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CONFERENCE ABSTRACT

Patient-Centered Care based on Fog Computing paradigm: A Case of Sleep Apnea Detection

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Introduction:

Sleep apnea is medical condition that affects about 4% of the population and may cause various medical complications such as: fatigue, hearth problems and elevated blood pressure, diabetes type II, metabolic syndrome and others. Nowadays, there is a huge demand for technology solutions and new care models that will help in understanding patient's needs and characteristics, facilitating treatment adherence and shared-decision making.

Theory/Methods:

This paper proposes a system and methodology based on fog computing paradigm to unobtrusively detect sleep apnea and to enable patients with sleep apnea and health care providers to be active participants and collaborate in chronic disease management. The methodology is based on findings that sleep apnea is accompanied by body or leg movement. Therefore, the proposed system uses non-invasive PIR and piezoelectric-based sensors placed under the mattress. Data processing and sleep apnea detection is performed by machine learning algorithms on the edge nodes. Anonymized data are also sent to the cloud for further evaluation and assessment by medical experts and are used for model improvement.

Results and discussion:

In order to evaluate the proposed system and methodology, an experiment for continuous monitoring of a single person over a period of 8 hours was conducted. Signals obtained from PIR and bed sensors were segmented and signal features were extracted. Depending on the window length 250 to 270 features in total were generated. Feature set was reduced to 32 features by discarding features with low importance or high data drift sensitivity. Four machine learning algorithms (Extremely Randomized Trees-ERT, Logistic Regression-LR, Random Forest-RF and Support Vector Machine-SVM) for sleep apnea detection were applied on the obtained feature set and the results were compared.

The accuracy of the different classifiers based on different sliding window configurations was analyzed. It was found that, as windows length increases, the accuracy increases too. When using windows of 5 seconds the accuracy was 80%. When the window length was increased to 10 seconds, the accuracy has improved and was about 90%. Next, when increasing the window length to 20 seconds, the accuracy further improved to above 95%.

Conclusion:

The use of novel technology, like unobtrusive sensors and fog computing, can improve the patient-centered care for patients with sleep apnea. The flexibility of the fog architecture enables better placement of computing and network resources. Smarter data flow could protect personal data, bandwidth cost could be reduced and more scalable, secure and interoperable systems can be designed.

Lessons learned:

The fact that accuracy is increasing for larger window length is an important discovery. It can be used for design of a system that makes several predictions at the same time.

Limitations and suggestions for future research:

In order to proof the concept of the proposed system architecture we have conducted experiment with only 3 patients. Future plan foresees increasing the number of patients in our experiments.

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