AUTOMATIC SPEECH PROCESSING FOR THE DETECTION OF ABNORMAL SPEECH ZONES IN DYSARTHRIC SPEECH

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Dysarthria is a motor speech disorder due to damages of the nervous system. Many studies are proposed in the literature to characterize dysarthria acoustically and/or to propose dysarthria classification [1-7]. Although the main features that differentiate "typical" patients affected by different dysarthria types have been identified, study of dysarthrias needs more comprehensive phonetic descriptions to overcome the great diversity observed in patient speech patterns.

In this study, the authors propose an original approach to detect automatically abnormal part of speech. This approach based on speech processing tools aims to help phoneticians in their manual investigation of dysarthric productions by guiding them towards acoustic zones potentially attractive for subsequent fine grained acoustic analysis. It also permits to deal with larger patient corpora as well as longer speech production since only restricted zones will be investigated in the speech.
The proposed approach relies on a text-constrained phoneme alignment system [8], providing phoneme boundaries automatically. A second process, based on the statistical modelling of phonemes in the acoustic domain and the computation of a "normality score" for each phoneme, permits afterwards to label the phonemes as "normal" or "abnormal".

This automatic detection is evaluated on the speech of 8 dysarthric patients suffering from lysosomal storage diseases and presenting different degrees of dysarthria severity. The corpus includes five patients suffering from a Niemann Pick C disease and three patients from a Late Onset Tay Sachs. These eight patients, under an experimental treatment, have been recorded longitudinally over 24 months while reading a French text. Additionally, the corpus contains recordings issued from control speakers collected in the same conditions.
To evaluate the reliability of the automatic approach, the patients' recordings (35 over the 8 patients) have been assessed manually by an expert: all the phonemes have been analysed and rated as a "normal" or "abnormal" production. This manual rating is compared with the results of the automatic detection, resulting in a 70% agreement rate. Regarding the behaviour of the automatic detection on the control speakers' recordings (for which all the phonemes are considered as normal), 12% of phonemes are misclassified, labelled as abnormal. Among these misclassified phonemes, 8% refers to plosives /p/, /t/, /k/.
In some cases, abnormality is automatically detected but assigned to the previous or next phoneme instead of being assigned to the phoneme targeted by the manual assessment. Considering this shift of one phoneme as a match between the manual and automatic rating, the agreement rate raises 80%.

Lying on the manual assessment and these encouraging results, further investigation will permit to outline if the automatic approach is reliable to detect any kinds of abnormality (voice quality, spectral distortion, dysfluencies, ...) or more reliable with some of them. The plosive misclassification observed on the control subjects will also be of interest since it can have some effects on the detection results obtained on the patients' speech.

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