

Analysis of Voiced to Unvoiced Ratio and Vowel Distribution for Sri Lankan Traditional Buddhist Chants

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Abstract

Pirith is a special type of chanting; believed to be a protective doctrine preached by the Lord Buddha in Pali language. Generally, a voice signal consists of the fundamental frequency, f_0 and a series of harmonic frequencies called as formants, F_n . As reported by several other studies, characteristic vowels and high frequency formants are identified in chanting, contrast to normal speaking. Hence, the motive of this study is to investigate vowel distribution of Pirith chants and quantify voiced to unvoiced ratio utilizing computer-aided tools. Pertaining to speech mechanism, vowels can be mapped using the relationship between lip opening width to the first formant frequency, F_1 and tongue constriction width to the second formant frequency, F_2 . In this study, samples of Rathana, Karaniya Metta and Angulimala Suttas recited by male monk chanters were recorded using high precision microphone array and 15 samples of each Sutta were analysed. Recorded samples were then subjected to splitting of smaller voiced segments of frame length 10 ms sampling at a rate of 44.1 kHz. In the computational speech model, a pre-emphasis filter is applied to the sampled time series of voiced segment to cancel out the effect of glottis. Then frame-by-frame analysis was used with hamming windows and linear predictive coding (LPC) and auto correlation to extract the formant values. Voiced to unvoiced ratio is assessed using zero crossing rate and energy content of the acoustic signal. Results of the Voiced to Unvoiced ratio indicates approximately 20:1, 6:1 and 14:1 for Rathana Sutta, Karaniya Metta Sutta and Angulimala Sutta respectively. Further, the vowel distribution reveals that the majority of vowels in Angulimala Sutta and Karaniya Metta Sutta are closer to cardinal vowel [a] while the vowels of Rathana Sutta remains closer to cardinal vowels [u],[o],[ɔ] and [ɐ].

Keywords - Cardinal vowels, Formant frequencies, Voiced to unvoiced ratio, Vowel distribution, Zero-Crossing rate