Automatic classification of French stops consonants

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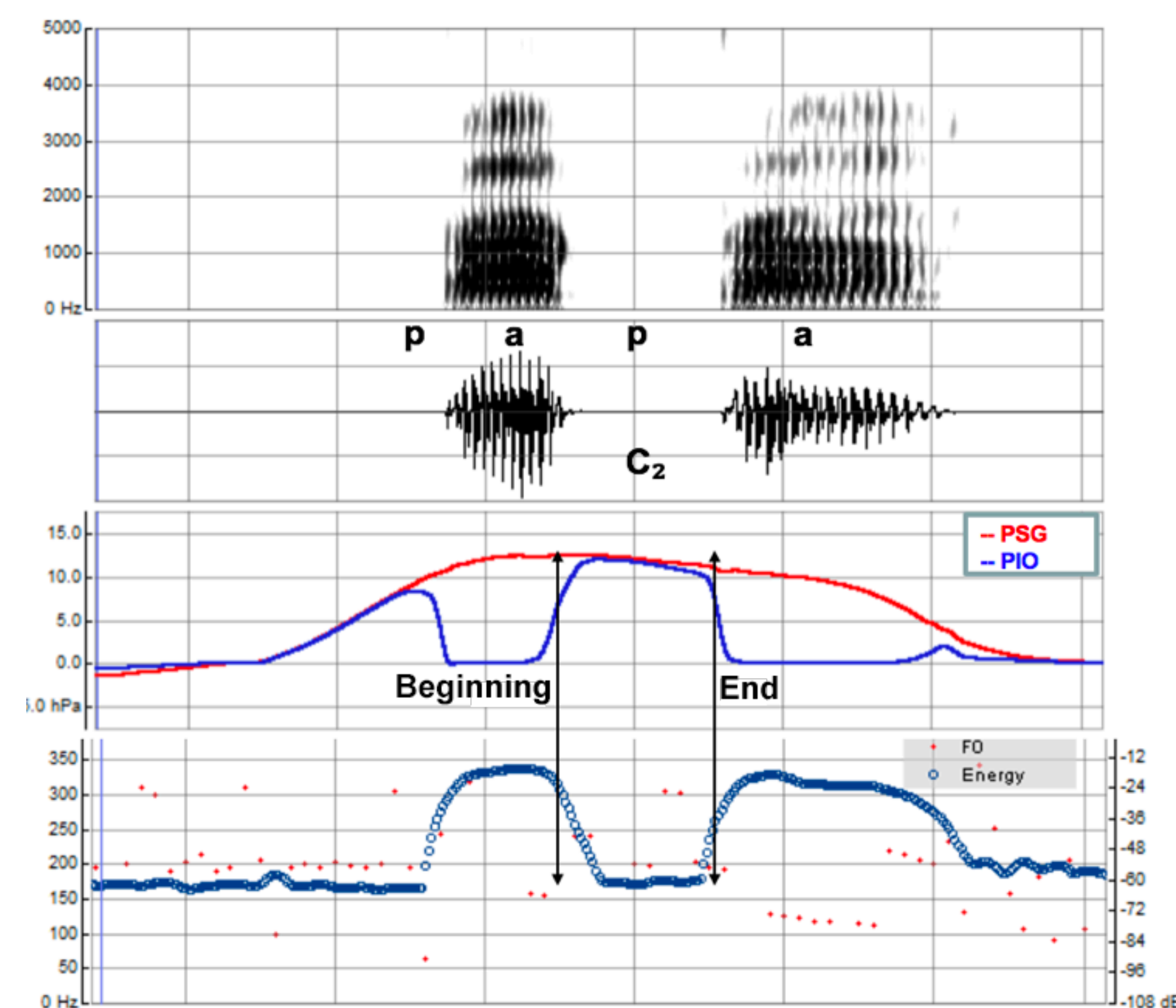
Abstract

The purpose of this study is to analyze aerodynamic parameters involved in the production of French stops consonants. We focus our analysis on intraoral pressure and subglottic pressure measurements. The main goal of this study is to automate the processing of aerodynamic data in order to contribute providing reference data that are limited in the literature. We also want to analyze pressure variations according to voicing contrast, intervocalic context and different places of articulation. To do this, we carry out a phonetic analysis by means of statistical tests in order to analyze the relevant descriptors to understand variations of consonants. Then, we perform a supervised classification task to assess the relevance of these descriptors. The field of research is multidisciplinary and involves methods in phonetics, automatic language processing and machine learning.
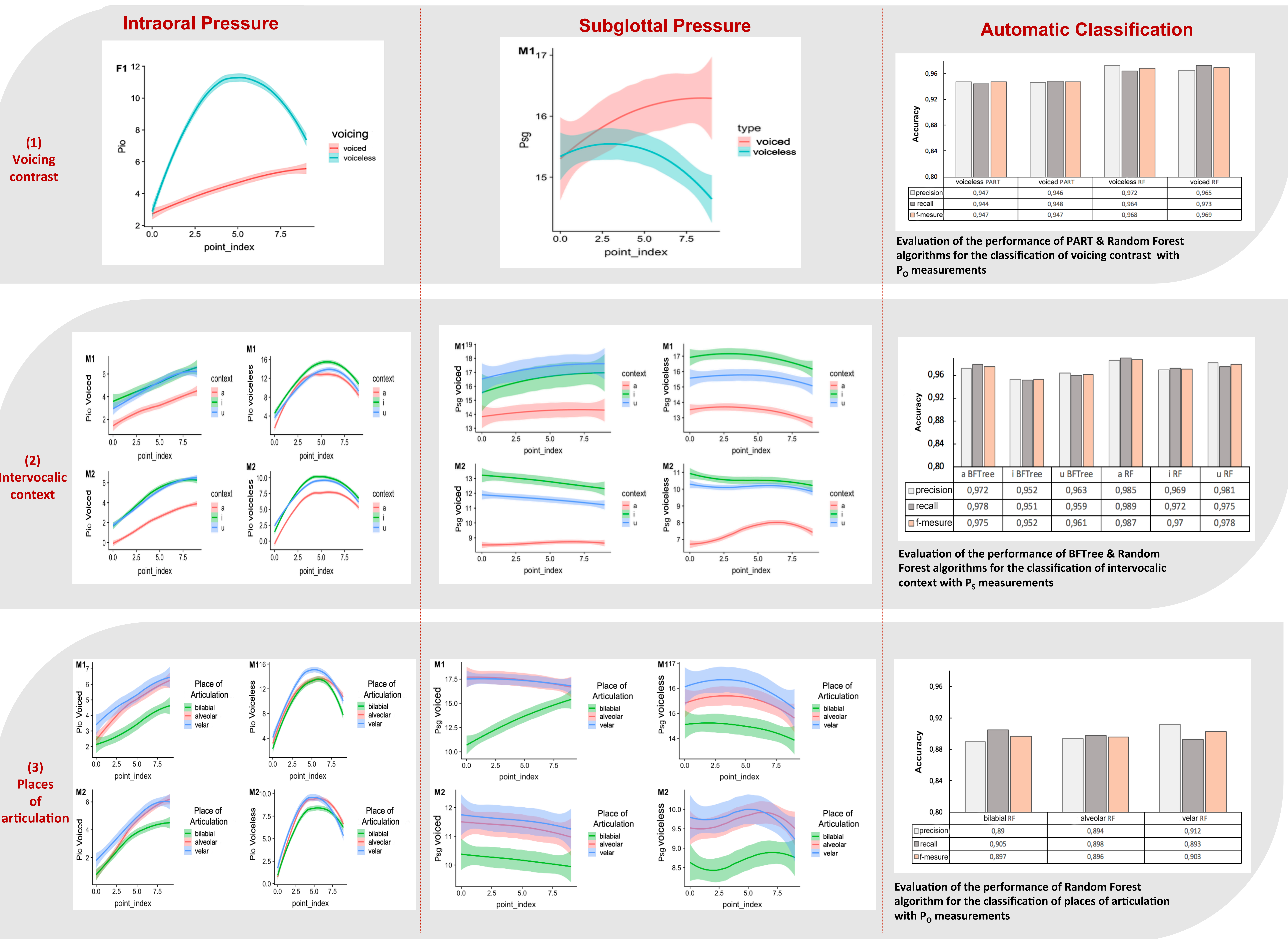
Materials

Participants 4 native French speakers: two women (labelled F1 and F2) and two men (labelled M1 and M2) with normal larynx and no voice problems.

Corpus series of logatomes combining each of the French stops consonants with the vowels /a,i,u/ inserted in the sentence "[C^1VC^2V] say [C^1VC^2V] again" (ex: "papa dit papa encore") to be repeated five consecutives times.

Aerodynamics data Subglottal pressure (P_S) by tracheal puncture & Intraoral pressure (P_o) with a tube inserted through the nasal cavity into the oropharynx.

Results

Intraoral Pressure

(1) Voicing contrast

Subglottal Pressure

Automatic Classification

	voiceless PART	voiced PART	voiceless RF	voiced RF
precision	0,947	0,946	0,972	0,965
recall	0,944	0,948	0,964	0,973
f-mesure	0,947	0,947	0,968	0,969

Evaluation of the performance of PART & Random Forest algorithms for the classification of voicing contrast with P_O measurements

(2) Intervocalic context

	a BFTree	i BFTree	u BFTree	a RF	i RF	u RF
precision	0,972	0,952	0,963	0,985	0,969	0,981
recall	0,978	0,951	0,959	0,989	0,972	0,975
f-mesure	0,975	0,952	0,961	0,987	0,97	0,978

Evaluation of the performance of BFTree & Random Forest algorithms for the classification of intervocalic context with P_S measurements

(3) Places of articulation

	bilabial RF	alveolar RF	velar RF
precision	0,89	0,894	0,912
recall	0,905	0,898	0,893
f-mesure	0,897	0,896	0,903

Evaluation of the performance of Random Forest algorithm for the classification of places of articulation with P_O measurements

Conclusion

This research work has highlighted the interest of using aerodynamic data for the automatic classification of French stops consonants. Indeed, during supervised classification, we obtained a performance of 97.8328% for the intervocalic context, 96.839% for the voicing contrast and 89.8821% for the automatic classification of places of articulation. These classification tasks revealed that subglottic pressure was sufficient to detect the consonantal context. The same is true for intraoral pressure coupled with duration, which appeared to be the most relevant parameter for detecting voicing contrast and places of articulation.