# Monitoring the sleep system with smart technologies
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**Abstract**

Monitoring the sleep system helps to better diagnose and theorize human health and sleep problems. Potential applications of smart technologies in sleep system monitoring include the regulation of sleep durations, diagnosis of sleep apnoea and other sleep disorders, clarification of the cause-and-effect relationships of sleep stages, and even the development of more effective sleep education programmes. could have important potential consequences. The development of smart technologies in the field of sleep system monitoring opens new perspectives in the analysis of human sleep and health and creates opportunities for rapid development and collaboration between researchers, medical professionals and technology companies in this field. It helps to open up innovative ways to help people improve their health and sleep.

**Keywords:** Sleep system, smart technologies, monitoring, polysomnography

Scientific studies show that sleep is very important for human health and functionality. During sleep, body energy is renewed, hormone levels and metabolic rate change, and the immune system is activated. During sleep, cells important for the body are renewed, toxins are cleared from the body, and the amount of drugs necessary for normal body functions increases[1]. The sleep process is also very important for the brain. Brain activity, memory, learning, remembering and other cognitive functions occur during sleep. Sleep is important for the brain to process new information, store existing information in memory and improve mental processes. Lack of sleep can cause serious problems in the body and brain. Lack of sleep can cause health problems, anxiety, changes in blood sugar levels, hormones and some immune functions[2]. Lack of sleep can also increase stress and cause problems in terms of psychological health. Therefore, a healthy and proper sleep routine is important for human health. Sleep duration and sleep quality are important for the body and brain, and if a person has sleep problems, it can cause health problems[3].

The sleep system is a neuronal network that enables the human or animal to adapt to the different states between sleep and wakefulness. The sleep system, which consists of several parts in the brain, regulates the stages of sleep and regulates many activities in the human body. During sleep, the human body is rebuilt, hormones are secreted and the nervous system is repaired. There are two main stages in the sleep system: Non-REM (non-dreaming) and REM (dreaming) sleep. Non-REM sleep has three stages and REM sleep is the last stage[5].

- Non-REM stage 1: This is the initial stage when the person gradually enters sleep mode. At this stage, the brain activity of the person decreases and the person's reaction to the events around him/her decreases. At this stage, the person's sleep is quite light.
- Non-REM stage 2: At this stage, the person's sleep is deeper. Brain activity increases and decreases intermittently. At this stage, the person's sleep is more productive and this is where the processes that are important for the body's regeneration and recovery are observed.
- Non-REM stage 3: One of the deepest stages of sleep. Brain activity decreases further. During this phase, our body works to recover more energy and repair damaged cells.
- The last stage, the REM stage: Also known as the Rapid Eye Movement (REM) stage, in this stage, the person's brain waves are activated while dreaming, just as they are while awake. The eyes make digital eye movements, the breathing process is efficient. With REM sleep, the most unique and vague dreams of the person also expand. The REM stage has an important role in monitoring the activity of people in the sleep stages and diagnosing sleep disorders.

Sleep monitoring allows people to monitor the different stages of their sleep life and the changes that occur there. Thanks to this monitoring, brain activity, blood oxygenation and many other physiological processes can be monitored during sleep. This information allows people to identify sleep problems, identify sleep apnoea syndrome and other diseases, as well as assess sleep-related stress, depression, anxiety and other psychological problems. Sleep monitoring helps people sleep better and healthier, improve their quality of life and prevent health problems.Several different technologies are available for sleep monitoring. Each of

these technologies has its own advantages and limitations[6]:

1. Polysomnography (PSG): This is the first-line technology and is considered the gold standard of sleep monitoring. With PSG, some important parameters such as brain electrical activity, eye movements, muscle activity, pulse and respiratory rate are monitored during sleep. PSG also helps to distinguish between deep sleep, light sleep and mixed sleep stages. The PSG procedure is performed in the laboratory, usually in bed. It is an effective and safe sleep monitoring option as it does not require any intervention. Polysomnography is a diagnostic research method used to monitor people with sleep apnoea, narcolepsy and other sleep problems. The advantages and disadvantages of this method are as follows[7]:

Advantages:
- It can be used to monitor any sleep progression.
- It helps in the accurate diagnosis of many sleep problems, including sleep apnoea, narcolepsy, REM gaps, parasomnias, etc.
- Polysomnography helps prescribe prescription medications to treat sleep apnoea and other sleep problems.

Disadvantages:
- May be dangerous for people with cancer, shock and some other diseases.
- As with the application of any medical device, proper preparation and observance of special rules are required.
- Any sleep progression at home can be carried out with certain restrictions and therefore the results can be influenced by many factors.

2. EEG- (Electroencephalography): This technology records brain activity during sleep. EEG is used in combination with PSG to differentiate sleep stages. EEG is an easier and cheaper alternative, but it is only capable of monitoring brain activity. Therefore, it is not possible to obtain information about other sleep indicators through this technology.

3. Actimetry: In this technology, a device covered with a motion detector or sensor is worn while the person is asleep or immobile. The actimetry determines the duration, speed and intensity of immobility. This technology is a high-quality sleep monitoring option because it is non-invasive and convenient[9]. There are many advantages and disadvantages of actimetry compared to other sleep monitoring technologies:

Advantages:
- Actimetry eliminates the need to install special sleep sensors or to connect with long cables and electrodes. It is therefore easier to use and the stress and effects associated with sleep disturbances are minimized.
- Actimetry is less expensive than other devices used for sleep monitoring.

Disadvantages:
- Actimetry is less accurate and efficient than other devices used for sleep monitoring.
- Actimetry uses only sensors to determine the cause of sleep disturbances and some research is required to identify suitable sensors. It also takes longer than advanced sleep monitoring technologies.
- Actimetry is less effective in detecting attention, concentration and memory disorders.

Actimetry is a useful tool to help with certain sleep problems such as insomnia, obstructive sleep apnoea syndrome (OAS) and other sleep apnoea syndromes. However, it is not enough to ensure that the causes of sleep disorders are fully identified.

4. Smart technologies: These technologies make sleep monitoring easier, more convenient and more useful. However, some researchers have doubts about the accuracy and security of the data from these devices[11].

Recently, the use of smart technologies for sleep tracking has been increasing. These devices monitor sleep

mode, sleep rate, pulse and a number of other parameters. This data is automatically processed to provide the user with a detailed analysis and evaluation of their sleep. In addition, smart sleep monitoring devices can also be connected to mobile applications to provide additional features such as sleep activity, alerts and sleep information.

Smart technologies used to monitor the sleep system include the following:

1. Smart watches: Many smartwatches have been developed to fulfil the sleep monitoring function. Thanks to the applications developed for these watches, accurate sleep tracking is possible.
2. Sleep tracking devices: These technologies are devices that monitor a person's sleep patterns. Sleep trackers can collect information such as a person's sleeping position, steps taken while sleeping, and calorie estimates.
3. Smart pillows: Smart pillows are equipped with sensors that track a person's sleep duration. These sensors monitor a person's sleep position, pulse and respiratory rate, collecting information about the sleep cycle and quality.
4. Smart mattress: A smart bed is a bed equipped with sensors to study the customer's sleep process. These sensors monitor the customer's sleeping position, bed movements, air temperature, humidity level, etc..
5. Wearable sensors: These sensors are responsible for sleep tracking and can be worn as accessories such as bracelets, watches or anklets. These sensors measure sleep activity and various customer health data.
6. Phone apps: Some apps can track a person's sleep patterns and automatically record sleep times in a calendar. Thanks to these applications, the person can observe their sleep patterns.
7. Smart home devices: Another smart technology for sleep monitoring is home devices. Some smart home devices help regulate sleep activity by automatically adjusting the humidity, light and sound levels of the room.

## Conclusion

These smart technologies offer an affordable and more convenient way to monitor sleep. It is also cheaper and easier than other monitoring methods. In conclusion, the integration of smart technologies in sleep monitoring represents a promising leap forward. This innovative approach not only empowers individuals to take control of their sleep quality but also opens new avenues for researchers, medical professionals, and technology companies to collaborate in the quest for better sleep and overall health.

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