing unit which interprets the uncooked EEG serial information referring to a selected thought.

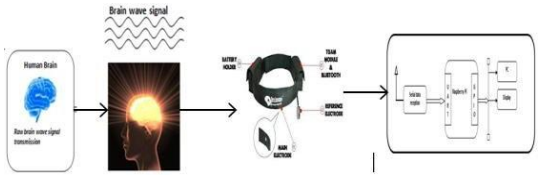

Fig 2. System Flow

BRAIN WAVE SENSOR:

If a person is having mental disorder then the attention level of brain signal will get changed than the normal condition. Brain wave sensor collects EEG based brain signals of different frequency and amplitude. Then convert these signals into packets and transmit through Bluetooth medium into the level splitter section to check the attention level.

Fig 3. EEG Sensor with parts

BRAIN SIGNALS

The key work of the project is analysing the brain signals. Human Brain consists of millions of interconnected neurons. This neuron pattern will change according to the human thoughts. At each pattern formation unique electric brain signal will form.

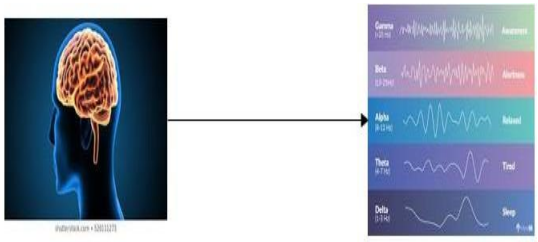

Fig 4. Brain wave signals

RASPBERRY PI

Level Splitter Section(LSS) analyse the level. In Splitter Section Raspberry Pi is used for analysing the signals.

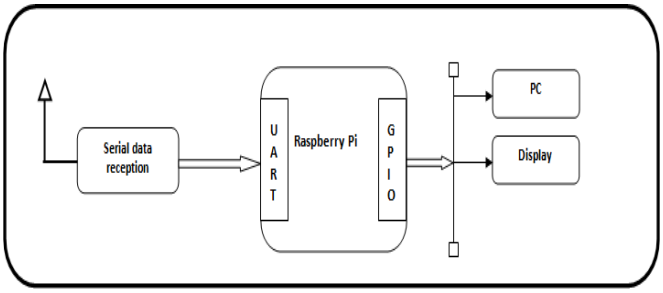

Fig 5. Raspberry Pi flow diagram

The EEG Headset or the Brainwave Sensor detects the electrical signals from the brain and sends them in the form of data packets to a Bluetooth. This received data is processed and the control commands are then transmitted to the Raspberry Pi via Bluetooth. Based on the data received by the Raspberry Pi it performs certain predefined action based on the level of concentration.

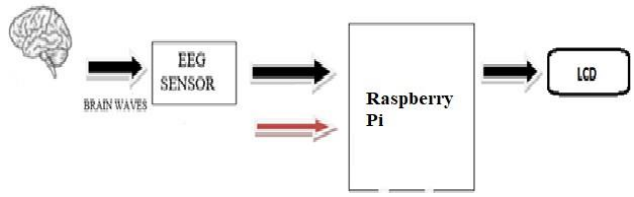

Fig 6. System flow Diagram

VI. OUTPUT

An adaptive decomposition is introduced for EEG signals, explores features for the identifying of apnoea episodes and the suggested procedure obtaines better sleep apnoea detection results as compared to the state-of-the-art methods.

VI. CONCLUSION

Our goal was to build a brain computer interface using an Raspberry Pi and the least invasive way of measuring brain waves using Electro-Encephalography(EEG) to record microvolt range potential differences across locations on the user's scalp. The signal generated by brain was received by the brain sensor and it will divide into packets and the packet data transmitted to wireless medium (blue tooth). The wave measuring unit will receive the brain wave raw data and it will convert into signal. Then the instructions will be sending to the home section to operate the modules.

Hence, the beginning process offers well- grounded automated answer for the figuring out of apnoea events, which may be blessings in scientific settings for the prognosis of sleep apnoea disorder.

VII. FUTURE ENHANCEMENT

Embedded system and testing into larger database can be improved. In the present work of sleep staging using single channel measurement of EEG signal has been performed, hence of optimum electrode for better performance remains as a possible future extension. The decisions of the sleep stage classification model and characteristics wave classification can be combined together to improve the performance of automatic sleep staging. Modifications in the signal conditioning circuit of the thermistor may be done to improve the diagnostic ability. It has been observed that short duration apnoea events which did not produce significant trace in amplitude reduction of acquired respiration signal have been treated as normal respiration. It might be due to the limitation of single channel recording. However, development of other classifiers and feature selection techniques can be done for more accurately.

VIII. REFERENCES

[1] Sachin Taran, Varun Bajaj. "Sleep Apnea Detection Using Artificial Bee Colony Optimize Hermite Basis Functions for EEG Signals" , IEEE Transactions on Instrumentation and Measurement, 2020 .
[2] houstonneurofeedback.net
[3] Hemant Sharma, K.K. Sharma. "An algorithm for sleep apnea detection from single-lead ECG using Hermite basis functions" , Computers in Biology and Medicine, 2016
[4] "Mind Wave Controlled Prosthetic ARM Without using Brain Implants" , International Journal of Recent Technology and Engineering, 2020
[5] Amal M Osman *et al.*, "Obstructive sleep apnea: current perspectives".
[6] TAKASHI NAKAMURA *et al.*, "Automatic Sleep Monitoring Using Ear-EGG".
[7] Araslanova *et al.*, "Publication trends in Obstructive sleep apnea: Evidence of for more evidence".
[8] Dayanand Vishwanath *et al.*, "Classification of sleep disorders based on EEG signals by using future extraction technics with KNN classifier".
[9] Bethuel Daurai *et al.*, "Sleep Physiological Parameter measurement for Breadth, Chest and Abdomen Effort to detect Apnea Hypopnea".
[10] Khald Ali I. Aboalayon *et al.*, "Sleep Stage Classification Using EEG Signal Analysis: A Comprehensive Survey and New Investigation".
[11] Farhin Ahmed *et al.*, "Detection of Sleep Apnea Using Sub-frame Based Temporal Variation of Energy in Beta Band in EEG".
[12] Celia Shahnaz *et al.*, "Sub-frame Based Apnea Detection Exploiting Delta Band Power Ratio Extracted from EEG Signals".
[13] Sebastien Bailey *et al.*, "Obstructive Sleep Apnea : A Cluster Analysis at Time of Diagnosis".
[14] Hemanth Sharma *et al.*, " An algorithm for sleep apnea detection from single-lead ECG using Hermite basis functions".
[15] Milos Brajovic *et al.*, " On the Parameterization of Hermite Transform with Application to the Compression of QRS Complexes".
[16] Lucia Spicuzza *et al.*, "Obstructive sleep apnea syndrome and its management".
[17] Wafaa S. Almuhammadi *et at.*," Efficient Obstructive Sleep Apnea Classification Based on EEG Signals".
[18] Jing Zhou *et al.*," Automatic detection of sleep apnea based on EEG detrended fluctuation analysis and support vector machine".
[19] Laiali Almazaydeh *et al.*," Apnea Detection Based on Respiratory Signal Classification".
[20] Miad Faezipour *et al.*, "Efficient Obstructive Sleep Apnea Classification Based on EEG Signals".