Classification by discriminant analysis of the energy in view of the detection of accentuated syllable in Standard Arabic

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Abstract

In this work, we exploited the acoustic parameter energy to a classification by a discriminant analysis to detect the primary accent syllables of type [CV] where [C] is a consonant and [V] a vowel, in Standard Arabic words. Generally, the three acoustic parameters used in prosody are: the fundamental, the duration and the energy, as well as the localization of the prominent syllable in final or initial position have an influence on the perception of the lexical accent in Arabic. A percentage of detection equal to 78% of the accentuated syllable shows the efficiency of such an approach that will be able to come to reinforce the methods based on the criteria of the fundamental, in the goal to improve the existing systems of synthesis and recognition in Standard Arabic.

Key words: classification by discriminant analysis, lexical accent, Standard Arabic, energy, accentuated syllable

Introduction

Arabic is a Semitic language, it is classified among the oldest languages in the world. The Standard Arabic counts 34 phonemes: 6 vowels and 28 consonants. We will speak of the language Arabic in reference to what is called "the Unified Modern Arabic" or "the Standard Arabic", that is the language taught in the schools, written and spoken in the official context.

From the acoustic point of view, the prosody indicates the phenomena bound to the variation in the time of the parameters of fundamental frequency (F_0), the intensity (I) and duration of emission (D) (Farinas 1998).

The accentuation is the setting in relief of a syllable in relation to those that surround it, and that are qualified therefore of not accentuated. These last years, we noted many works concerning the study of the Arabic prosody. What strengthened the hypothesis according to which the lexical accent exists in Arabic. Bohas (1979) admits the existence of the accent by showing that it plays a distinctive role. Rajouani (1989) confirmed that the detection of the primary accent seems sufficient for the study of the Arabic intonation and found from his experiments, the following result: the hierarchy (F_0 , I, D) for the Arabic language.

Arabic language and accent

For Ghalib, the accent exists in Arab but has no linguistic function and its importance is much lesser compared with English or Germany where it has incidences on the sense and the grammatical function of some words of the lexicon. Any isolated word in Arabic receives an accent which will be carried on the stressed syllable.

Al-Ani (1970) establishes the more used rules governing the place of the accent. He speaks about of the presence of three levels of accent: a first level or Primary Accent; a second level or Secondary Accent and a third level or Weak Accent. The position and the distribution of the accent depend on the number and the types of syllables contained in the word.

Simulations and results

We have 4 Arabic-speaking: 2 men and 2 Women, who pronounce each one Arabic words having the following three-syllabic structure $[S_1 S_2 S_3]$: $[C_1V C_2V C_3V]$ with $[C_1]$, $[C_2]$ and $[C_3]$, 3 different Arabic consonants and $[V]$ a vowel. These words are pronounced inside carrier sentences. These sentences with $[C_1V]$, always corresponding to a syllable whose accent is primary. The recording was made in an anechoic room at the level of the Laboratoire Parole et Langage (LPL) then treated by a computer program PRAAT which can analyse, synthesize and manipulate speech data.

In our approach, we followed the following stages:

Stage 1: Segmentation and phonetic transcription of the recorded words

Stage 2: Extraction then the calculation of the medium-term spectre for every vowel detected inside the used word

Stage 3: Make a discriminant analysis to classify all the vowels in an orderly structure and create the appropriate configuration

Stage 4: Generate the matrix of the confusions to verify the conformity of the predictive classification with the reality

Stage 5: Consider values for additions of vowels not being present in the sample of training. We shall so manage to predict the values of new observations in the classification or the already existing regrouping

Stage 6: Generate the corresponding matrix of confusion.

To be able to interpret the results, we exploited the method of the bootstrap (Efron and al. 1994) in our corpus. This method gets organized around a technique of re-sampling, accompanied with a “big” number of iterations which result from the application of the method of Monte Carlo (Landau and al. 2000).

We proceeded to the learning of sentences of our corpus. Once realized, we passed to the recognition of other sentences not included in the first phase of calculation. We proceeded to the calculation of the matrix of total

confusion for every sentence as well as the percentage of correct affectations.

To end on the efficiency of the used method, we appealed to the principle of the method of Bootstrap (defined previously) and we then calculated the matrix of total confusion corresponding to the tested corpus.

Table 1. Matrix of confusion in learning (L) and in recognition (R) and the percentages of affectation obtained according to every sentence.

Removed sentence Speakers $X_1 - X_2$	Sentences		
$X_1 - X_2$	540L	424	87 29
		92	320 128
		33	241 266
	60R	62.35 %	
		S1 : 78.52 %	
		S2 : 59.26 %	
$X_1 - X_2$	540L	47	10 3
		12	33 15
		6	27 27
	60R	59.44 %	
		S1 : 78.33 %	
		S2 : 55 %	
$X_1 - X_2$	540L	424	87 29
		92	320 128
		33	241 266
	60R	62.35 %	
		S1 : 78.52 %	
		S2 : 59.26 %	
$X_1 - X_2$	540L	47	10 3
		12	33 15
		6	27 27
	60R	59.44 %	
		S1 : 78.33 %	
		S2 : 55 %	

We obtained then the Table 1 which allows us to conclude as follows: the phase of learning gives a good percentage of recognition equal to 62.35%. It is clear that it is the classification of both unaccented syllables (S_2 and S_3) that are at the origin of this reduction, the accentuated syllable S_1 is classified with a good rate equal to 78.52% and the global phase of test is very slightly superior to the threshold corresponding to an unpredictable classification. However, we note the very good classification of the syllable S_1 (78.33%).

Conclusion

In this work, we took advantage of the classification by discriminant analysis based on the acoustic parameter energy to detect the primary accent in SA in the syllable of type [CV]. Our choice limited itself to the three-syllabic Arabic words. After having segmented and transcribed manually the used corpus, we applied him our algorithm based on the discriminant analysis. A percentage of detection equal to 78% of the accentuated syllable has been obtained.

This is only a first approach in the detection of the primary accent in standard Arabic by a discriminant analysis of the prosodic parameter energy. The obtained results are to be tested on more important corpuses of Arabic. But already, we can say that the classification by discriminant analysis of the

criterion energy can be a supplementary parameter for the detection of accentuated syllables what can come to enrich the methods of recognition already existing, based only on the criterion of the fundamental.

References

- Al-ani S.H. 1970. Arabic phonology: An acoustical and physiological investigation, Mouton and Co. (Ed.), The Hague, Netherland.
- Bohas G. 1979. Contribution à l'étude de la méthode des grammairiens arabes en morphologie et en phonologie d'après les grammairiens arabes tardifs. Thèse de doctorat, Université de Lille 3, France.
- Efron B., Tibshirani R.J. 1994. An Introduction to the Bootstrap, Chapman & Hall/CRC (Ed.), USA.
- Farinas, J. 1998. La Prosodie pour l'Identification Automatique des Langues, Rapport de DEA, Université Paul Sabatier, France.
- Ghalib M. (ND). Etude de quelques aspects de l'intonation en Arabe, Revue de l'Université de Bassorh, Vol. 10, pp. 198-228, Irak.
- Landau D.P., Binder K. 2000. A guide to Monte Carlo simulations in statistical physics, Lavoisier (Ed.), France.
- PRAAT, Praat : doing phonetics by computer, www.praat.org.
- Rajouani A. 1989. Contribution à la réalisation d'un système de synthèse à partir du texte pour l'arabe, thèse de doctorat, Université Mohamed V, RABAT, Maroc.