AN IMPLEMENTATION OF BODY SENSOR BASED SLEEP POSTURE PREDICTION FOR HEALTH MONITORING

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ABSTRACT

Health is Wealth as important as a proverb has become more important as a rule in This life. After the evolution of computers and information technology, people have got addicted to sitting in front of the laptops, personal computers and spending the most of the time sitting in improper postures causing the sleep posture to be improper. The various researches have been done to analyze the postures of the sleeping bodies so as to determine the prevailing mistakes and wrong habits of sleeping and thereby make the improvement in the postures by prescribing proper positions. This survey also makes the in-depth analysis of such researches done before to overcome the drawbacks of the existing systems and determine the accuracy of the sleeping postures for proper diagnostic solutions.

Keyword: *—Sleep apnea, Monitoring, Wrist, Training, Accelerometers, Sensor systems .*

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1. INTRODUCTION

Some research works for sleep quality measurement have been reported in detecting sleep events, such as snoring and body movement [6, 7]. However, sleep posture detection techniques for improving health care have been seen rarely. In This literature review, Authors categorize the existing research regarding sleeping posture monitoring into two classes, contact body and non-contact body type. In the contact body class, the equipment deployed to monitor care reception has contact with a care receiver's body; in the non-contact body class, the equipment does not contact the receiver's body. In this section, Authors will introduce the equipment and the usage of the equipment in each class.

Bad sleep postures affect This health and even cause injuries. For example, sleep apnea is a disorder, which causes multiple pauses in breathing during sleep. Different sleep postures will affect the apnea index [1, 2], i.e., the severity of sleep apnea. It is found that the apnea index of a back sleepers is more than twice as high as that of a side sleeper [2]. As another example, a prolonged same sleep position may result in pressure ulcers, which is particularly serious for the elderly or diabetic patients. One simple pressure ulcer prevention approach is to

have caregivers move patient's bodies to avoid patients lying in the same posture for more than two hours. However, the need for caregiver's intervention is not only high cost, but it is often limited to nursing homes and hospitals. Hence, inexpensive, self-applicable and automatic sleep posture monitoring technologies will play a key role in health care and eldercare. In the literature, many research works on the monitoring and prediction of sleep postures have been proposed. For example, a depth camera and a video camera were set up for monitoring and predicting sleep positions at the cost of revealing the customers privacy [3]. A pressure mat was placed under the bed to capture the pressure distribution for Figure 1 (a) (b) (c) (d). Four sleep postures (a) back, (b) left side, (c) right side and (d) stomach [5].

Quantifying sleep postures, but it was proved to be expensive [4]. The aforementioned approaches require a high threshold to implement because the environmental setting is troublesome and the cost of the equipment is high. Thus, the techniques are difficult to extend from the hospitals or nursing homes to personal homes.

Figure 1. Various Sleep Postures

During the past years, the importance of sleep evaluation has increased due to a considerable number of pathologies that implies sleep disorders. Furthermore, the performance of many basic activities in the normal life, such as memorization, learning, productivity, and concentration, are closely connected to a good sleep quality [1]– [4]. The social and physical consequences produced by low sleep quality, the sleep evaluation is a time-consuming task which can be done by intelligent doctors.

2. LITERATURE SURVEY OF DISTRIBUTED DENIAL OF SERVICE

2.1 Neill AM, Angus SM, Sajkov D, McEvoy RD, "Effects of sleep posture on upper airway stability in patients with obstructive sleep apnea", 1997.

Changes in sleep posture have been shown to improve obstructive sleep apnea (OSA). To investigate the mechanisms by which this occurs Authors assessed upper airway stability in eight patients with severe OSA in three postures (supine, elevated to 30 degrees, and lateral). Elevation or lateral positioning produced a 50% reduction in mean UAOP (supine 10.4 +/- 3.5 cm H2O compared with 30 degrees elevation 5.3 +/- 2.1, $p < 0.05$; and lateral 5.5 +/- 2.1 cm H2O, $p < 0.05$). Authors conclude that in severely affected OSA patients' upper body elevation, and to a lesser extent lateral positioning, significantly improve upper airway stability during sleep, and may allow therapeutic levels of nCPAP to be substantially reduced.

2.2 A study of automatic classification of sleeping position by a pressure-sensitive sensor, 2015

A Currently in care facilities, a fall preventive movement sensor is often used to prevent falls of care receivers during the night. But the current sensors are usually designed to detect the motion of care receivers' getting out of bed. Therefore, there are cases where the care receiver has already fallen from the bed by the time the sensor reacted to the movement. It is a common knowledge that a person frequently changes position while sleeping. In this research, Authors focus on the frequency of sleeping position changes, and aim to realize a method for precise prediction of care receivers' attempt to get out of bed sufficiently before the actual action. Authors employed the automatic classification method of sleeping position in the pressure-sensitive sensor, with consideration to privacy of the research subjects, and identified nine types of sleeping position that are common, with 77.1% of accuracy. This result is reported in this paper.

2.3 Poyuan Jeng , Li-Chun Wang, "An accurate, low-cost, easy-to-use sleep posture monitoring system", 2015

Sleeping is one of the most important activities in This daily lives and affect This health. However, very few people could really understand their sleeping habits, which is important to avoid potential sleep-related diseases. Most current studies on sleeping posture studies aim at the monitoring of sleeping postures. However, they are limited to be used in hospitals and need experts to operate these equipment. In this paper, Authors proposed an automatically sleeping posture estimation system for ordinary people to use in their homes. The customers are only required to wear two sensors, one on chest and the other on wrist during the training process of the sleeping posture monitoring model. Authors adopted random forest algorithm in the model training algorithm. After this training procedures, users' sleeping postures can be recognized by only wearing one sensor on the wrist. Also, Authors proposed a data cleaning procedures to process raw sensor data to find the ground truth of sleeping posture. This experiment results showed that the proposed sleep posture technique can estimate the body posture accurately.

2.4 Christoph Kalkbrenner, Philipp Stark, Guy Kouemou, Maria-Elena Algorri, Rainer Brucher, "Sleep monitoring using body sounds and motion tracking ", 2014

This paper presents a system for sleep monitoring that can continuously analyze snoring, breathing, sleep phases and the activity of the patient during the night and the beginning of the day. Early results show that the system can be used to detect the occurrence of obstructive sleep apnea syndrome (OSAS). OSAS is traditionally diagnosed using polysomnography, which requires a whole night stay at the sleep laboratory of a hospital, where the patient is attached to multiple electrodes and sensors. Our system detects heartbeats, breathing, snoring, sleeping positions and movements using a special electret microphone and an inertial measurement unit (IMU). The system first analyses the sleep using the acoustic information provided by the electret microphone. From the acoustic information breathing events and heartbeats are identified. The system also analyses the patient's activity and positions from data delivered by the IMU. The information from both sensors is fused to detect sleep events. First experiments show that the system is capable of detecting and interpreting relevant data to improve sleep monitoring.

2.5 Xuefeng Liu, Jiannong Cao, Shaojie Tang, Jiaqi Wen, "Wi-Sleep: Contactless Sleep Monitoring via WiFi Signals", 2014

Is it possible to leverage WiFi signals collected in bedrooms to monitor a person's sleep? In this paper, we show that with off-the-shelf WiFi devices, fine-grained sleep information like a person's respiration, sleeping postures and rollovers can be successfully extracted. We do this by introducing Wi-Sleep, the first sleep monitoring system based on WiFi signals. Wi-Sleep adopts off-the-shelf WiFi devices to continuously collect the fine-grained wireless channel state information (CSI) around a person. From the CSI, Wi-Sleep extracts rhythmic patterns associated with respiration and abrupt changes due to the body movement. Compared to existing sleep monitoring systems that usually require special devices attached to human body (i.e. Probes, head belt, and wrist band), Wi-Sleep is completely contact less. In addition, different from many vision-based sleep monitoring systems, Wi-Sleep is robust to low-light environments and does not raise privacy concerns. Preliminary testing results show that the Wi-Sleep can reliably track a person's respiration and sleeping postures in different conditions.

2.6 Bed Times Magazine, Black Sleep Council Research," Does Sleep Position Indicate Intelligence? ", 2018

The study, commissioned by the Better Sleep Council (BSC), the nonprofit consumer-education arm of the International Sleep Products Association, found those who reported higher levels of education, such as graduate school or more, were less likely to sleep in Fetal position – the most common sleeping position among Americans (47%). Differences between age groups became apparent in reported sleep position preferences as well: Gen Xers and Millennials were more likely to sleep in Freefall position (arms and legs outstretched) than Baby Boomers.

Although sleeping position is largely a matter of perceived comfort and habit, the study found sleep positions affect sleep quality. For example, people who sleep in the Log position report getting a better night sleep than those in the Fetal. Also, people who sleep in the Starfish or Log positions are more likely to sleepwalk.

This sleep positions can tell us other things about ourselves too. The study found that Log sleepers are more likely to consider themselves to be healthy, while introverts have the strongest aversion to the Freefall sleep position.

Other insights include:

Figure 2. Women Sleep Posture

3. PROPOSED SYSTEM:

Bad sleep postures affect our health and even cause injuries such as, sleep apnea is a disorder, which causes multiple pauses in breathing during sleep[2,11]. We need to monitor our sleep habits. Majority of the back and neck related diseases are due to wrong and improper sleeping positions. Recent survey says that the breathing pauses, heart attacks have been occurred while sleeping due to wrong sleeping postures. The proposed system will be having a scope limitation of monitoring a single persons sleeping posture due to hardware availability constraint.

3.1 System Architecture

Fig 3.1 System Architecture

The proposed system will contain the accelerometer being mounted by microcontroller in order to receive the values from the sensor and send to the remote server using wireless technology[15]. The proposed system makes the sleeping position be predicted and quantify whether person should follow which sleeping position by taking sensor data as input from the wearable sensor and thereby making predictions based on training data input.

3.2 Proposed System Methodology:

- A sensor connected to a micro-controller will be connected to a board which will act as the wearable device on chest.
- The micro-controller will be also connected with a HC-05 Bluetooth module to send the sensor values continuously to the user android device.

- Once the android device starts receiving the values from the sensor, it will be analyzed and quantifying process is done to determine the sleeping posture.
- The final sleeping posture value which is predicted based on sensor coordinates will be sent to server by android device[19].

3.3 System Working Model:

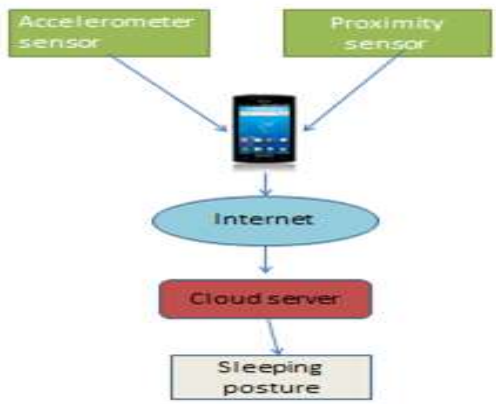

Fig 3.2 System Working Model

- The proposed system focuses on a sleep posture analysis, prediction and quantification system, which requires only one accelerometer to be worn by the care receivers[19].
- Accelerometers are readily available and at least indirectly familiar to most people because they exist in smartphones[5,19]. During a training stage, one accelerometer is used. The care receivers wear one accelerometer on the chest.
- Data collected from the wrist accelerometer sensor are processed using a sliding window approach to obtain the features of a body's motions.
- Our system then maps these features to current positions based on the chest accelerometer sensor and generates the training data for a predictive model for use in the future.
- After the training stage, our system during actual use by a care receiver can recognize four sleep postures: supine, stomach, right side and left side.

3.2 MATHEMATICAL MODEL

- Accelerometer values for x, y and z coordinates:
- Analysis of sleeping posture and quantification:
- Functions :
- – Training Data Set
- – Prediction of Postures
- – Quantifying sleeping diseases likelihood.
- Success Conditions: If the human being is wearing the wearable accelerometer mounted device and the sleeping posture is rightly predicted based on training data set, successful results will be obtained.
- Failure Conditions: If the human being wearing the accelerometer based device and sleep posture is wrongly predicted, quantifying of any sleeping habits becomes difficult.

3.4 Algorithm Used:

Learning Algorithm: A random forest learning algorithm is used to train the sleep posture model for the proposed monitoring system[17]. Random forest algorithm is an ensemble learning method, consisting of many decision trees each trained by a random subset of the entire training data. Each tree brings in the data then outputs a class as a result when the algorithm is used as a classifier. Among the different output results of decision trees, the one with the most votes will be the final output of the entire forest.

1. Randomly select **“k”** features from total **“m”** features.
2. Where **k << m**
3. Among the **“k”** features, calculate the node **“d”** using the best split point.
4. Split the node into **daughter nodes** using the **best split**.
5. Repeat **1 to 3** steps until “l” number of nodes has been reached.
6. Build forest by repeating steps **1 to 4** for “n” number times to create **“n” number of trees**.

4. CONCLUSION

In this paper, Authors covered an overview of the DDOS problem, available DDOS attack tools, defense challenges and principles, and a classification of available DDOS prevention algorithms. This provides better understanding of the problem and enables a security administrator to effectively equip his arsenal with proper prevention algorithms for fighting against threat. The current prevention algorithms reviewed in this paper are clearly far from adequate to protect internet from DDOS attack. The main problem is that there are still many insecure algorithms over the internet that can be compromised to launch large scale coordinated DDOS attack[20].

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