Mobile Acquisition Platform for Sleep Assessment

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Abstract

Polysomnography (PSG) is the preferred tool for monitoring and diagnosis of sleep disorders. It acquires a large amount of data useful for an accurate diagnosis. However, the exam is expensive, uncomfortable for the patient and usually it must be performed in clinical facilities, under controlled conditions, thus preventing long time monitoring exams.

In this work, a highly portable alternative system based on a mobile phone is proposed. Though it acquires a more limited set of physiological data than the PSG, it does not interfere in the normal life routines of the patient. This allows long time monitoring exams and the diagnosis of other types of disorders not easily detectable by the PSG.

Additionally, the system includes complementary diagnosis tools like the Sleep electronic Diary (SeD), Dream electronic Diary (DeD) and actigraphy.

1 Introduction

Sleep disorders affect a large percentage of the population all over the world, but specially the western countries, which represent about 20% [3]. These disorders are often related with diabetes, obesity, depression and cardiovascular diseases.

An accurate diagnosis of this type of disorders is usually performed with polysomnography (PSG) which involves complex hardware, is uncomfortable to the patient, as shown in Fig. 1, and is usually done in clinical facilities [1]. These highly constrained conditions prevent its use in a non-intrusive way in normal day life conditions.

However, some of the most common disorders can be detected with less physiological data and therefore with lighter equipment. Among them, Narcolepsy, Periodic Limb Movement Disorder (PLMD), Restless Leg Syndrome (RLS), Delayed Sleep Phase Syndrome (DSPS), Shift Work Sleep Disorder (SWSD) and Obstructive Sleep Apnea Syndrome (OSAS). All these disorders can be easily detected using actigraphy [4], Sleep Diary (SeD), temperature and electrocardiogram (ECG) as a set of diagnosing tools.

Here, a highly portable mobile phone based system is proposed. It will acquire, process, store and transmit a small set of physiological and patient quotidian data, in order to perform long time monitoring exams and detect some of the previously referred disorders. The system, called Mobile Acquisition Platform for Sleep Assessment (MAPSA), is based on a physiological acquisition belt and a mobile phone, as shown in Fig. 2.

2 System Architecture

Nowadays, mobile phones are a very attractive application platform, as they endure a lot of interesting characteristics: significant computing power, long battery life, many built-in sensors and wireless connectivity capabilities, such as Wi-Fi and Bluetooth technologies. Furthermore, such mobile phones are becoming more and more a common tool among the general population. The Symbian mobile operative system is widely spread, reaching low-cost devices, but still possessing a broad range of options and a user-friendly approach [2], which is why it was chosen for the present MAPSA system.

Cardiac belts, on the other hand, which some years ago...
were a tool only available for high performance athletes, these days are used by people to monitor their jogging activities. Such belts, traditionally used with specific fitness watches, were very limited in battery and transmission range capabilities. For the present system, though, a modern belt was intended, which comprises both a set of physiological measures and Bluetooth transmission, very important for mobile connectivity purposes. With this purposes, the BioHarness Bluetooth Zephyr Belt (Fig. 3) was chosen, for it offers an interesting set of signals, which include ECG waveform, R to R data, skin temperature, GPRS activity and breathing rhythm [5].

The diagram in Fig. 2 shows the architecture of the proposed system. The mobile phone establishes a Bluetooth connection with the Zephyr Belt, which, in turn, starts to record physiological data for a selected period of time. Through the Bluetooth connection, this data is permanently sent to the mobile phone, which analyses and records it. Once the acquisition is terminated, or whenever the patient returns the system to the clinic, the data may be sent via Bluetooth to a computer, a device which properly displays it, allowing the intended diagnosis.

Furthermore, the mobile phone functions as an electronic alternative to traditional sleep and dream register. This presents a more interactive event registry method for the patient, while, at the same time, enables an immediate cross analysis recurring to the remaining set of physiological registered data.

3 Application Outputs

From the variety of data measured by the cardiac belt and recorded by the mobile phone, numerous analyses can be made. The chosen approach includes the simultaneous displaying of both the physiological and the user input data via sleep (SeD) and dream (DeD) diaries. This way, the clinician can relate the ECG waveform, R to R data, beats-per-minute (BPM), respiration frequency, skin temperature, GPRS activity and, also, the everyday life events of the patient, such as sleeping hours, meals, work-outs and complaints, as headaches or palpitations.

Such a system presents a different approach to sleep disorders diagnosis. While not as thorough as polysomnography, it offers a cross analysis of useful data acquired in a non-intrusive way which is presented as a strong added value to this system. Furthermore, the clinician is immediately provided with a variety of simultaneous diagnosing data, aiding in the establishment of an accurate diagnosis.

4 Conclusions

In the present work, a mobile application for sleep assessment is proposed as a more simple, non intrusive approach, to polysomnography. It is intended as a diagnosis tool for sleep disorders such as narcolepsy or periodic limb movement. The referred system consists of a cardiac belt, which acquires a significant variety of physiological signals, and a mobile phone, which receives, processes and records the referred data, while also incorporating electronic sleep and dream diaries, both complementary diagnosing information.

References