

Using a Bed Sensor Array to Monitor Sleep

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ABSTRACT

Introduction

Falls are a leading cause of injury and death among older adults and can cause lasting emotional damage. Research studies have shown that poor sleep quality has been associated with medical impairments amongst older adults and may be a predictor of falls.

The TAFETA (Technology Assisted Friendly Environment for the Third Age) Project for Older Adults has experimented with an unobtrusive bed-based pressure sensor array to identify nocturnal breathing rates and sleep quality. This poster outlines a preliminary study of this technology as an innovative tool for the assessment of sleep quality and explores the tool's potential as an early warning system of "risk for fall."

Methods

The subject, a 63-year old female, was monitored overnight for three nights in her home. A Bed Occupancy Sensor (BOS) from Tactex Controls Inc. was placed under the subject's top mattress. As the subject slept, data was extracted from the bed-based pressure sensor array and stored on a laptop computer. A custom-designed respiratory rate estimation algorithm processed the data using the following steps: data retrieval/segmentation, source extraction, frequency estimation, and data fusion.

Results

Data collected was converted to breathing rate (bpm) and a "restlessness index." Over the three nights, there was consistency between the average breathing rates and the restlessness indices.

Conclusion

It is possible to use an unobtrusive bed-based pressure sensor array to identify nocturnal breathing patterns and to identify changes in sleep quality. As sleep quality is correlated to risk of falls, this technology shows promise as an early warning system within the home environment to prevent fall-related injuries and promote aging in place.

The next step for this study is to validate the data collection and transformation techniques in a sleep lab environment.

INTRODUCTION

- Falls and hip fractures are a significant issue for older adults, the aging society, and the health care system.^{1,2}
- Falls are a common cause of injury and are a leading cause of death amongst older adults.³
- Research studies have shown that poor sleep quality has been associated with certain medical conditions amongst older adults and may be a predictor of falls.⁴
- Sleep apnea is an example of a breathing disorder that impacts the quality of sleep.⁵
- Breathing-related disorders, including sleep apnea, increase as we age and are common in the older adult population.⁶
- The TAFETA Project Team has obtained an unobtrusive pressure sensor array, or "pressure-sensitive mat," which has been used under a mattress to sound an alarm when a patient gets out of bed.
- In this study, it was hypothesized that a custom computer algorithm could be written to work with the mat, allowing for the detection of small movements, such as breathing, and large movements, such as turning in bed.

METHODS

Participant Description

- Case Study: 63-year old Female

Timeline

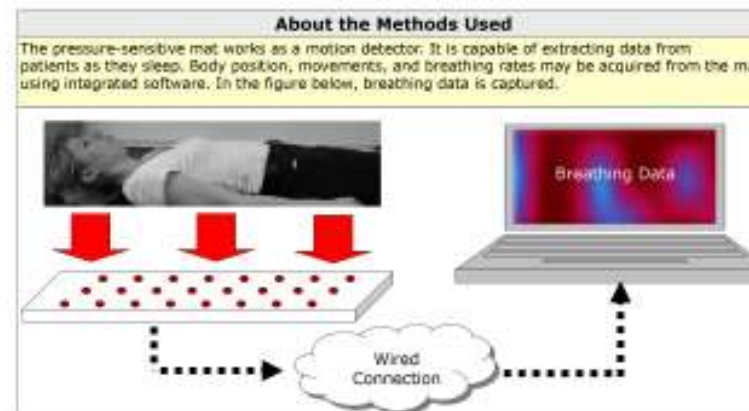
- 3 Consecutive Nights (August 25 to 27, 2006 – Approx. 11 p.m. to 6 a.m.)

Materials

- Location: Patient's Home (Bedroom)
- Equipment: Bed-Based Pressure-Sensitive Mat, Laptop Computer, and Data Extraction Software
- Mattress: 6" Mid-Firm Futon Above with Wooden Slats Below

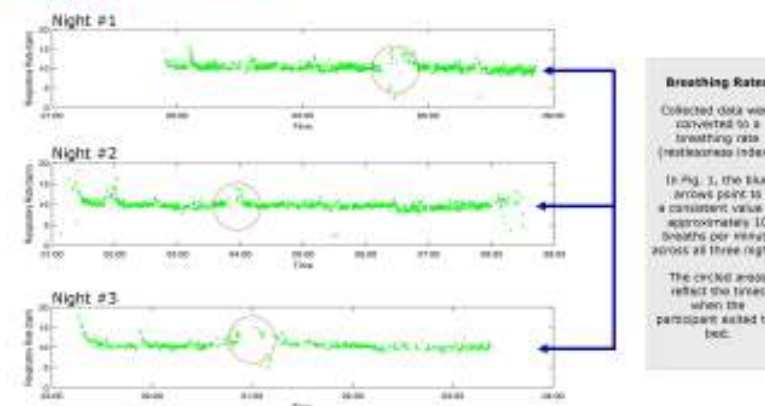
Testing

- Data Retrieval/Segmentation
- Source Extraction
- Frequency Estimation
- Data Fusion



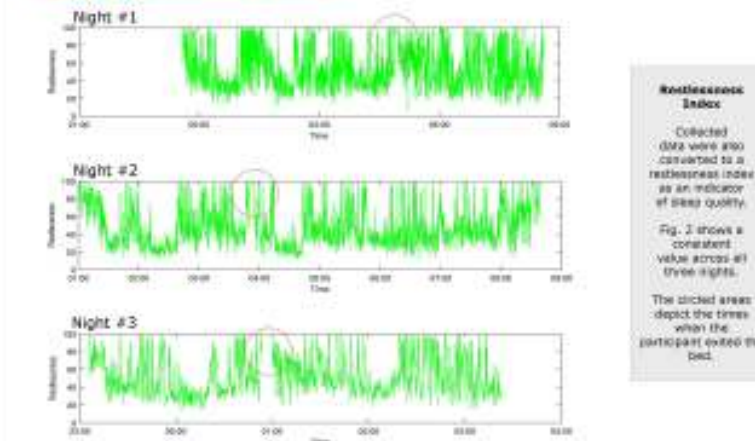
RESULTS

Figure 1: Breathing Rate



RESULTS CONTINUED

Figure 2: Restlessness Index



DISCUSSION

- The pressure-sensitive mat, coupled with the custom-designed software, is able to create two parameters that may be related to sleep quality: breathing rate and restlessness.
- These data collection and transformation techniques will require further validation in a sleep lab environment.
- The TAFETA Project Team will investigate the usefulness of these results as a means to predicting mobility impairments.
- This may prove useful in a smart home environment that is designed to facilitate aging in place.

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