Chapter 98
Hybrid Approach for Analyzing Acute Spots of Clinical Speech Data Using Fuzzy Inference System

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ABSTRACT

Acoustical measures of vocal functions are used in the assessments of voice disorders and monitoring the subject's improvement with speech therapy. In this chapter, a hybrid approach is proposed to identify the acute spots in pathological speech signals. These spots represents where the speech disorder occurs. The speech training for that specific portion of speech in particular could be given for enhancing the speeches. Dimensionality reduction is done using Principal Component Analysis (PCA) on Mel Frequency Cepstrum Coefficients (MFCC) extracted. By statistical method it is proved that overall 91.60% of the words were classified correctly. The features were trained using Support Vector Machines (SVM) for categorizing normally and abnormally pronounced words. The peaks found by Fast Fourier Transform (FFT) in abnormal words is made use of in the Fuzzy Inference System (FIS) for finding the acute spots in which the aberration has occurred in the word. This hybrid approach was found to have around 98% accuracy.

INTRODUCTION

Speech sounds are sensations of air pressure vibrations produced by air exhaled from the lungs and modulated and shaped by the vibrations of the glottal cords and the resonance of the vocal tract as the air is pushed out through the lips and nose. Speech is an immensely information-rich signal exploiting frequency-modulated, amplitude-modulated and time-modulated carriers (e.g. resonance movements,

harmonics and noise, pitch intonation, power, duration) to convey information about words, speaker identity, accent, expression, style of speech, emotion and the state of health of the speaker (http://dea. brunel.ac.uk/cmsp/Home_Saeed_Vaseghi/Chapter13-Speech%20Processing.pdf).

It is a well known fact that the fundamental frequency of children's voices is much higher than for adults, where average values of 130 Hz for adult males and 220Hz for adult females can be found. No statistically significant gender difference exists for children below twelve. Children's voices are also known to have much higher formant frequencies (specially for the second and third formants), attaining values above 4 kHz. The boundary values of the phonetic vowel space decrease with age, becoming more compact, and leading to a decrease in dynamic range of the formants values and to a decrease of the variability of spectral values. (Rui, 2009)

A 5-year old child presents values of formants 50% higher than an adult male. Whereas in adults there are typically 3-4 formants in the 0.3-3.2kHz range, for children one can only find 2-3 formants in this range. The features most typically found in gender/age classification methods are pitch, formants, Mel-Frequency Cepstral Coefficients (MFCC), Perceptual Linear Prediction Coefficients (PLP), auto-correlation coefficients, linear prediction coefficients (or equivalent), etc. The slower average speaking rate of children relative to adults is also a motivation for including delta, RASTA-PLP, or any other temporal modelling coefficients in the feature set. This large number of features also motivates the adoption of dimensionality reduction approaches such as Independent Component Analysis and Principal Component Analysis.

Speech Recognition proves itself as a very essential tool in terms of people with disabilities. The first area researched was use of Speech Recognition applications by individuals having physical disabilities but no speech impairment. Investigation in a second area expanded to include use of Speech Recognition by person with impaired or dysarthric speech. Speech Recognition was viewed to have the potential to make hard to understand speech more easily recognizable.

However millions of people are suffering from disabilities associated with speech. According to an UNICEF estimate as many as 150 to 250 million children are disabled worldwide. Speech disability forms one of the widely encountered among the various disabilities among children. The Basic facts are stuttering is a chronic communication disorder that interferes with a person's ability to speak fluently. While the cause of stuttering is not known, there is evidence that the disorder has strong genetic and neurological components. (http://www.disabilityworld.org/06-08_03/children/unicef.shtml)

Stuttering is a communication disorder involving disruptions, in a person's speech. Stuttering affects the fluency of speech. It begins during childhood and, in some cases, lasts throughout life. Some people who stutter appear very tense or "out of breath" when talking. Speech may become completely stopped or blocked. Blocked is when the mouth is positioned to say a sound, sometimes for several seconds, with little or no sound forthcoming. After some effort, the person may complete the word. For young children, it is important to predict whether the stuttering is likely to continue. An evaluation consists of a series of tests, observations, and interviews designed to estimate the child's risk for continuing to stutter. No single factor can be used to predict whether a child will continue to stutter. Vocal functions from acoustical measures are used in the assessments of voice disorders and monitoring the subject's improvement over the voice therapy. There are several organic and psychological factors that can affect speech. (http://www.westutter.org/what-is-stuttering/stuttering-info/)

Classifying speech into normal and disordered is more problematic. By a strict classification, only 5% to 10% of the population has a completely normal manner of speaking and healthy voice; all oth-

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