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Classification of Coughing and Breathing Activities Using Wearable and a Light-Weight DL Model

Authors : Subham Ghosh, Arnab Nandi

Abstract : Background: The proliferation of Wireless Body Area Networks (WBAN) and Internet of Things (IoT) applications demonstrates the potential for continuous monitoring of physical changes in the body. These technologies are vital for health monitoring tasks, such as identifying coughing and breathing activities, which are necessary for disease diagnosis and management. Monitoring activities such as coughing and deep breathing can provide valuable insights into a variety of medical issues. Wearable radio-based antenna sensors, which are lightweight and easy to incorporate into clothing or portable goods, provide continuous monitoring. This mobility gives it a substantial advantage over stationary environmental sensors like as cameras and radar, which are constrained to certain places. Furthermore, using compressive techniques provides benefits such as reduced data transmission speeds and memory needs. These wearable sensors offer more advanced and diverse health monitoring capabilities. Methodology: This study analyzes the feasibility of using a semi-flexible antenna operating at 2.4 GHz (ISM band) and positioned around the neck and near the mouth to identify three activities: coughing, deep breathing, and idleness. A vector network analyzer (VNA) is used to collect time-varying complex reflection coefficient data from perturbed antenna near field. The reflection coefficient (S11) conveys nuanced information caused by simultaneous variations in the near-field radiation of three activities across time. The signatures are sparsely represented by Gaussian windowed Gabor spectrograms. The antenna is biocompatible in terms of specific absorption rate (SAR). The sparsely represented Gabor spectrogram pictures are fed into a lightweight deep learning (DL) model for feature extraction and classification. Two antenna locations are investigated in order to determine the most effective localization for three different activities. Findings: Cross-validation techniques were used on data from both locations. Due to the complex form of the recorded S11, separate analyses and assessments were performed on the magnitude, phase, and their combination. The combination of magnitude and phase fared better than the separate analyses. Various sliding window sizes, ranging from 1 to 5 seconds, were tested to find the best window for activity classification. It was discovered that a neck-mounted design was effective at detecting the three unique behaviors.

Keywords : activity recognition, antenna, deep-learning, time-frequency
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