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Compressive SensingBased Remote Monitoring Systems for IoT applications

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Internet of things (IoT) is shifting the healthcare delivery paradigm from in-person encounters between patients and providers to an «anytime, anywhere» model delivery. Connected health has become more profound than ever due to the availability of wireless wearable sensors, reliable communication protocols and storage infrastructures. Wearable sensors would offer various insights regarding the patient's health (electrocardiogram (ECG), electroencephalography (EEG), blood pressure, etc.) and their daily activities (hours slept, step counts, stress maps,) which can be used to provide a thorough diagnosis and alert healthcare providers to medical emergencies. Remote elderly monitoring system (REMS) is the most popular sector of connected health, due to the spread of chronic diseases amongst the older generation. Current REMS use low power sensors to continuously collect patient's records and feed them to a local computing unit in order to perform real-time processing and analysis. Afterward, the local processing unit, which acts as a gateway, feeds the data and the analysis report to a cloud server for further analysis. Finally, healthcare providers can then access the data, visualize it and provide the proper medical assistant if necessary. Nevertheless, the state-of-the-art IoT-based REMS still face some limitations in terms of high energy consumption due to raw data streaming. The high energy consumption decreases the sensor's lifespan immensely, hence, a severe degradation in the overall performance of the REMS platform. Therefore, sophisticated signal acquisition and analysis methods, such as compressed sensing (CS), should be incorporated. CS is an emerging sampling/compression theory, which guarantees that an N-length sparse signals can be recovered from M-length measurement vector (M<<N) using efficient

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algorithms such as convex relaxation approaches and greedy algorithms. This work aims to enable two different scenarios for REMS by leveraging the concept of CS in order to reduce the number of samples transmitted form the sensors while maintaining a high quality of service. The first one is dedicated to abnormal heart beat detection, in which, ECG data from different patients is collected, transmitted and analysed to identify any type of arrhythmia or irregular abnormalities in the ECG. The second one aims to develop an automatic fall detection platform in order to detect falls occurrence, their strength, their direction in order to raise alert and provide prompt assistance and adequate medical treatment. In both applications, CS is explored to reduce the number of transmitted samples form the sensors, hence, increase the sensors lifespan. In addition, the identification and the detection is enabled by means of machine learning and pattern recognition algorithms. In order to quantify the performance of the system, subspace pursuit (SP) has been adopted as recovery algorithm. Whereas for data identification and classification, K-nearest neighbour (KNN), E-nearest neighbour (ENN), decision tree (BDT) and committee machine (CM) have been adopted.