Controlled Breathing Effect on Respiration Quality Assessment Using a Convolutional Neural Network

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Aims: Thoracic bio-impedance (BioZ) measurements have been proposed as an alternative for respiratory monitoring. Given the ambulatory nature of this modality, it is more prone to noise sources. In this study, a pre-trained convolutional neural network (CNN) was used to distinguish clean from noisy BioZ signals. Its performance was evaluated on patients undergoing bariatric surgery resulting in substantial weight loss (WL). Additionally, transfer learning (TL) was used to optimize the network for the new patient cohort. Lastly, the effect of different breathing patterns on the performance of the CNN was studied.

Methods: The CNN was trained on 1896 one-minute segments recorded from 47 chronic obstructive pulmonary disease patients during spontaneous breathing. It was validated, before and after TL, on 868 thirty-second segments from 20 WL patients. These patients performed a respiratory protocol consisting of one minute of spontaneous breathing, and five blocks of thirty seconds of chest, shallow, abdominal, slow, and fast breathing. To investigate the effect of different breathing patterns, the classification probabilities given by the last CNN layer were analyzed.

Results: The AUC of the original CNN (92.67%) was increased with TL (93.20%). The mean probabilities of being classified as clean were 0.24 for noisy and 0.57 for clean signals, without TL, and 0.16 and 0.60 with TL. This means that noisy signals were better discriminated, despite the changes in breathing pattern. For the clean signals, the original CNN performed worse for the slow and fast breathing segments. TL increased the probabilities of the clean signals to be classified as such, for all patterns, except fast breathing.

Conclusions: The network performs accurately when applying it to another patient population and its performance is improved by TL. However, the classification performance is mostly affected by different respiratory frequencies, which was also observed by the lack of improvement after TL.