Speech Evaluation of Cleft Palate - Velopharyngeal Dysfunction Affected

Manasi R.Dixit[1]
[1] Department of Electronics K.I.T.'s College of Engineering, Kolhapur,416008 Maharashtra,India

Shaila D. Apte[2]
[2]Department of Electronics and Communication Engineering, Rajarshi Shahu College of Engineering, Pune Maharashtra,India

Abstract

Communication disorders are very complicated in individuals with cleft lip and/ or palate. In this paper , the pathological cases of speech disabled children affected with cleft type characteristics (CTCs) and Velopharyngeal dysfunction (VPD) are analyzed. The speech signal samples of children of age between three to eight years are considered for the present study. These speech signals are digitized and are used to determine the pathologic speech characteristics. This analysis is conducted on speech data samples which are concerned with both place of articulation and manner of articulation. The speech disability of pathological subjects was estimated using results of above analysis.

Keywords

CTC,VPD, Hypernasality ,Hyponasality ,Audible nasal turbulence ,Consonant production errors Speech intelligibility, nasality severity index *--NSI, Speech-recognition, spectrograms, pitch-formant analysis*

1. Introduction

Children with a cleft lip or palate have difficulties controlling the muscles of the soft palate leading to impaired speech and language development. The disorders of the Velopharyngeal valve are known as Velopharyngeal dysfunction (VPD). It includes three sub terms. Velopharyngeal insufficiency occurs in children with a history of cleft palate or sub mucous cleft, who have short or otherwise abnormal vela. Velopharyngeal inadequacy is defective closure of the Velopharyngeal valve due to its lack of speed and precision. It is caused by a neurologic disorder or injury (e.g. cerebral palsy or traumatic brain injury).

Velopharyngeal mislearning is observed in normal children . If the child has never learnt how to use the valve correctly then it leads to hyper nasal speech. The child cannot produce oral sounds (vowels and consonants) correctly. Only the nasal sounds can be be correctly produced. Speech Intelligibility requires the ability to close the nasal cavity, as all English sounds, except "m", "n", and "ng", have airflow only through the oral cavity. The nasality severity index (NSI) is an objective measurement of hyper nasality based on a multiparameter approach. The multiparameter approach consists of the nasalance, the nasality, and aerodynamic capacities. A new method based on pitch correlation, formant analysis and NSI evaluation is developed for the analysis of perceptual speech. In this present work, the speech data utterances by children of age group of 3 to 8 years were recorded and digitized. The digitized signal was further processed by using a MATLAB platform. The speech data was analysed to check the disorders due to pharyngeal articulation, glottal articulation, active nasal fricatives, double articulation ,weak and or nasalized consonants, nasal realization of plosives, gliding of fricatives/affricates. The acoustic analysis (e.g., spectrography, the oral-nasal acoustic ratio) is conducted on speech data. Perceptual assessment of speech is done so as to get important information regarding articulation, resonance, voice and speech intelligibility. Perceptual assessment provides important information regarding Misarticulation, resonance, voice and speech intelligibility, In this present work ,it is observed that the speech disabled children produce Compensatory or Misarticulation leading to nasal air emission or hypernasality that is phoneme-specific.

2. Methodology

The present work is based on study of children with Marathi mother tongue. The speech data of normal subjects/children and pathological subjects/children of the same age group between 5 to 8 years is collected. The children were trained to utter similar words before recording. The speech data consists of isolated words, connected words , fast uttered sentences and songs for eg. Prarthana-School-Prayer, National anthem and Pledge ,Nursery Rhymes ,famous film songs etc. The speech data was recorded using Sony Intelligent Portable Ocular Device (IPOD) in digital form. The recording was carried out in a pleasant atmosphere and maintaining the children in tension-stress free environment. The recorded signal is transformed into .wav file by using GOLDWAVE software. The data was collected at Chetana Vikas Mandir, a special school established to educate Mentally Retarded children as well as children with various disorders. It is located at Kolhapur, India.

The Formant analysis was carried out for particular isolated words. The utterances made by 20 normal subjects was analyzed and reference /threshold level was considered for each phoneme. Various Misarticulation cases were analyzed in case of pathological subjects. The spectrograms were studied for Formant analysis. Fast uttered words or continuous sentences exhibit greater complexities with respect to speech intelligibility.

The nasality severity index (NSI) is also calculated in case of pathological speech data. The isolated word speech data emphasised in the present work is described below. It indicates case studies of different types of Articulation errors with respect to both place of articulation and manner of articulation. The isolated word speech data is given in table-1.

Table-1. List of specific place of articulation and manner of articulation

Sr. No.	Place of articulation	Manner of articulation	English Letters
1	bilabial	plosive	p,b
	bilabial	nasal	m
	bilabial	approximant	w
2	labio-dental	fricative	f,v
3	dental	fricative	th,<u>th</u>
4	alveolar	plosive	t,d
	alveolar	nasal	n
	alveolar	fricative	s,z
	alveolar	approximant	r/l
5	post-alveolar	fricative	sh,zh
	post-alveolar	affricate	ch,j
	post-alveolar	approximant	y
6	velar	plosive	kg
	velar	nasal	ng
7	glottal	fricative	h

3. DETERMINATION OF FUNDAMENTAL FREQUENCY F_0 AND VARIATIONS OF F_0

TABLE-2. F0 and variations of f0 for different speakers

Sr. No.	SUBJECT	F_0	VARIATIONS OF F_0	REMARKS
1	Speaker 1	255 Hz	Min 204-318max Hz	Female-Normal
2	Speaker 2	195 Hz	Min 150-320max Hz	Male-Pathologic-VPD, Hyper nasality
3	Speaker 3	180 Hz	Min 104-300max Hz	Male -Pathologic-,hyper nasality, weak consonants
4	Speaker 4	280 Hz	Min 210-325max Hz	Female - Pathologic - gliding of fricatives
5	Speaker 5	290 Hz	Min 204-352max Hz	Female - Pathologic -active nasal fricatives
6	Speaker 6	185 Hz	Min 100-312max Hz	Male -Pathologic-hyper nasality
7	Speaker 7	198 Hz	Min 104-328max Hz	Male-Pathologic-only nasal consonants
8	Speaker 8	170 Hz	Min 140-290max Hz	Male-Normal with nasality shown
9	Speaker 9	205 Hz	Min 170-338max Hz	Male -Pathologic –No alveolar approximant (r/l)

				or alveolar plosives(t/d)
10	Speaker 10	175 Hz	Min 120-320max Hz	Male-Normal with nasality shown

Table-3. F_1 AND F_2 FOR DIFFERENT SUBJECTS

Sl No.	SUBJECT	f_1	VARIATIONS OF f_2	f_2	VARIATIONS OF f_2
1	Speaker 1	515 Hz	Min 440-570max Hz	778 Hz	Min 700-842max Hz
2	Speaker 2	400 Hz	Min 340-490max Hz	590 Hz	Min 505-670max Hz
3	Speaker 3	368 Hz	Min 310-420max Hz	560 Hz	Min 496-642max Hz
4	Speaker 4	562 Hz	Min 500-630max Hz	844 Hz	Min 740-910max Hz
5	Speaker 5	582 Hz	Min 460-673max Hz	872 Hz	Min 740-922max Hz
6	Speaker 6	372 Hz	Min 290-470max Hz	558 Hz	Min 495-652max Hz
7	Speaker 7	398 Hz	Min 295-493max Hz	595 Hz	Min 500-684max Hz
8	Speaker 8	342 Hz	Min 300-395max Hz	512 Hz	Min 453-585max Hz
9	Speaker 9	414 Hz	Min 368-497max Hz	622 Hz	Min 560-714max Hz
10	Speaker 10	354 Hz	Min 278-411max Hz	528 Hz	Min 470-652max Hz

4. Conclusion

The pathological subjects affected with CTC-VPD exhibit very weak consonant production.
Various types of misarticulation errors occur in different subjects. Very strong nasal consonants follow almost every phoneme uttered. Utterances of some of the plosives and alveolar approximants were not possible in case of some of the subjects. The Formants were seen to be widely spread in pathological subjects.

5. References

[1]R.Cmelja, J. Rusz "Laboratory Tasks From Voice Analysis in the Study of Biomedical Engineering using MATLAB" Research Program MSM6840770012 Trans Disciplinary Research in Biomedical Engineering-Voice and Speech Disorders, Charles university ,Prague, Czech Technical university ,Prague , Dallas university

[2] Marcelo de Oliveira Rosa*, José Carlos Pereira, and Marcos Grellet" Adaptive Estimation of Residue Signal for Voice Pathology Diagnosis" IEEE TRANSACTIONS ON BIOMEDICAL ENGINEERING, VOL. 47, NO. 1, JANUARY 2000

[3] Darush Mehta "Aspiration Noise During Phonation: Synthesis, Analysis, And Pitch -Scale Modification" MASSACHUSETTS INSTITUTE OF TECHNOLOGY February 2006

[4] Lingyun Gu, John G. Harris,et.al. "Disordered Speech Assessment Using Automatic Methods Based on Quantitative Measures " EURASIP Journal on Applied Signal Processing 2005:9, 1400–1409 c_ 2005 Hindawi Publishing Corporation

[5] Oscar Saz,1 Javier Sim´ on,2 W.-Ricardo Rodr´ıguez,1 Eduardo Lleida,1 and Carlos Vaquero1 *Research Article* "Analysis of Acoustic Features in Speakers with Cognitive Disorders and Speech Impairments" Hindawi Publishing Corporation EURASIP Journal on Advances in Signal Processing Volume 2009, Article ID 159234, 11 pages doi:10.1155/2009/159234

[6] Juan Ignacio Godino-Llorente,1 Pedro G´omez-Vilda (EURASIPMember),2 and Tan Lee3 *Editorial* "Analysis and Signal Processing of Oesophageal and Pathological Voices" Hindawi Publishing Corporation EURASIP Journal on Advances in Signal Processing Volume 2009, Article ID 283504, 4 pages doi:10.1155/2009/283504

[7] CatherineMiddag,1 Jean-PierreMartens,1 Gwen Van Nuffelen,2 andMarc De Bodt2 *Research Article*"Automated Intelligibility Assessment of Pathological Speech Using Phonological Features "Hindawi Publishing Corporation EURASIP Journal on Advances in Signal Processing Volume 2009, Article ID 629030, 9 pages *doi:10.1155/2009/629030*