IoT Based Smart Sleep Monitor

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Abstract - Obstructive Sleep Apnea (OSA) is one of the most critical sleep disorders. People who are suffering from OSA may not be aware that their upper airway is blocked and they have difficulty to breathe. For this reason, daily real-time sleep monitoring is important. In response to this need, the aim is to develop an unobtrusive, wireless sleep monitoring system called Smart Sleep Monitor. It is a smart mattress topper, which is integrated with sensors and allows people to monitor their sleeping habits and respiration rate in real-time in their own bed with its IoT functions.

Index Terms - Obstructive Sleep Apnea (OSA),Internet on Things (IoT).

I. INTRODUCTION

Sleep-disordered breathing (SDB) is a common problem, affecting at least half of people over the age of 65 and a significant number of children. SDB includes conditions such as Obstructive Sleep Apnea, Central Sleep Apnea, Upper Airway Resistance, and obesity hyperventilation, which all involve interrupted breathing during sleep. These conditions have different causes, with Obstructive Sleep Apnea being the most common and caused by blocked airways. With an aging population and rising obesity rates, the prevalence of SDB is expected to increase. To address this issue, the "Smart Sleep Monitor" is proposed as an IoT-enabled sleep monitoring device that uses a new fashion of cardiac and respiratory dimension. While IoT technologies for sleep monitoring are developing rapidly, their adoption in the healthcare industry is slow due to factors such as data quality, trust ability, and ease-of-use. The Smart Sleep Monitor aims to provide maximum convenience to the user during ECG measures, especially for long-term use, using wireless technology to induce interactive healthcare exercising ultramodern technology and telecommunication. The wireless ECG detector is used for effective remote monitoring, providing real-time, continuous, and accurate information on the patient's heart condition.

II. Literature survey

Georges Matar, Jean-Marc Lina, "Unobtrusive sleep monitoring using cardiac, breathing and movements activities: an exhaustive review," IEEE Access, vol. PP, no.c, pp. 1–1, 2018. At least 50% of the world's elderly population, experience disturbed sleep. Sleep studies have become an extensive approach serving as a diagnostic tool for healthcare professionals. Currently, the gold-standard is Polysomnography (PSG) recorded in a sleep laboratory. However, it is obtrusive, requires qualified technicians, and is time and cost expensive. With the introduction of commercial off-the-shelf technologies in the medical field, alternatives to the conventional methods have been conceived to ensure sleep stages and sleep quality detection which may be now used at home on several nights. Cardio-respiratory and physical activities abide the most promising physiological measurements to detect sleep stages without complete PSG. The statistically proven impacts and budgets related to sleep disorders are phenomenal, showing that the field needs more research. This paper aims at providing the reader with a multidimensional research perspective by presenting a review of research literature on developments made in unobtrusive sleep assessment. Additionally, a categorization of current approaches is presented based on methodological considerations, from data acquisition frameworks and physiological measurements, to information processing.

E. Dafna, T. Rosenwein, A. Tarasiuk, Y. Zigel, "Breathing Rate Estimation during Sleep Using Audio Signal Analysis", 978-1-4244-9270-1/152015 IEEE. Sleep is associated with important changes in respiratory rate and ventilation. Currently, breathing rate (BR) is measured during sleep using an array of contact and wearable sensors, including airflow sensors and respiratory belts; there is need for a simplified and more comfortable approach to monitor respiration. Here, we present a new method for BR evaluation during sleep using a non-contact microphone. The basic idea behind this approach is that during sleep the upper airway becomes narrower due to muscle relaxation, which leads to louder breathing sounds that can be captured via ambient microphone. In this study we developed a signal processing algorithm that emphasizes breathing sounds, extracts breathing-related features, and estimates BR during sleep.

Thomas Penzel, ChristophSchöbel "Development of methods for sleep disordered breathing to identify phenotypes" 2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). Stated in 2017 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC). Sleep disordered breathing a very common disorder with prevalence rates of up to 49% in large epidemiological studies on subjects older than 40 years. A recent study showed that applying CPAP treatment to patients with sleep disordered breathing recruited by their number of apnea and hypopnea events alone, does improve sleepiness but does not improve overall cardiovascular mortality. Based on older large studies however it is know that sleep disordered breathing is a cardiovascular risk and that treatment lowers mortality and morbidity. These results appear to be contradictory. However, they might be explained if patient population investigated are carefully reviewed further, and if sleep apnea severity metrics are reconsidered. According to this, it appears that studies speak of different populations. Whereas epidemiological studies use sampled subjects willing to participate, earlier studies used patients contacting a sleep center with complaints and symptoms. In this paper two studies are presented with an assessment of anatomical metrics for upper airway morphology in order to derive parameters for better prediction. Different phenotypes can explain why some people benefit from treatment and others do not benefit equally. Therefore more than just counting apnea and hypopnea events is needed in order to identify patients at risk and patients who have a lower risk when treated. This will require large data set evaluations with hard outcome data.

Stefano Milici, Antonio Ramon Lázaro Guillen, Ramòn Maria Villarino, and David GirbauSala, A Wearable, Wireless, and Long Lifetime Device to Detect Sleep Disorder Diseases, Annual International Conference of the IEEE Engineering in Medicine and Biology Society 2017. The device consists of two simple sensors; a thermistor placed close to the nose, which detects the changing in airflow during breathing, and a galvanic skin response (GSR) sensor, which measures the conductivity of the skin. The information is extracted by a low power microcontroller, which calculates RR, TA and the activation of the SNA. The information is collected by a smartphone using the low energy Bluetooth feature to guarantee a long lifetime to the device that uses a small coin battery. Different algorithms are described to minimize the payload on the connection, and therefore power consumption too. The amount memory used to store data on the smartphone is approximately 0.01% compared to a continuous recording.

Alexander B Tataraidze ; Lesya N. Anishchenko ; Lyudmila S. Korostovtseva ; Mikhail V. Bochkarev, Non-contact Respiratory Monitoring of Subjects with Sleep-Disordered Breathing, 2018 IEEE International Conference "Quality Management, Transport and Information Security, Information Technologies" (IT&QM&IS). This paper presents an algorithm for breathing cycle detection on non-contact bioradiolocation signals for subjects with sleep-disordered breathing (SDB), which is the first step in the development of a technology for continuous sleep monitoring for the SDB population. The quality of the proposed algorithm was estimated based on comparison with a standard contact respiratory sensor. Our results contribute to extension of non-contact sleep monitoring technology.

I. Chouvarda ; M. O. Mendez ; V. Rosso ; A. M. Bianchi ; L. Parrino ; A. Grassi ; M. Terzano ; N. Maglaveras, CAP sleep in insomnia: New methodological aspects for sleep microstructure analysis, 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society. The dynamic in the structure of CAP activation events is studied by use of wavelet analysis and the content of events, i.e. EEG dynamics, is studied in terms of complexity analysis. Both in structure and content, features exhibiting statistically significant differences are proposed, opening new perspectives for the understanding and the quantitative characterization of sleep and its disorders.

III. OBJECTIVES

- To Provide maximum convenience to the user or patient
- To Develop interactive healthcare device for the efficient remote monitoring of the user or patient, exercising ultramodern technology

IV. METHODOLOGY

The core requirement of the device is to monitor cardiac and respiratory function. It further needs to be aware of body position and activity such that artefacts resulting from movement may be detected. Data needs to be captured, recorded and transferred to an external PC/Mobile Phone and subsequent Cloud for further analysis. Ultimately, the physiological signals intended to be extracted from the raw data are -

1. Breathing pattern
2. Respiration effort
3. Cardiac activity

The following features are required to obtain this raw data successfully.

- Wireless untethered operation.
- Easy to don, comfortable to wear for long periods and easy to remove following use.
- An interface enabling a live stream of sensor data, allowing the user to determine if the sensors are working correctly before use.
- An interface to enable transfer of data to a secondary device, e.g. phone, computer.

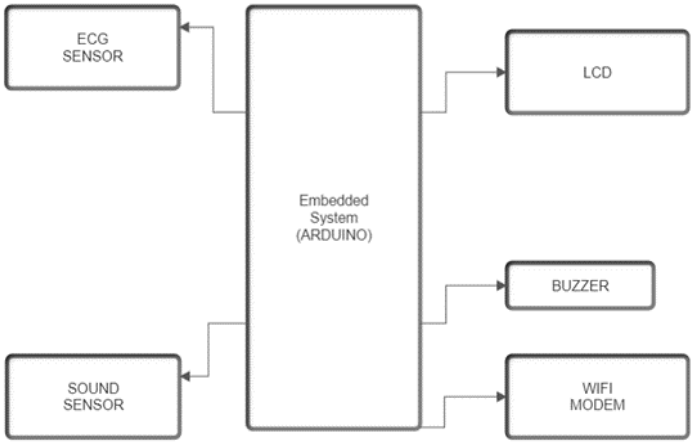

Fig 4.1. Block Diagram

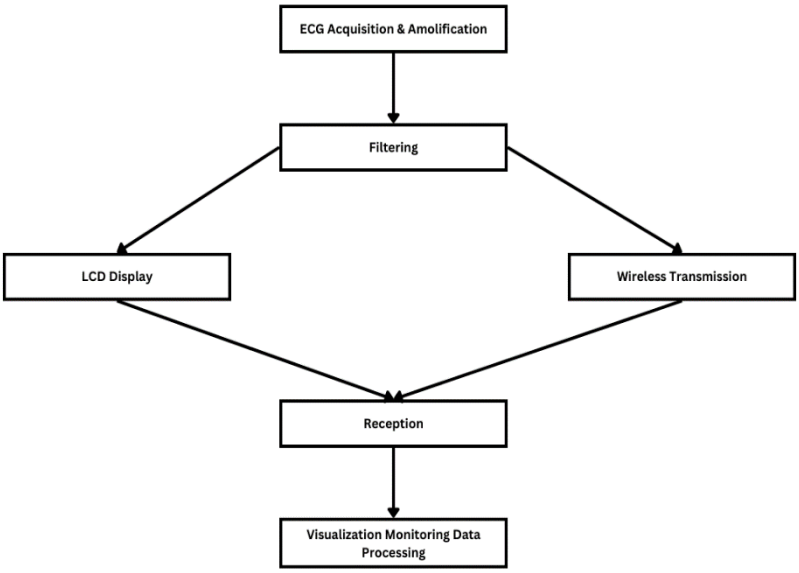

Fig 4.2. System Flow Chart

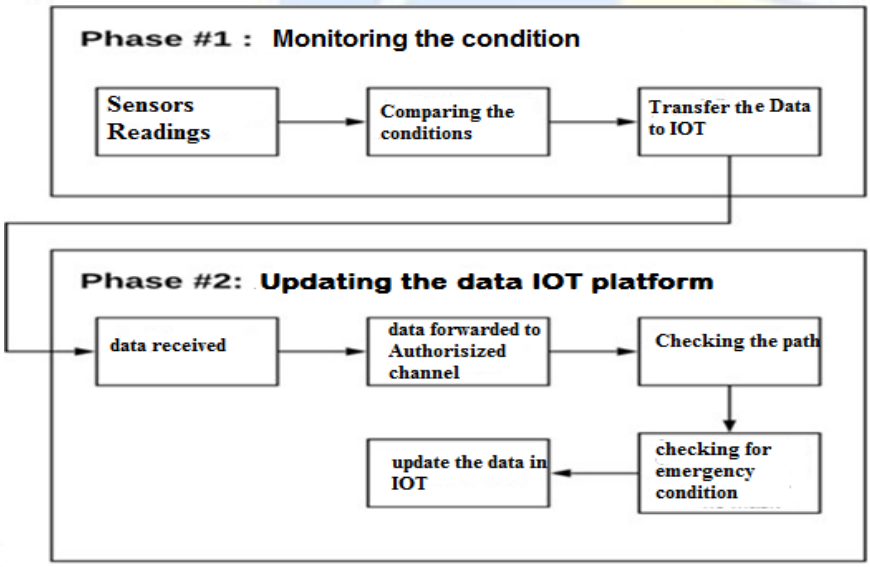

Fig 4.3 Dataflow Diagram

V. PROBLEM STATEMENT

To design and develop a IoT grounded Smart Sleep Monitor to track sleep disorders which saves time and trouble of the user.

VI. CONCLUSIONS

Sleep attributes are the main factor to determine mortal health & good. Monitoring is the result to maintain the attributes & to take preventives from sleeping diseases, IoT technology offers a great result for real- time & nonstop monitoring system for the users or patients.

VII. REFERENCES

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