Vocal Fold Dynamics for Automatic Detection of Amyotrophic Lateral Sclerosis from Voice

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Abstract

Amyotrophic Lateral Sclerosis (ALS) is a progressive neurodegenerative disease. Current diagnostic methods for ALS are complicated and rely on subjective judgements from physicians. This situation motivates the development of an expedient and objective diagnostic aid. Since ALS affects motor neurons and causes dysfunctions in speech and respiration, we hypothesized that analyses of features that capture the essential characteristics of the biomechanical process of voice production can successfully distinguish ALS patients from non-ALS controls. We focus on representing voices with algorithmically estimated vocal fold dynamics from physical models of phonation and aim to validate our hypothesis by identifying a set of features that are effective for our desired separation. To achieve our goal, we have explored 2 main sets of features: simple statistical measurements (Set 1) and phase-space characterizations (Set 2) of estimated vocal fold displacements and range of displacements. Random Forest Classifiers based on these features were used to differentiate the voices of ALS and non-ALS individuals. In 10-way cross-validation experiments, classifiers with Set 1 and Set 2 features yielded average AUC-ROC of 99.6% and 82.3%, respectively. These results demonstrate the potential of the use of vocal fold dynamics in detecting ALS from voice recordings.