Snoring-based screening for sleep apnea syndrome

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1. Introduction

The incidence of sleep apnea syndrome (SAS) in the general population is speculated to be high[1)], and SAS patients are reportedly at increased risk for lifestyle diseases such as diabetes and hypertension[2),3)]. Ascertaining respiratory status during sleep is therefore important in preventative medicine. On the other hand, SAS diagnosis requires tests such as polysomnography (PSG), which makes it difficult to examine large numbers of people at once. This study focused on changes in snoring sounds associated with respiratory status during sleep, and examined the relation between acoustic signal features obtained from snoring and respiratory status determined through PSG. If a technique were established where respiratory disorders could be inferred from sound of snoring, assessment of SAS would become easier. This presents the promising possibility of coping with potential patients of SAS.

2. Method

The subjects were ten general examinee undergoing PSG. They ranged in ages from 23 to 82, and consisted of nine men and one woman. Oral consent was obtained to fit subjects with one microphone to record snoring in addition to the regular PSG sensors.

The microphone used was an Audio-Technica AT9904, and the recorder a Roland R-26. The microphone was fitted with a stethoscope-like attachment through a rubber tube to enhance sensitivity.

In PSG, occurrences of apnea or hypopnea events were determined same as a practical medical care. The sounds of snoring were extracted from the apnea and hypopnea intervals identified in PSG, and periods of up to 30 s preceding and following those intervals. Then the snores were divided into one sample unit per single breath. The pitch of each sample was detected using Fast Fourier Transform, and 518-dimensional feature vectors were obtained by statistical analysis.

The feature vectors were classified by whether they were acquired during apnea/hypopnea events identified by PSG, or outside of those intervals (other). The key components of the feature vectors were examined using principal component analysis (PCA), and classifiers were obtained through linear discriminant analysis (LDA) based on vectors transformed with PCA. R 3.2.0 was used for PCA, LDA and multiple comparison tests.

3. Results

Analyzable snoring recordings were obtained for eight subjects, and from these 132 samples were acquired for apnea, 1,571 for hypopnea, and 1,964 for other. In a PCA of these data, the cumulative contribution ratio exceeded 0.7 until the 43rd principal component. Furthermore, the absolute values of the coefficients for each predictor variable were summed, and a LDA was performed selecting the top 51 predictor variables. For the two discriminant functions (DFs) obtained, means and standard deviations (SDs) in each category are shown in Table 1. A multiple comparison using a Wilcoxon rank sum test showed significant differences between all categories (critical p-value 1%).

Table 1 Means and SDs of DFs for each sample category. Values are shown as mean±SD.

Category	DF 1	DF 2
Apnea	0.368 ± 0.956	0.717 ± 1.43
Hypopnea	0.174 ± 0.878	-0.0946 ± 0.996
Other	-0.164 ± 1.09	0.0278 ± 0.968

4. Discussion / Conclusion

This study has shown that indices showing useful respiratory status-based differences can be obtained from acoustic features of snoring occurring during apnea and hypopnea events and other periods, as determined by PSG. As classification of the indices obtained in this study is not possible with high accuracy (in terms of sensitivity and specificity), new features and a small number of data other than sounds need to be introduced, and a classifier with higher classification capability needs to be designed. Furthermore, since the airflow is virtually suspended during apnea events, and no clear snoring is produced, a combination with a different approach to detect apnea events is required.

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References

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