

Chapter 11

Perception of Vowels and Dental Consonants in Bangla Speech Processing

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ABSTRACT

The aim of this chapter is to clearly understand the salient features of Bangla vowels and the sources of acoustic variability in Bangla vowels, and to suggest classification of vowels based on normalized acoustic parameters. Possible applications in automatic speech recognition and speech enhancement have made the classification of vowels an important problem to study. However, Bangla vowels spoken by different native speakers show great variations in their respective formant values. This brings further complications in the acoustic comparison of vowels due to different dialect and language backgrounds of the speakers. This variation necessitates the use of normalization procedures to remove the effect of non-linguistic factors. Although several researchers found a number of acoustical and perceptual correlates of vowels, acoustic parameters that work well in a speaker-independent manner are yet to be found. Besides, study of acoustic features of Bangla dental consonants to identify the spectral differences between different consonants and to parameterize them for the synthesis of the segments is another problem area for study. The extracted features for both Bangla vowels and dental consonants are tested and found with good synthetic representations that demonstrate the quality of acoustic features.

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INTRODUCTION

A fundamental distinctive unit of sound of a language is called phoneme. It is distinctive in the sense that differentiates words of a language (Pickett, 1980). In English the words “cat,” “bat,” and “hat” consists of three speech sounds having distinctive meaning due to different phoneme classes. Different languages contain different phoneme sets. Syllable contains one or more phonemes, while words are formed with one or more syllables, concatenated to form phrases and sentences. Phonemes can differ across languages despite similar grammatical rules.

A phoneme arises from a combination of vocal fold and vocal tract articulatory features. Articulatory features include the vocal fold state i.e. whether vocal folds are vibrating or open; the tongue position and height, i.e. whether it is in the front, central or back along the plate and whether its constriction is partial or complete; and the velum state i.e. whether a sound is nasal or not. In English, the combination of features are such as to give 40-44 phonemes, while in other languages the features can yield a smaller or a larger phoneme set (Quatieri, 2002).

Bangla (or Bengali), one of the more important Indo-Iranian languages, is the sixth-most popular in the world and spoken by a population that now exceeds 250 million. Geographical Bangla-speaking population percentages are as follows: Bangladesh (over 95%), and the Indian States of Andaman & Nicobar Islands (26%), Assam (28%), Tripura (67%), and West Bengal (85%). The global total includes those who are now in diaspora in Canada, Malawi, Nepal, Pakistan, Saudi Arabia, Singapore, United Arab Emirates, United Kingdom, and United States.

In linguistic relationship, Bangla is closer to Assamese than to Oriya and Hindi. The general structural patterns show numerous resemblances to the Dravidian languages of south India. About sixty percent of the word types in formal Bangla are classical Sanskrit; the rest contains British

English, Persian, Portuguese and other South Asian languages (Islam, 1970). The Bangla script is historically derived from ancient Indian Brahmi, itself a modification of ancient southern Arabic (Hai, 1966).

Bangla is read and written from left to right and has no capitals. It uses diacritics in all four directions to indicate non-initial vowels and some consonants. There are ten vowels (among which two are diphthongs), three semivowels and thirty-five (phonetically twenty-nine) consonants in present day Bangla, but in early days two more vowels namely *hri* (ঝ) and *hli* (ঞ) were used. Any kind of combination of vowels, semivowels and consonants can form a syllable in Bangla but a consonant is always uttered with the first vowel /আ/ or [a] which is called an inherent vowel unless it is followed by a sign called hash sign called diacritics (Islam, 1970).

According to Bangla Linguistics, based on the IPA (International Phonetic Alphabet) representation, there are eight classified cardinal vowels grouped into categories of frontal and back vowels and one central or neutral vowel /আ/ [aa]. The frontal vowels are /ই/ [e], /এ/ [a], /ঐ/ [ae] and back vowels are /অ/ [ao], /ও/ [o], /ঔ/ [ou] and /উ/ [u] respectively (Hai, 2000).

The goals of this study are: to develop linguistic classification of Bangla vowels based on relevant normalized acoustic features applicable to Bangla vowels; to propose a Bangla vowel system for the normalized acoustic parameters based on formant frequency extracted from males and females; and to make a comparative study of Bangla dental consonants. In the review of the literature, various non-linguistic speaker-dependent sources of variation and previous normalization procedures are examined. Then, this particular study evaluates two specific methods: one using formant values in Hz, the other using the values in Bark units, and compares the two versions with other procedures in terms of minimization of male and scaled female differences in database.

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