PHYSICAL PROPERTIES OF SPEECH SOUNDS

Speech exhibits great acoustic variability and the utterances of different individual native speakers show a great difference in their physical properties. It is difficult to detect these physical properties or acoustic features of utterances by the investigator without using the technical device (computer) and the programs (softwares). Experience in analyzing various acoustic features by instrumental (=experimental) study enables one to pick out the essential acoustic features (we generally do not require all acoustic information because our analysis is based on the variability of speech). These essential acoustic features have the qualities in distinguishing one sound/utterance from another. The procedure of the recognition of essential acoustic features requires the identification of essential acoustic parameter. These acoustic parameters are used for diagnostic purposes and the basic function of acoustic parameters is to enable the investigator to make a distinction between sounds/utterances belonging to different sound/utterance classes. The investigation of acoustic parameters is done through the study of spectrograms and waves by using PRAAT program.

Acoustic analysis (Sound Waves and Spectrograms)

Spectrographic analysis is the most common method of analyzing a speech sound. The summary of the acoustic features (=physical properties) is quite useful for the speech analysis of the data and this is provided by the sound spectrograph (a device or an instrument). Recently certain softwares have been used for solving all types of spectral or spectrographic problems. Spectrogram (a graphic view of the energy patterns of speech sounds) can detect the various frequencies and can also measure the relative intensities, pitches and several other acoustic elements, as we shall see now in Fig. 1 given below.

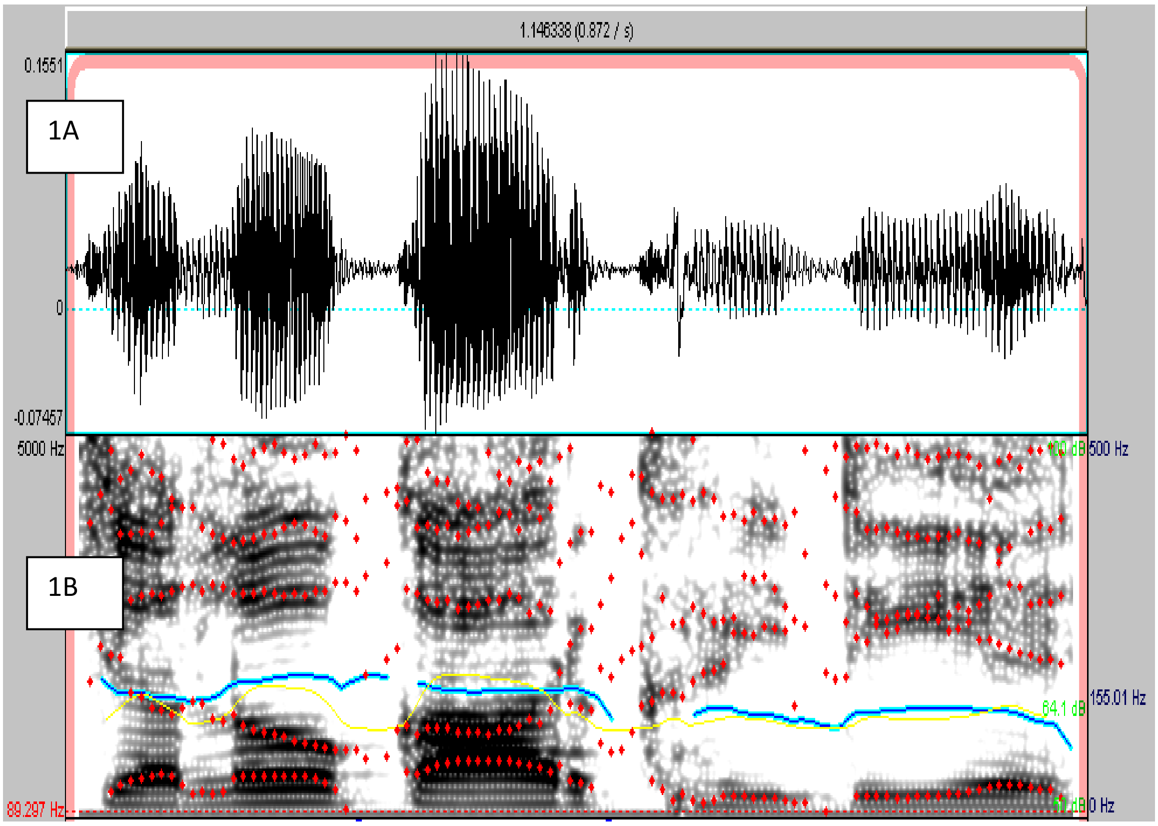

Fig. 1: Sound Waves and Spectrogram.

The above figure (Fig. 1) has two parts: Sound Waves (1A) and Spectrogram (1B). In this figure (Fig. 1), yellow line in (1B) shows the intensity and blue depicts the pitch. Spectrograms and sound wave patterns provide the visual effects (as in the above figure) so that the analysis becomes easier and faster for the investigators or speech analysts. However sound waves are always in the form of complex waves which is quite difficult to be inspected by the researcher. The essence of spectrogram makes these complex waves the comprehensible component frequencies with readable formants (the energy patterns) of the speech sound. To make this clear let's focus on 1B alone.

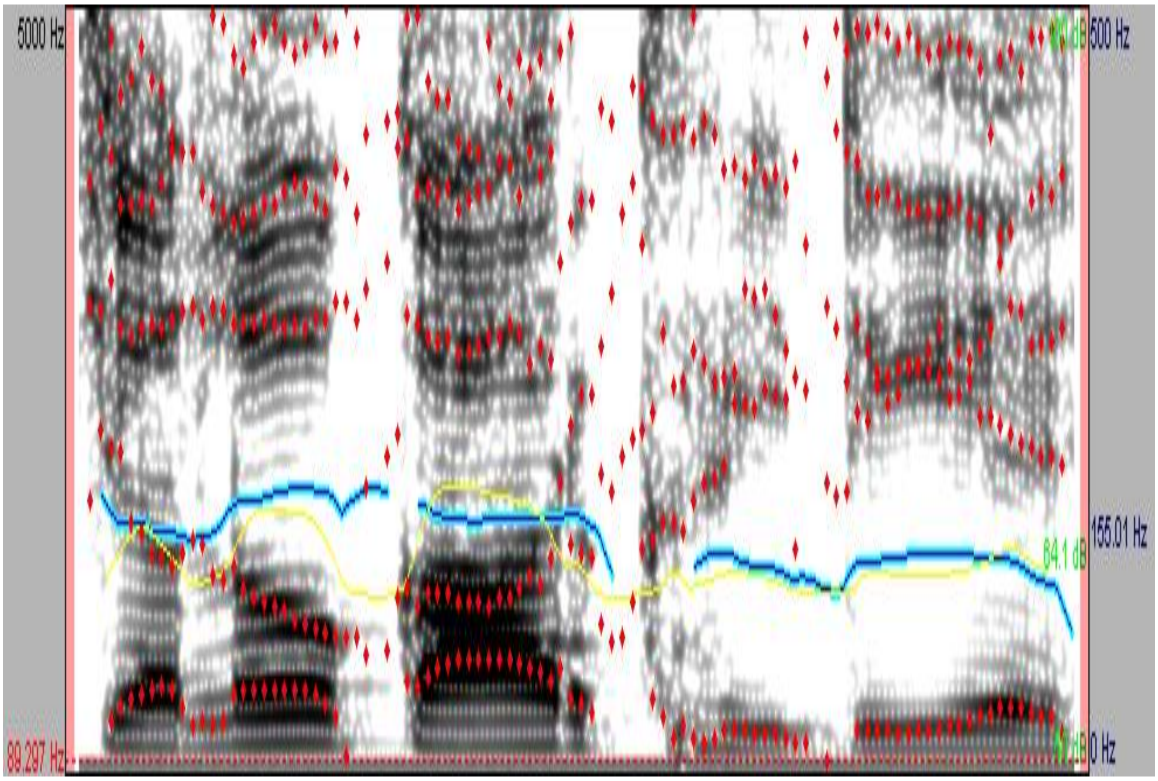

Fig. 1B: Spectrogram showing the formant patterns.

In this figure (Fig. 1B) the formants are shown by the red dotted lines on the dark bands on the spectrograms. The element which plays a vital role in this type of analytical work is the use of electronic filters. These filters can be well understood through the explanation provided by Fry (1979:95) who says: "…. a filter is really a resonator …… when we think of resonance we are more concerned with the frequencies which are favored by the resonator, whereas in the filter attention is directed more to the frequencies which are rejected, but the operation is the same…". Fry (1979: 95) further states: "A suitable arrangement of electronic components will form a circuit which will admit or pass frequencies within a certain band with very little loss of energy but will drastically reduce the energy of any frequencies on either side of this band. A filter of this kind is called a *bandpass* filter…. A filter might,…. pass frequencies from 135 Hz to 180 Hz….. The band between these two frequencies is 45 Hz wide and this is termed the *band width* of the filter”. Spectrographic analysis is based on the use of filters. The spectrograms produced by spectrographic analysis depend on the band width of the system. On the basis of the band width, the spectrograms can be divided into two types:

1. Narrow-band spectrograms
2. Wide-band spectrograms

1. Narrow-band spectrograms

A filter with a band width of 45 Hz can produce the Narrow-band spectrograms. Narrow-band spectrograms can easily register each successive harmonic (vibration or the movement of wave) and harmonic changes. This type of spectrogram is very useful for identifying tonal features and intonation pattern because it provides the sharp and visible picture of the speech sound and one can inspect every minute visible indication of the differences in frequencies and time resolution in the spectrogram. All analysis in this study are done by using Narrow-band spectrogram.

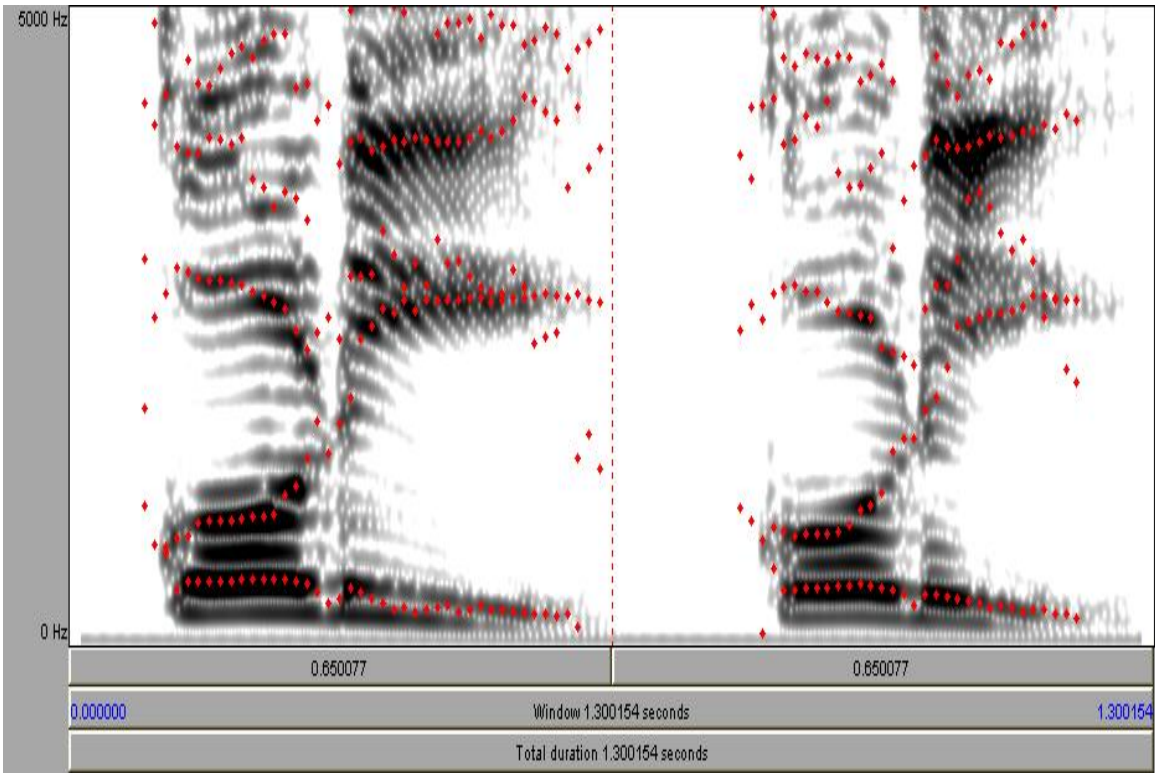

Fig. 2: Narrow-band spectrogram.

2. Wide-band spectrogram

Wide-band spectrograms are used with a filter band 300 Hz wide. Wide-band spectrogram comprises much broader and darker formant bars (unlike Narrow-band). Wide-band spectrograms are quite useful for the acoustic study of consonants and vowels and several other acoustic features because the formant bars are thicker and broader (as shown in the Fig. 3) to be noticed easily by the investigator during process of analyzing the speech sound system of a language/the languages.

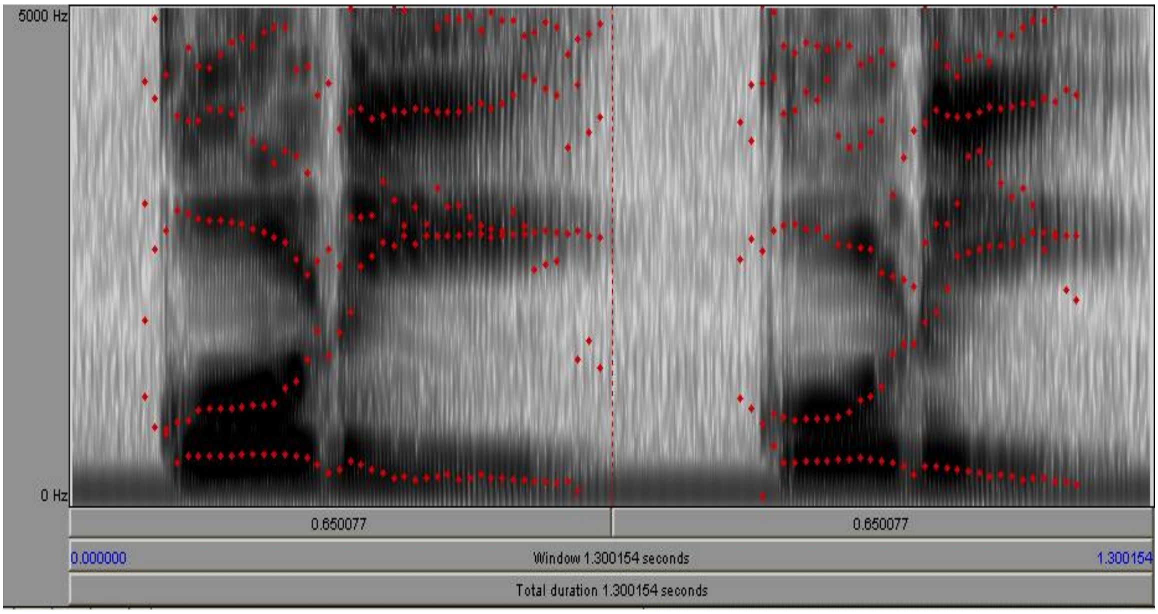

Fig. 3: Wide-band spectrogram.

The spectrogram is selected on the band width of 300 Hz. Narrow band spectrogram is selected because this could be considered as the best way of analyzing the intonation pattern. For speech analysis, sound waves are generally picked up by a microphone and sometimes from other recording devices (manual tape-recorders, digital recorders etc.) but normally a proper speech laboratory in which all devices are available are used for the analysis.

Reference:

Fry, D.B. 1979: *The Physics of Speech*. Cambridge: Cambridge University Press.