Pitch Study of Both Rabha and Bodo Phonemes

Dr. Nityananda Barman

Assistant Professor, Department of Statistics, B N College, PO.Bidyapra, Dist: Dhubri, Assam-783324

ABSTRACT

Rabha and Bodo language has assimilated words from the dialects of many tribes. The rate of vibrations of the vocal folds is the pitch or fundamental frequency of the voice. Relative differences in the fundamental frequency of the voice are utilized in all languages to signal some aspects of linguistic information. The present study is undertaken to detect the pitch or fundamental frequency of Rabha and Bodo phonemes and also to see whether the pitch or fundamental frequency can be effectively used as a technique of sex verification of different languages. The fundamental frequency ranges between 80Hz and 160Hz for male speakers and between 160Hz and 400Hz for female speakers. The estimation of pitch and formant frequencies finds extensive use in speech encoding, synthesis and recognition. The present study also revealed that the pitch or fundamental frequency can be effectively used for sex verification of Rabha and Bodo speakers.

Summary : The fundamental frequency of Rabha and Bodo phonemes ranges between 80Hz and 160Hz for male speakers and between 160Hz and 400Hz for female speakers respectively. The estimation of pitch and formant frequencies finds extensive use in speech encoding, synthesis and recognition.

KEYWORDS : Bodo, Rabha, Pitch and Language

1. INTRODUCTION

Human speech has been a crone stone in the success of the mankind. Over the period of evolution, we the human have developed over speech faculties far ahead of any other species. Speech is defined as a set of audible sound produced by distributing the air through the integrated movements of certain groups of anatomical structures. It has evolved as a primary source of communication between humans i.e., speech and hearing are man's most used means of communication.

The speech organs are divided into three main groups: the lungs, larynx and vocal tract. The lungs act as the power supply and provide airflow to the larynx stage of the speech production mechanism. The larynx modulates airflow from the lungs and provides either a periodic puff-like or noisy airflow source to the third organ group, the vocal tract. The vocal tract consists of oral, nasal and pharynx cavities, giving the modulated airflow its "color" by spectrally shaping the source. Sound sources can also be generated by the constrictions and boundaries that are made within the vocal tract itself, yielding in addition to noisy and periodic sources, an impulsive airflow source [1].

The smallest units of human speech, which are more refined, are called phonemes. Phonemes essentially represent the various kinds of sounds occurring in the speech. Depending upon the way of articulation phonemes can be classified into different groups. They may be voiced or unvoiced. Voice sounds are produced by the involvement of glottis in the speech production process. They have low zero-crossing rate. Vowels are voiced sounds and consonants may be voiced voice less. Unlike the voiced sound, the unvoiced sounds do not involve 'active' participation of the glottis in their production. They are non-periodic, low peak-to-peak amplitude and high zero-crossing rate. They are random noise sound [2].

1.1 Brief description of Rabha and Bodo language
1.1.1 Rabha Language
Rabha is the fifth largest tribe among the 21 ethnic minority communities of Assam. The Rabha community comprises 1.05 % of Assam's total population. The distribution of Rabha language speakers in the different districts of Assam are Dhubri, Khokrajhar, Bongaigaon , Goalpara, Nalbari, Kamrup and Darrang and Northern part of Garo Hill district of Meghalaya.

Anthropologically Rabhas fall within the Boro-Naga group of the Mongoloid population. Linguistically they belong to the Tibeto- Burman group of languages. There are as many as 11 sub-groups. They are: Rangdani, Maitoria, Dahori, Patirabha, Sunga, Bitolia, Kosa, Dumesa, Totla, Mohadi and Hana. Rangdani, Maitori and Kosa are the primary dialects of the Rabha community [3]. It is noteworthy that among those various subclasses, the Rabha language is spoken only by a handful of the tribes who belong to the Randhani, Maitori and

Kosa groups of these sub-classes. There is almost 99% similarity of speech between Randhani and Maitori and 50% between them and Kosa. The Rabhas who live in the forest villages have retained their original Rabha dialect to a great extent. It is seen that the Rabha language has assimilated words from the dialects of many tribes as well as from various developed language both India and foreign.

Out of eleven linguistic sub-groups of Rabhas, only three of which have their own writing system. However all the sub-groups are now unifying to identify a commonly accepted form of the language i.e. Rangdania, using Assamese script. This has helped the groups that had already lost their language to re-learn it.

Originally, the Rabha language was a tonal language like other languages of the Boro-Naga group. But at present Rabha fails in keeping them. Rabha language has six vowel phonemes and twenty two consonant phonemes.

1.1. 2. Bodo Language
The Bodos are considered as one of the most important ethnic and linguistic community. The Bodo speech community is now well-spread throughout the north-east India including Assam, Arunachal Pradesh, Meghalaya, Nagaland, Mizoram, Manipur, Tripura, northern part of West Bengal, Bihar and adjoining areas of Bangladesh, Nepal and Bhutan.

In Assam, according to 1991 census report of Assam, the estimated Bodo speakers was 11, 84,569. Genetically the Bodos of Assam belong to the Tibeto-Burman sub-family within the Sino- Tibetan family of language. The Bodos represent one of the largest of the 18 ethnic sub-groups within the Kachari group, first classified in the 19th century. The overarching term "BODO" is a collective designation to include the peoples of the region who share some degree of cultural and linguistic heritage; however, the term embraces many distinct populations, societies, and ethnic groups like Kachari, or Boro, Lalung (now called Tiwa), Dimasa, Garo, Rabha , Tripuri, Koch, Chuttiya and Moran etc. who each have their own particular traditions, language ,cultures, and historical identity

The Bodo language is a member of the Tibeto-Burmese family. However, they are mostly use Assamese language as a media of communication during conversation with the Assamese people and Bodo within themselves The Bodo language is a tonal language. It has six vowels and sixteen consonants.

The aim of the present study is to detect the pitch or fundamental frequency of Rabha and Bodo phonemes. Further, this study will also observe whether the pitch or fundamental frequency can be effectively used as a technique of sex verification of different languages with ref-

erence to Rabha and Bodo language.

1.2 Pitch estimation of Rabha and Bodo phonemes

The opening and closing of the vocal folds that occurs during speaking, breaks the air steam into chains of pulses. The rate of repetition of these pulses is the pitch and it defines the fundamental frequency of the speech signal [4]. In other words the rate of vibrations of the vocal folds is the fundamental frequency of the voice. The frequency increases when the vocal folds are made taut. Relative differences in the fundamental frequency of the voice are utilized in all languages to signal some aspects of linguistic information [5].

The general problem of fundamental frequency estimation is to take a portion of signal and to find the dominant frequency of repetition. Thus the different difficulties that arises in the estimation of fundamental frequency are (i) all signals are not periodic,(ii) those are periodic may be changing in fundamental frequency over the time of interest, (iii) signals may be contaminated with noise , even with periodic signals of other fundamental frequencies, (iv) signals which are periodic with interval T are also periodic with interval 2T, 3T etc., so we need to find the smallest periodic interval or the highest fundamental frequency, and (v) even signals of constant fundamental frequency may be changing in other ways over the interval of interest [6].

2. MATERIALS AND METHODS

The fundamental frequency of the speech wave is estimated using autocorrelation. The mathematical model used estimating the fundamental frequency is given below [7]:

A discrete-time short-time sequence is given by

$$s_n[m] = s[m]w[n-m] \quad \dots \quad (1)$$

Where w[n] is an analysis window of duration N_w .The short-time au-

tocorrelation function $r_n[\tau]$ is defined by

$$r_n[\tau] = s_n[\tau] * s_n[-\tau]$$

$$= \sum_{m=-\infty}^{\infty} s_n[m] s_n[m+\tau] \quad \dots \quad (2)$$

Where s[m] is periodic with period p, $r_n[\tau]$ contains peak at or near the pitch period p. For unvoiced sound no clear peak occurs near an expected pitch period. Location of the peak in the pitch period range provides a measure of pith estimation and voicing decision.

The above correlation pith estimator can be obtained more formally by minimizing, over possible pitch periods (p>0), the error criterion given by

$$E[p] = \sum_{m=-\infty}^{\infty} \left(s_n[m] - s_n[m+p] \right)^2 \quad \dots \quad (3)$$

Minimizing E[p] with respect to p yields

$$\hat{p} = \max_{p} \left(\sum_{m=-\infty}^{\infty} s_n[m].s_n[m+p] \right) \cdots \quad (4)$$

Where $p > \varepsilon$, i.e., p is sufficiently far from zero.

This alternative view of autocorrelation pitch estimation is used to detecting the pitch of Rabha and Bodo vowels.

3. RESULTS AND DISCUSSION

The speech waveform and corresponding pitch spectra of six Rabha and six Bodo vowels have been depicted in Fig-1 and Fig-2 for both male and female informants. The estimated values of the fundamental frequency or pitch have been given in Table 1 for Rabha and Bodo vowels.
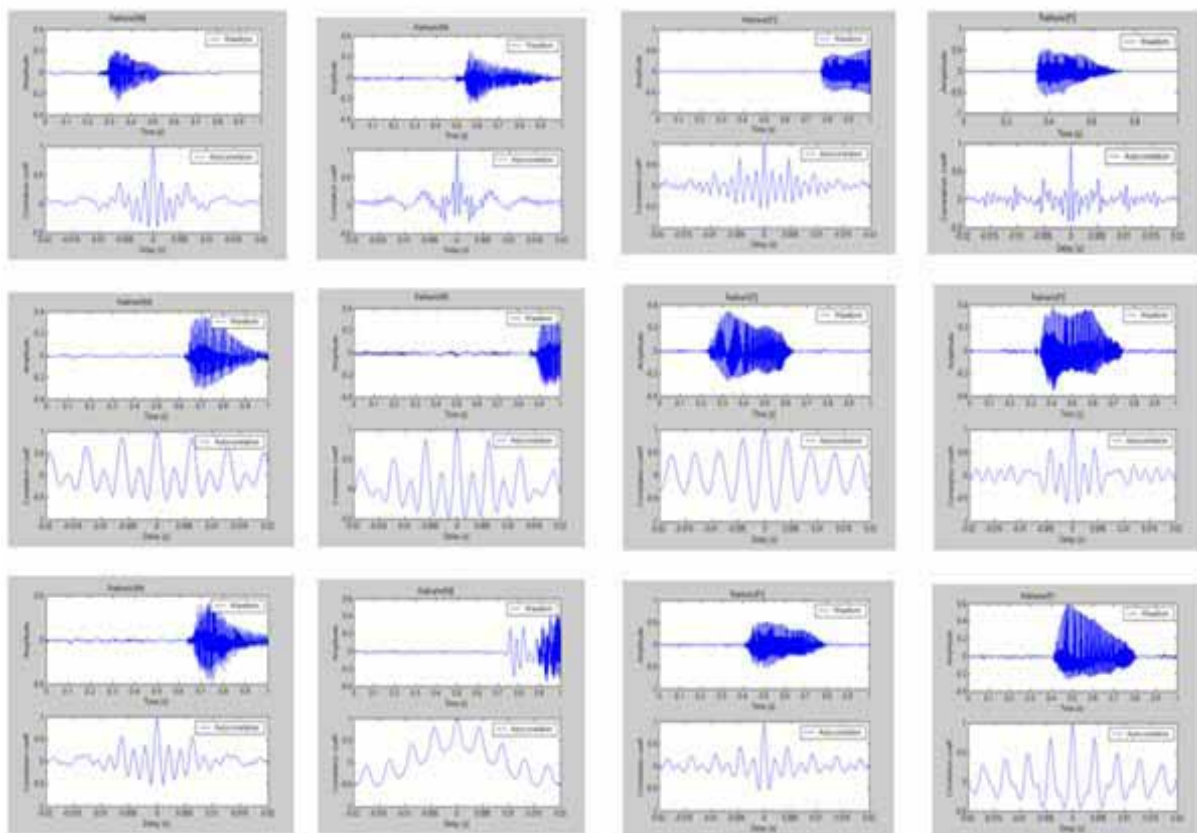
Fig -1: Estimation of pitch of Rabha vowel of male and female informants (time domain)
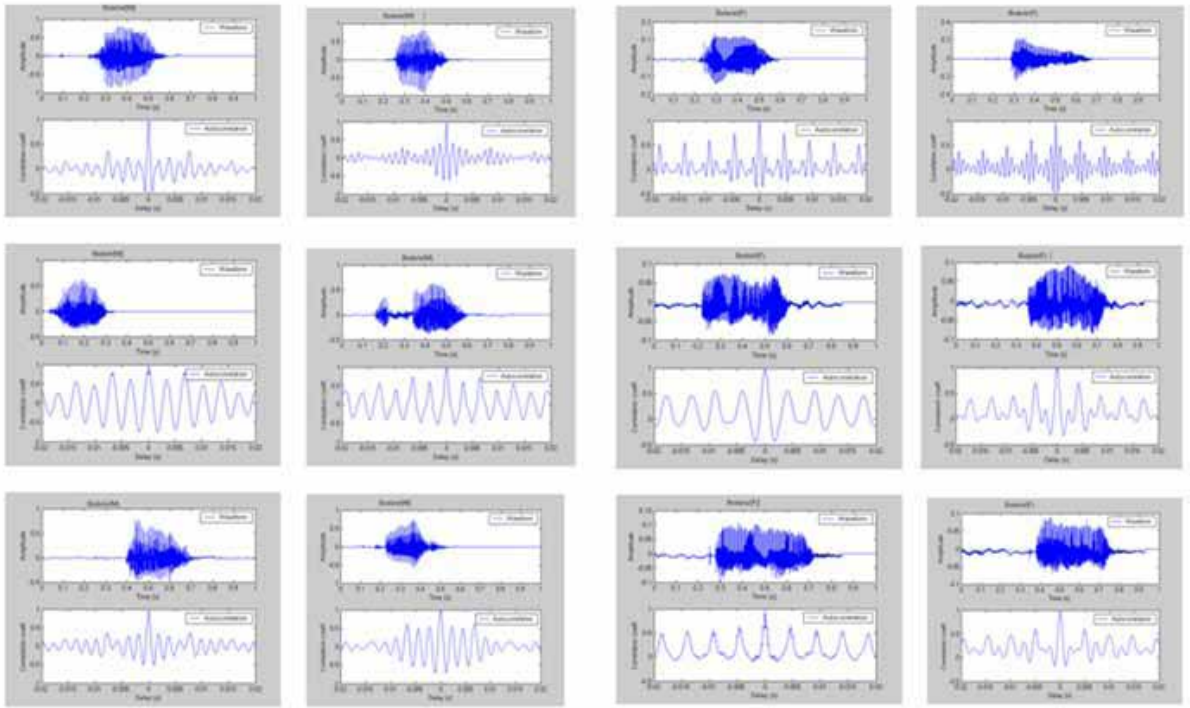
Fig-2: Estimation of pitch of Bodo vowel of male and female informants (time domain)

Typically the pitch or fundamental frequency ranges between 80Hz and 160Hz for male speakers and between 160Hz and 400Hz for female speakers [1]. The formant frequencies are usually greater than the pitch frequency. The estimation of pitch and formant frequencies finds extensive use in speech encoding, synthesis and recognition. In adult, generally the length of vocal folds in male is more than that of female counterpart. The more is the vocal fold length, less is the pitch frequency. Thus the pitch differs in male and female informants.

In our present study, as given in Table 1, we observe that the values of pitch or fundamental frequency for female informant are higher than that of male informants which as proposed by Pinto-et-al [4]. Thus, the pitch or fundamental frequency can be effectively used for sex verification of Rabha and Bodo speakers.

Table-1: Pitch of six Rabha and Bodo vowels

Fundamental Frequency(Hz)	Specimen (Rabha)		Specimen (Bodo)	
	Male	Female	Male	Female
/a/	156.86	210.53	129.03	228.57
/e/	160.00	190.48	380.95	242.42
/i/	156.86	235.29	148.15	266.67
/o/	113.27	228.57	153.85	250.00
/u/	513.85	222.22	125.00	117.65
/w/	222.22	228.57	145.46	250.00

REFERENCES [1]. Wanda,W.Zhao and Ogunfunmi,T.;" Formant and Pitch Detecting Using Time-Frequenc Distribution", Inernational Journal of Speech Technology, 1999. | [2]. Ching,P.C.; Lee,T. and Zee,E.; " From Phonology and Acoustic Properties To Automatic Recognition of Cantonese", Proceeding of 1994 Internal Symposium on Speech, Image Processing And Neural Network, Hong Kong, vol.1, pp. 127-132, 1994 | [3]. Barkataki D. Experiment in Rabha language development, 1-3, 2003 | [4]. Wanda,W. Zaho and T.Ogunfunm; " Formant and Pitch detection using Time-frequency distribution'"International J. of speech Technology,pp-35-49,1999 | [5]. Choudhury,S. ;" A Statistical Analysis of Speaker dependent / Indepen- dent Pattern Congruity of Assamese and Bodo Phonemes", a Ph.D. Thesis. | [6]. Nickel, R.M. and Williams,W.J.; "Using the Time-frequency structure of Pitch Periods to improve speaker Verification systems", Proc. IEEE int.conf.on Acoust. Speech and sig.Proc, pp—145-1148, 1998 | [7]. Quatieri,T.F.; "Discrete Time Speech Signal Processing –Principle and Practice", Low Price Edition, Pearson Education, 2004. |