

# A Review on Detection of Nasalized Voiced Stops in Cleft Palate Speech

Jihan N. K<sup>1</sup>, Sreevarsha. V<sup>2</sup>

<sup>1</sup>Student, <sup>2</sup>Assistant Professor,

<sup>1,2</sup>Cochin College of Engineering and Technology, Valanchery, Kerala, India

## ABSTRACT

Cleft palate and cleft lip end result when facial structures which are developing in an unborn child do not close absolutely. Individual with cleft palate shows deviant speech characteristics due to the presence of velopharyngeal dysfunction. This velopharyngeal dysfunction causes nasalized voice stops in cleft palate. The detection of nasalized voice stops is considered in important during the diagnosis and speech therapy of individuals with CP. There are several methods used for the detection of nasalized voice stops. The purpose of this report is to provide a survey of research related to nasalized voiced stops in cleft palate speech detection methods.

**KEYWORDS:** Cleft palate, Cleft lip, nasalized voiced stops, velopharyngeal dysfunction

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## INTRODUCTION

Cleft palate (CP) and cleft lip are common birth disorder. They commonly occur due to many inherited genetic condition or syndromes. Cleft palate is a disorder in which two skull plates that shape the roof of the mouth is not completely joined. In most cases cleft lip is also present along with cleft palate. Uvula is usually split when cleft palate occurs. Due to this individual with cleft palate have a hole in the roof of the mouth caused by a cleft connects the mouth directly to the inside of the nose. Individual with cleft palate have velopharyngeal dysfunction (VPD) which is a generic term that describes a set of disorders in the leakage of air into nasal passages during speech production. VPD causes a failure of the velum to close against the posterior pharyngeal wall during speech production in order to close off the nose during oral speech production. Due to this, it causes hypernasal voice resonance, nasal emissions while talking, speech articulation errors, compensatory misarticulations and mispronunciation. Speech therapy, prosthetics, augmentation of the posterior pharyngeal wall, lengthening of palate and surgical procedures are primary treatment options.

Nasalization is the important characteristic of cleft palate speech. It results in reduction of intraoral pressure so that oral consonants are nasalized. This is considered as an indicator of velopharyngeal dysfunction. Hypernasality is condition in which nasal consonants are produced with less normal amount of nasal resonance. For finding the severity

rating of hypernasality identification of nasalized voiced stops is necessary. Therefore, detection of nasalized voiced stops is important during speech therapy and diagnosis. There are several ways to detect the voiced stops in CP.

## OVERVIEW OF DETECTION OF NASALIZED VOICED STOPS

Detection nasalized voiced stop is helpful in the objective assessment of velopharyngeal dysfunction in cleft palate. Due to VPD the voiced stop consonants produced by cleft palate look like nasal consonant. This is mainly due to two reasons (i)during the production of nasalized voiced stops, the velopharyngeal port is not fully open like nasal consonant, and (ii)leakage of airflow during speech production. The issues related to segmentation of cleft palate speech and the shortcoming of short-time spectral features are considered as the major challenges for detection of nasalized voiced stops.

## METHODS

The main interest of detection of nasalized voiced is to estimate the effect of velopharyngeal dysfunction on speech production. In terms of research objectives, the previous works can be divided into three category. First category include the detection based on speech language pathologist, second category is detection based on hidden markov model and third category include detection based on mel frequency cepstral coefficient.

### A. Detection Based on Speech Language Pathologist

Speech language pathologist (SLP) detects the deviant speech characteristics of CP due to velopharyngeal dysfunction. In work [1], it is a time consuming process and the perceptual evaluation results are subjective and also depends on the mental status of SLPs at the evaluation. The evaluation result of SLPs mainly depends on their mental status. Also the number of SLPs is very much lesser than cleft palate population. Speech language pathologist [2] need to able to be document and quantify speech result of spatial growth studies. Due to limited availability of SLPs computerized speech computation tools can be used by cleft palate individuals [3].

### B. Detection Based on Hidden Markov Model

Hidden markov model based force-alignment method is used in [4] for the segmentation of consonant production errors. Due to reduced energy difference between consonant and vowel regions this method is not suitable for segmentation consonant and consonant vowel transition region. HMM based detection shows false detection and timing errors which cause severe degradation. Training of HMM method [5] require numerous data conditions. The accurate vowel onset point is difficult to obtain using HMM based approach since onset of vowel is defined by sudden change in the signal strength. An automatic calculation of hypernasality levels and detection consonant omission methods are proposed in [6]. Here a stop algorithm is proposed in order to identify four levels of hypernasality which includes normal, mild, moderate and severe. But this method was unable to provide more information about velopharyngeal dysfunction since VPD also affects the production mechanism of voiced stop and fricatives.

### C. Detection Based on Mel Frequency Cepstral Coefficient

In work [7] a method to track natural variations in the characteristics of vocal tract system from speech signals is proposed. Mel frequency separates glottal source and vocal tract filtering information by computing cepstrum. It represent the features of vocal tract and simultaneously takes human auditory experience under consideration. Computation of MFCCs require block processing of speech signals using a fixed window of 20-30ms duration and the position and duration of the analysis of window effect the spectral estimation [8]. Therefore MFCCs is not suitable for the characterization of weak nasal resonances present in nasalized voiced stops. Also MFCC is not efficient to represent the spectro-temporal dynamics of transition region. Epoch extraction method [9] works for speech collected with a close speaking microphone, even with a additional degradation but it is not likely work well when degradations produce additional impulse-like sequences in the speech data. In work [10] group delay based approach is used for detection of hypernasal speech. This method is refined by band limiting the signal to avoid the influence of undefined formants in the region of interest of spectrum.

### CONCLUSION

We have presented a various methods that used for the detection of nasalized voiced stops in cleft palate. The advantages and limitations of various methods are

described. However, for the automatic detection of consonant production errors only very few attempts are made. Detection of nasalized voice stops is important during diagnosis and speech therapy. Also detection is helpful for the severity rating of hypernasality. Therefore, the demand for an automatic detection with good accuracy is increasing.

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