Smart Textiles and Artificial Intelligence for Analysis of Sleep Quality and Early Disease Diagnosis

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Abstract

Given the importance of sleep quality for preventing and treating a wide range of diseases, but also considering technological advances in artificial intelligence and smart textiles, the type and number of data recorded during sleep have increased considerably in recent years. Diseases such as Parkinson's, cancer, scoliosis, diabetes, or heart disease can be diagnosed early with wearable sensors. Also, smart textiles, which involve integrating low-energy wearable sensors into clothing, allow analysis of sleep movements, patient position, and number of breaths per minute and can be used to automatically alert the doctor if the patient seems to need clinical care. However, current monitoring solutions are limited in the number of parameters considered to determine sleep quality, generally relying on empirical solutions to rate sleep or to identify a particular disease. To harness the amount of the recorded data and the advances of Artificial Intelligence, this paper proposes a fuzzy logic-based solution for the analysis and determination of a new sleep quality index for the early identification of diseases and reduction of associated risks. For the determination of this new index, the fuzzy system input was taken as values related to room temperature, skin temperature, environmental noise, blood pressure, pulse, VO2max and the number of breaths per minute a patient experiences during sleep. Using a predefined fuzzy rule table, each simulated sleep period was given a score in the range of 1-4, where 1 means totally inadequate sleep and 4 means excellent sleep quality. Recent findings were used to establish the range of variance of the 7 monitored parameters, as evaluated by scientific papers published in prestigious international journals. The system successfully passed the authors' tests and can be further improved by including additional parameters and by using a neural network to assess sleep quality using this new index.

Keywords: Smart Textiles; Wearable Sensors; Artificial Intelligence; Fuzzy Logic