DEVELOPMENT OF SYSTEM FOR SLEEP MONITORING OF STUDENT

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ABSTRACT

This paper includes a new sleep monitoring system for home use. The basic system consists of a wearable ECG sensor & software on computers to analyse the sleep quality from the electrical and muscular functions of user's heart. There are different techniques, used by doctors in hospitals, like polysomnography which includes the tests done to diagnose the sleeping disorders user is suffering through. This project includes the small, easy to use system that a person can use it at home. This system is used for checking of user's daily sleep pattern. The system can also be used for self-care. The readings from an ECG sensor are taken on the basis of which the graph of sleep cycle versus time is plotted on MATLAB software which is called as Hypnogram. The algorithm to compute the quality of sleep is developed in this system.

***Keywords: ECG sensor, Hypnogram, MSP430, MATLAB, Sleep monitoring**,*

I.INTRODUCTION

A student or pupil is a learner, or someone whoattends an educational institution. To have a bright future & agood career it is really necessary for a student to maintain agood academic performance. But now-a-days, it is seen thatthat there are so many problems faced by them which areaffecting their mental & physical health which in turnaffecting their academic performance adversely.The excessive use of mobile, social networking sites,financial stress, homesickness, irregular sleeping patterns,adjustment with new education system are some of thoseproblems. Due to such problems students are facing heavymental stress, irritation, anxiety, depression. Through thisproject, how those problems faced by students are affectingtheir mental conditions and their sleeping patterns, ismonitored.

In recent years, many people have been sufferingfrom sleep disorder caused by mental stress, irregular lifestyleor shift work. However, it is not easy to determine the qualityof sleep because deep sleep is not always good sleep andshallow sleep is not always bad sleep. However, there is nogood system to record and analyse daily sleep.It is too difficult for a normal person to handle PSGat home because it involves the use of many electrodes formeasuring the physiological data.A simple and easy-to-use sleep monitoring system

that can be used in the home is strongly desired in order to getobjective data on sleep habits. In order to develop such asystem, a wearable physiological sensor that monitors user'swrist motion and pulse wave intervals (Pulse-to-PulseIntervals: PPIs). The sensor can be made small and simplebecause wrist motion and pulse wave can be easily measuredcompared to the case of using PSG.

II.RELATED WORK

Kemeng Cheng et al. have developed a wearable technology which has been widely used in clinical context such as disorder detection, treatment efficiency assessment and other healthcare research. An important application of this system is stress management. This paper describes the architecture of the new stress management system. At the front end, wearable sensors such as Zephyr sensor provide measurements of patient's respiration rate, heart rate, body movement & other basic information. An app is situated on amobile platform to perform front end real time stress management [1].

Jennifer A. Healey et al. have proposed that there are four types of physiological sensors used during the experiment: electrocardiogram (ECG); electromyogram (EMG); skin conductivity (also known as EDA, electrodermal activation, and galvanic skin response); and respiration (through chest cavity expansion). These sensors were connected to a FlexCompanalog-to-digital converter, which kept the subject optically isolated from the power supply. The FlexComp unit was connected to an embedded computer in a modified Volvo S70 series station wagon. The ECG electrodes were placed in a modified lead II configuration to minimize motion artifacts and to maximize the amplitude of the R-waves, since both the heart rate and heart rate variability (HRV) algorithms used in this analysis depend on R-wave peak detection. The EMG was placed on the trapezium (shoulder), which has been used as an indicator of emotional stress. The skin conductance was measured in two locations: on the palm of the left hand using electrodes placed on the first and middle finger and on the sole of the left foot using electrodes placed at each end of the arch of the foot [2].

J. M. Perez-Macias et al. described that sleep is a kind of brain activity and its purpose is recovery from brain fatigue. Therefore, sleep state is measured mainly by EEG, and is classified into several stages. Sleep state is roughly divided into REM (rapid-eye movement) sleep and NREM (Non-REM) sleep. NREM sleep is divided into 4 stages. Stages 3 and 4 of NREM sleep are so called deep sleep, and stages 1 and 2 are shallow sleep. These stages are decided by a sleep specialist using PSG data and their change is shown in a graph called a hypnogram. A doctor mainly uses a hypnogram for evaluating a person's sleep quality. For example, the doctor checks the quantity of deep sleep if a patient complains about oppressive drowsiness in the daytime. If the patient frequently wakes up in the night and experiences difficulty in breathing, he/she might be suffering from sleep apnea syndrome. If REM sleep always occurs soon after falling asleep, there might be a problem concerning the patient's nervous system. From the viewpoint of healthcare, it is important to check the balance of deep sleep, REM sleep or sleep cycle. Therefore, a sleep monitoring system for home use can also show the result of one night's data in a graph similar to a hypnogram. [3].

C. J. Deepu et al. have presented that a joint approach for QRS detection and ECG compression algorithm for use in wireless sensors. The central idea of the proposed algorithm is to use a single technique for processing of QRS detection and data compression, instead of using two distinct approaches. The algorithm lowers the average computational complexity per task by sharing the computational load among two operations. This is done using a shared adaptive linear predictor for performing both ECG beat detection and lossless data compression. In addition, a novel fixed-length data coding-packaging technique for convenient representation of the signal entropy is presented [4].

MishaPavel et al. have developed the HR monitoringthat allows the assessment of the intensity of physical activity, as HR is almost linearly associated with oxygen consumption (VO2) at moderate to submaximal intensities in steady-state exercise. However, the intensity of real-life physical activity usually changes repeatedly, and the relationship between HR and VO2 is curvilinear for very low-intensity physical activities and near-maximal exercise. HRV monitoring allows reliable continuous assessment of physical activity, exercising, and energy expenditure in real-life conditions. HRV is associated with functioning of the autonomous nervous system and, hence, is modified by stress and relaxation, physical activity, and health status. However, HRV has high inter- and intra individual variability, which complicates the interpretation and the use of HRV as a measure of stress. The HRV signal is first analysed using a sliding window approach to quantify HRV, detect respiration rate (based on respiratory sinus arrhythmia), and estimate momentary oxygen consumption (VO2) and excess post exercise oxygen consumption. This modeling step transforms raw sensor data into physiologically relevant parameters. The next step applies adaptive segmentation to divide the data into stationary and transient segments, which are further classified based on their physiological parameter values into the physiological states of physical activity, physiologicalrecovery, stress, and other [5].

III.PROPOSED WORK

Generally speaking, sleep is a kind of brain activityand its purpose is recovery from brain fatigue. Therefore, sleep state is measured mainly by EEG, and is classified into several stages. Sleep state is roughly divided into 2 stages,

1.REM (Rapid-Eye Movement) sleep and

2.NREM (Non- Rapid-Eye movement) sleep.

NREM sleep is divided into 4 stages.

1.Stages 1 and 2 are shallow sleep

2.Stages 3 and 4 are deep sleep

These stages are decided by a sleep specialist using PSG data, and their change is shown in a graph called a Hypnogram as shown in fig 1

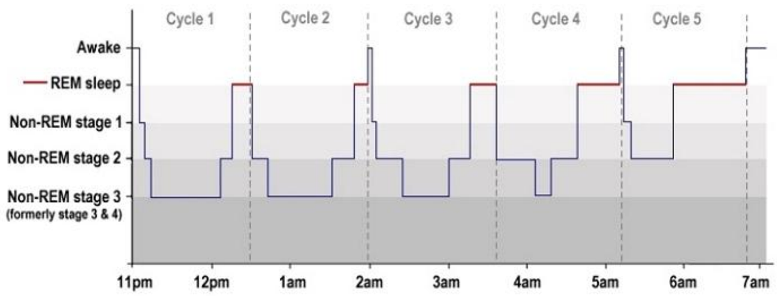

Fig. 1: Sleep Hypnogram

Fig 2 shows the wearable system used for monitoring the sleep cycle of student. ECG sensor module is used to get the heart activity output of student. The data collected from ECG sensor is further processed for sleep cycle tracking. The output from this sensor is given to microcontroller MSP430. The data given to laptop or computers through I2C bus through serial port on which it is further processed to get a plot of Hypnogram.

The microcontroller MSP430 is used. It has low power consumption, low cost, Extended battery life inportable measurement, 4 universal serial communicationinterfaces, Real time clock (RTC) module with alarm capability. The system also provides a smart alarm to wake the student up at the optimal stage of sleep.

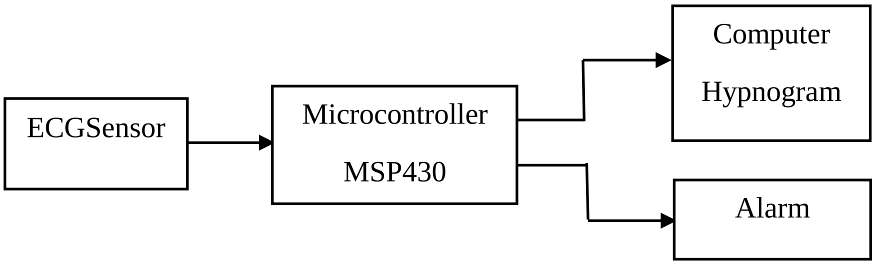

Fig. 2 Proposed Block Diagram

So the proposed work of this project is to develop a system which provides the information about the sleep cycle of student.

IV. ALGORITHM

Fig. 3 shows the algorithm to plot Hypnogram.

4.1. The R-R interval is obtained from ECG signal by acquiring the signal through an ECG sensor and loaded in MSP430.

4.2. The loaded data contains several signals like ECG, EMG etc. The slider time is set and the signal in that time duration is divided into parts.

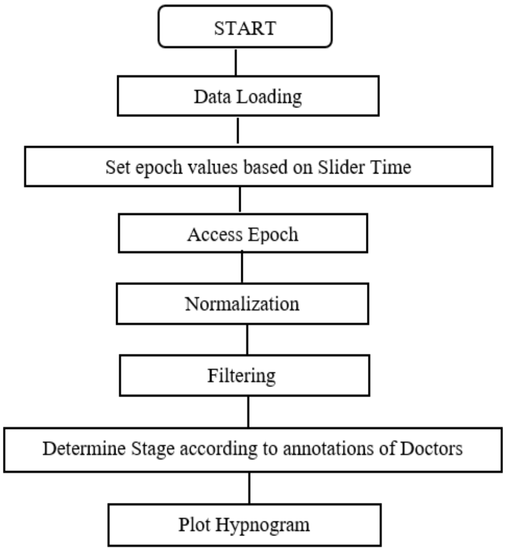

Fig.3 Algorithm

4.3. Then in that every part the epoch values, which contains theimportant information, are taken which are based on the slider time.

4.4.Then epoch values are accessed and the data is normalizedand then filtered.

4.5.According to annotations of Doctors the Hypnogram isplotted.

V.RESULTS

As the Microcontroller MSP430 is used into thesystem which is the TEXAS instrument. Energia is a rapid prototyping platform for TEXAS instruments MCU Launchpad. After loading the data from a patient, in this case student, it is provided to MATLAB where it is processed to plot a hypnogram. As seen from the plot, the ECG & EMG signals do more affect to the hypnogram. So for processing the data those 2 waves are more emphasized.

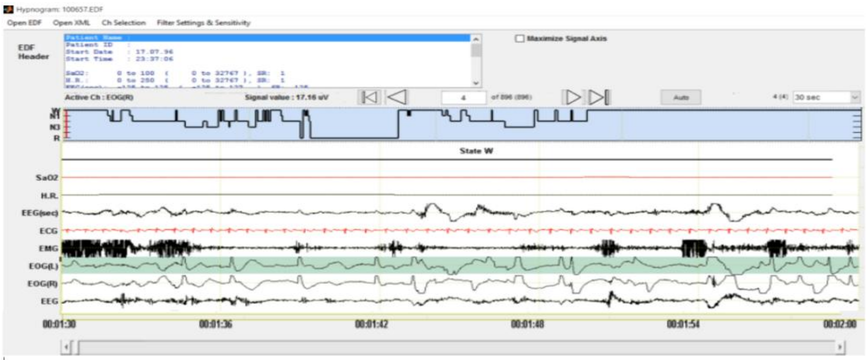

Fig.4 Various signals obtained from patient (ECG, EMG etc.)

Fig.4 shows the signals obtained from patient. They are obtained by using various channels. The main 2 channels are more emphasized to get the proper reading to plot Hypnogram.

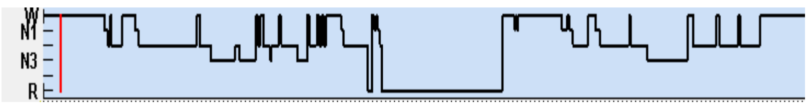

Fig.5 Hypnogram

Above Fig.5 shows the Hypnogram of a person which states us various stages of sleep, which includes Wakeup stage (W), Non Rapid Eye Movement (N1 & N3) and Rapid Eye Movement (R), with respect to time.

VI. CONCLUSION

The monitoring of sleep patterns is a new field to study in medical. Our health invisibly gets affected by ourdaily sleep pattern. So it becomes very convenient for us if a system which is easy to use & which monitors daily sleep patterns at home level. For the daily sleep cycle analysis the new system is developed, by using ECG sensor & MATLAB software, in this project. Also the smart alarm is included which will in turn make the student to wake up at proper time.

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