ANALYSIS OF DISORDERED SPEECH OF CHILDREN WITH CLEFT PALATE

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Electronics and Telecommunication Engineering

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APPROVAL

This Thesis titled **"Analysis of Disordered Speech of Children with Cleft Palate**", submitted by Nusrat Jahan to the Department of Electronics and Telecommunication Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Masters of Science in Electronics and Telecommunication Engineering and approved as to its style and contents. The presentation was held on December,2018.

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DECLARATION

We hereby declare that, this thesis has been done by us under the supervision of **Ms.Shahina Haque, Asistant Professor, Department of ETE** Daffodil International University. We also declare that neither this thesis nor any part of this thesis has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Speakers with velopharyngeal incompetence,produce hypernasal speech across voiced elements.During the production of vowels,due to the defective velopharyngeal mechanism,oral cavity gets coupled with the nasal cavity.This coupling may introduce resonances of nasal cavity in the resulting vowel sound.Speech signal of eight cleft palate children with various VP opening have been studied. By considering normal and nasal vowel formants of normal speakers as reference, we have observed that variation in the spectrum of their speech occurs due to various types of VP opening due to abnormal coupling of oral and nasal cavity. In case of large VP opening an extra peak or nasal resonance is seen to appear around 600Hz and for small VP opening around 950 Hz. As the VP opening or cut of the cleft palate increases, the first formant reduces and lowers the extra formant.

Keywords: Linear Predicative Coding, Formant,Vowel, CP.

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ABBREVIATIONS

LPC	Linear Predicative Coding
F1	First Formant Frequency
F2	Second Formant Frequency
F3	Third Formant Frequency
F0	Fundamental Frequency (pitch)
DFT	Discrete Fourier Transform
DTFT	Discrete-time Fourier Transform
IIR	Infinite Impulse Response
ASCII	American Standard Code for Information Interchange
TTS	Text to Speech

VC	Vowel – Consonant
CVC	Consonant - Vowel - Consonant
CP	Cleft Palate

CHAPTER-01

INTRODUCTION

1.1 OVERVIEW:

A authentic method for acoustically detecting hypernasality in speech has been proven to be a tough proposition to develop.From the very beginning many method has been tried,often with inconsistent results or general disagreement across different methods.Hypernasality is normally occurs in children with cleft palate due to excessive nasal resonance perceived during the speech because the oral cavity is not properly separated from the nasal cavity.In these cases in addition to surgical interventions like palatoplasty,patients should receive speech therapy.Therefore, assessment of nasality is necessary to facilitate the evaluation of the operation efficacy and help the therapist to manage the speech therapy sessions[1].Approaches for the assessment of hypernasality classified into two categories of invasive and non invasive techniques.Hypernasality is a parameter of cleft palate speech that has elicited a huge amount of research.An important goal has been to develop a method of evaluation which would be objective,reliable,valid and comparable.In general,an operation is necessary to reduce the hypernasality and therefore an assessment of hypernasality is imperative to quantify the effect of the surgery and design the speech therapy sessions,which are crucial after surgery.Here we will see the variation of hypernasal speech through the speech parameter.All the vowel sound has been characterized by a pronounced nasality of cleft palate children speech.Problems of inability to pronounciation the dentals t and d,the labials p.Many of cleft palate are exist: a cleft exist in the soft palate,a cleft exist in the hard palate,a cleft exist in the both or a cleft in the upper lip.Defect of specch happen is because of failure of function on the part of the palate. If there is a cleft in the palate,Defect in closure will be present,breathing stream problem through the mouth,escape into the nasal cavities and the speech production is nasalized or of a snorting quality.

The nursing of the cleft lip or palate is operational.Surgery is including space over the palatal part.If operation is performed before then, result will be more perfect.Every case,voice therapy is important to get control of the defective phonation[2].

A popular problem is cleft palate which is cured by doctors.This problem is detected by a space in the roof of the mouth. These children are suffer from many diseases with dental development and many diseases.They faces from drinking water,suffer from ear problems.

In recent years, Scientists shown that cleft palate speech and the influences on speech quality has been increased. This overview of contemporary research reveals new perspectives on cleft palate speech development and the phonological consequences of early articulatory constraints.Developmental influences on cleft palate speech are considered in the context of previous vocalisations of cleft and non- cleft patients, following of literature to examination of bubble progress, the emergence of previous words and consonant progress in patients born with cleft palate.

In this work I use wavepad for taking the exact vowel sound from the cleft palate children from their voice. Then I analyze the signal,normalized and use software for taking formant data,which I have used for my data analysis.

In this thesis,I will analyze abnormal voice of hypernasal speech of children with cleft palate.

1.2 WHY CHOOSE THIS TOPICS ?

In 1940,the comcept of speech analysis was started the first specch analysis program was appeard practically in 1952 at bell lab.In bangladesh,every year 150,000 children are born with cleft lip and palate,day by day its increasing in our country.But surgery in bangladesh is very expensive and there are few trained cleft surgeon in the country.In bangladesh just few years back,people were merely aware about this diseases.Only the parents in urban area area are mainly concerned about their children with cleft lip and palate.Most of these unfortunate children live their lives in shame,unable to talk,go to school and taunted by people,eat properly.Many children are abandoned while they birth by their parents.But at present,the situation is improving gradually throught the country.A recent pilot study in bangladesh,we found that most of the hospital has proper opportunity to treat the children and adults with cleft lip and palate.

It is difficult to diagnostic of hypernasality in children with cleft palate and lip because of many instruments were using while testing speech problem.On the other hand,it is quite easy for the test of adults people,but it is pathetic test for all.

In the above secnario,I would like to say,not only develo country but also in bangladesh is familier with electronic device.For detectin hypernasality we can use electronic instruments,so that while testing children and adults are not get afraid.Researchers are developing many method for detecting,analysis hypernasality in children and adults with cleft palate and lips.Day by day easier methods are coming to detecting hypernasality accurately to help the surgeon,to detect the depth of the hypernasality while testing speech.

1.3 MOTIVATION:

Cleft palate children are increasing day by day in our society.A cleft palate of a child progress in a fetus when the two part of the palate does not come together and fuse in the middle.Due to cleft palate cause sufferings with dentalprogress,speech,hearing,eating and drinking.A patients also experienced constantly colds,fluid in the ear,sore throat and problem with the tonsils and adenoids.

Hypernasality in children may be caused by a cleft palate,a too short palate,or the inability move muscles involved in the closure of velopharyngeal complex,as in cases of cerebral palsy.Less commonly,hepernasality may result from an undiagnosed palate muscle problem,especially if a person has undergone an adenoidectomy.As a treatment,the first step should be the speech therapy for hypernasal specch.Speech therapy commonly helps the children of hypernasal speech with cleft palate.As hepernasality in cleft palate child is increasing day by day in our country and others,that's why we should do more research about it.Speech problems are increasing day by,we many researchers are doing great job at speech problems and hypernasality.

As a developing country,so many people in our country has suferring from this problem,we should make awareness and make proper guidence about this desease to reduce it.Thus I have motivated about this problem,and I have tried my level best to detect the hypernasality in cleft palate children.

1.4 AIM :

This paper aims to establish how to analyze some disordered speech of hypernasal speech of children with cleft palate as there is a speech disorder in cleft palate child.A speech parameter is used for detecting hypernasal speech of children with cleft palate.My study is to showing the variation of speech parameter of hypernasal speech.This study using the wave pad to

select the vowel form from the cleft palate children whose speaking is not clear as normal children.

1.5 OBJECTIVE:

1.5.1 General Objective: The objective of this thesis is to analyzing disordered speech of hypernasalityin cleft palate or lip children.

15.2 Specific Objective: The specific objectives of the thesis work are-

- Working with the depth of voice problem of hypernasality in cleft palate child.
- Detect the formant of normal and hypernasal voice.
- To obtain better accurecy in specch processing using LPC analysis.

1.6 ORGANIZATION OF THE THESIS:

The paper is organized in to six chapters.The 2nd chapter focuses on literature review,the different techniques or approaches used to detect hypernasality in cleft palate children.Chapter three discuss about basic acoustics of speech signal,definition of hypernasality,causes of cleft lip or palate,syndrome of hypernasality on cleft palate children.Chapter four discuss about analysis technique and mathematical tools used for the speech detection of hypernasal.Chapter five includes result and experimental data,discussion about the whole experiment,and lastly chapther six include conclusion and future work for the speech problems.

CHAPTER- 02
LITERATURE REVIEW

2.1 INTRODUCTION:

The separate speech with cleft lip palate (CLP) is initially divided by abnormalities in oral resonance. This is a direct result of unoperated cleft or fistula and/or velopharyngeal dysfunction (VPD). The cleft / fistula may alter the resonance characteristics resulting in the increased nasality in speech. The individuals with VPD cannot either adequately or consistently close the velopharyngeal port during speech.Therefore, sound energy directed orally escapes through the nasal cavity. Compensatory and obligatory articulation errors and reduced voice quality are the speech characteristics observed in these individuals. The final result is a reduction in speech intelligibility[13].The speech characteristics of individuals with CLP are atypical, complicated, and present articulation errors,abnormal voice and resonance characteristics.

It has also been reportedthat there is a high incidence of voice disorders in individuals with CLP.This can be attributed to the laryngeal hyperfunction in an attempt to compensate for acoustic effects of VPD or compensatory articulation of glottal stops.Deviant resonance and nasal airflow characteristics such as hypernasality,hyponasality,nasal emission,and nasal turbulence are common in these individuals as a result of associated VPD.

In 2001,some researchers reported that a minimum of five hundredth of youngsters with CLP entails the services of a Speech-language medical specialist. These youngsters typically need analysis and intervention to boost their articulation or phonologic development or general communicative language functioning. Some people with CLP might have articulation and resonance issuesrelated to VPD[6]. This speech downside will typically impede.

education, employment and becomes a social stigma lasting a lifespan.The speech characteristics associated with articulation and resonance issues in kids.With CLP needs a

details assessment to grasp the anatomical and physiological changes contributory to abnormal speech patterns.The analysis of speech in individual with CLP is of utmost importance for comprehensive understanding of speech and to arrange effective rehabilitation.Although several tests and procedure ar wont to assess utterance patterns and nature of the disorders during this population,every kid should to be fastidiously examined as a result of a myriad of issue will contribute to the error patterns.It is typically assumed that the first goal within the assessment of kids with CLP is characteristic and treating the utterance issues related to VPD.Therefore,the assessment procedure ought to be immaculate.The assessment of speech of people with CLP may be bestowed through subjective and objective evaluations.It is necessary to grasp the strength or limitations of every style of analysis,so that associate degree final amalgamated analysis procedure may be applied for the assessment of speech in people with CLP.The following section deals with the review of sensory activity and objective analysis centered on kidswith CLP.

2.2 PERCEPTUAL EVALUATION:

The perceptual assessment was considered as gold standard[7][8]is analysis of speech among individuals with CLP. The perceptual assessment procedures started during early 1930-40‟s. During the initial stages, the perceptual evaluation was restricted to investigation of articulation skills which focused predominantly on description of articulation errors,frequency of these errors and type of errors.The comparisons of these errors were usually done with non cleft children by using traditional SODA(substitution,omission,distortion,addition)analysis[9]. Later during 1950-60’s the researchers identified many other speech parameters which were affected in individual with CLP.The parameters such as presence of compensatory articulation,scoring of articulatory errors by using various types of Rting scales etc,were explored.It was during this decade,the focus was shifted on parameters such as resonance,nasal grimaces etc[10].This gave rise to development of different perceptual assessment protocols.Some of the protocols has been reviewed and used in various research studies[11]reat Omond street speech.Assessment(GOS,SP,ASS)is one such protocol which evaluate different parameters

such as articulatory charactristics,phonation,resonance,nasal emission,nasal turbulance,grimace,mirror test and oral examination.This test was surveyed for its reliability and its use for inter center comparisons[12].The survey related ambiguities in the protocol.To overcome the shortcomings of this test Razzell(19996) and Harding,Harland and Razzel(1997) developed clinical Audit protocol for speech(CAPS).A revised version of CAPS-A was proposed by some researchers..This include explicit assessment of cleft type characteristics using a colour coding rating system.These protocols proposed many assessment schedule and scoring pattern was also recommended.However,lack of agreement about how to measure and report speech of CLP outcomes still persisted.Hence,this was revised and proposed as universal parameters for reporting speech outcomes in children with CLP[13].

Henningsson(2007)studied various parameters such as hypernasality,hyponasality,nasal air emission and consonant production errors.These parameters were used to report speech outcomes in individual with cleft to achieve greater consistency in reporting speech outcomes globally regardless of the language or language spoken.Aworking group of six individuals experienced in the area of speech and cleft palate was formed to develop a system of universal parameters for reporting speech outcomes in individual born with cleft palate.The system was adopted in conjunction with a workshop held in Washington,D.C,that was devoted to developing the universal system.The system,which was refined further following the workshop,involves a three satge plan consisting of 1)evaluation, 2)mapping, and 3)reporting.This report focuses primarily on the third stage,reporting speech outcome.They however opined that perceptual evaluation remains the gold standard for evaluating speech,as well as the most commonly used method.

The reporting stage focuses on the speech parameters as shown in table 1. The guidelinesfor speech sampling content and scoring procedures in relation to parameters are described in detail in their study. The primary imperative use of such a universal system would be as a tool in clinical trials involving collaborative groups from different. geographic regions,including countries or regions that differ not only in how they rate and report perceptual speech data but also in the language spoken

Parameters(words)	Parameters(Sentences)	Rating
Hypernasality	Hypernasality	0 to 3 = Within normal to Severe
Hyponasality	Voice disorder, whole speech sample	0= within normal limits 1= present
Audible Nasal Emission	Audible nasal emission	0= within normal limits 1= present
Consonant production errors	Consonant production error	0= within normal limits 1= present
Speech Understandability conversation sample	Speech acceptability, Whole speech sample	0= within normal limits to 3= severe

Table-1: Universal parameters for reporting speech outcomes of individual with CLP**.**

The perceptual evaluation is influenced by various factors such as type of stimuli,phonetic context, voice quality, pattern of articulation, listener previous experiences and expectations[14].The perception of hypernasality varies as a function of other aspects of speech. It is more severe on high vowels than on low vowels [15]and varies according to phonetic context[16]. The perceptual judgments by observers are not presented with convincing reliability. This could be due to variable internal standards acquired by different individuals, i.e., all observer experiences are thought to be stored in the memory and are believed to form the internal standards[17]. Today,a variety of psychological scaling procedures are being used[18].Two scientists stated that both descriptive category judgments and rating of severity will continue to be useful in describing changes in resonance after surgical or behavioral intervention.However,there is a great deal of variability among the various system that are being used to collect and analyze data by using various rating scales and tests to measure the speech and language abilities[19].This can lead to differences in inter and intra judge reliabilities.Many studies[20]have focused

on evaluating intra and inter judge reliability measures.Protocols despite being presented with many drawbacks in evaluating procedures.In 1991,some reashers defined it as the core of speech and language evaluations against which the instrumental measures are validated[21]It is widely reported that the accurate and language evaluation against which the instrumental measures are validated[22].It is widely reported that the accurate assessment of the degree of nasality is an exceptionally difficult perceptual task[23].The perceptual resonance evaluation should be accompanied with objective measure for accurate diagnostic and timely intervention strategies.Hence many studies[24]have coupled perceptual evaluation with objective measures and they have proven it to be an impeccable assessment procedure.Hence,perceptual evaluation is considered to derive NSI.The perceptual evaluation is given considerable importance in investigating the speech in adults with CLP and only few studies have focused in children with CLP.The studies on perceptual evaluation in CLP are focused as a part of other assessment protocols[25]perceptual and instrumental correlation studies[26]by using various rating scales and stimuli[27]by using various rating scales and stimuli[28] From the review of literature, it can be noted that the perceptual evaluation has proven to be the preordained aspect of evaluation procedures.Though the perceptual evaluations are associated with many drawbacks, it still certainly is irrefutable aspect in analysis of speech of individuals with CLP. The perceptual evaluations can complement the objective evaluations which as amalgamated assessment procedure can provide detailed understanding about speech skills of an individual with CLP. Therefore, it has to be thoroughly reviewed and along with objective evaluation it can be manifest as ironclad assessment protocol.

2.3 OBJECTIVE EVALUATION:

The speech of individual with CLP exhibiting errors in articulation, resonance, voice and speech intelligibility draws attention for evaluating the presence, extent, and location of abnormalities in VPD. The review of various studies which has employed perceptual evaluation protocols has discovered that the these measures ar influenced by numerous factors like stimuli, judges, rating scales, listening conditions, quality of recordings, and articulative characteristics of speech in kids with CLP. This typically ends up invariations in responsibility measures[29].The challenges of modality sensory

activity assessment have secured for objective analysis that may offer reliable measures. Kuehn and Moller,(2000) expressed that no instrumental analysis will substitute the sensoryactivity analysis. but practitioner will complement sensory
activity analysis with instrumental analysis.Hence,even though sensory activity analysis is taken into account as gold customary, consolidation of modality sensory activityassessment with a minimum of one instrumental or objective assessment of velopharyngeal perform is suggested for refinementthe understanding of cleft speech[30].

The objective measures of hypernasality typically ar centered on assessing velopharyngeal closure victimisation direct and indirect assessment procedures[31]. Few of the direct imaging techniques offer dynamic and natural pictures of the anatomical structures of the voice box, pharynx, and cavum. therefore this imaging technique is taken into account jointly of the potential technique for evaluating VPD[32]. These techniques offer data regarding the pattern of velopharyngeal closure and presence of VP gap. The abnormal VP closure patterns ar typically evident throughout the speaking and ar manifested as deviant resonance characteristics in speech. In such condition, frequent changes within the degree of sentimental roof of the mouth movement and tubular cavitywall movements ar documented[33]Several direct strategies of mental image of the velopharyngeal valve techniques were utilized by researchers to guage velopharyngeal operate. These embody Multiview videofluoroscopy, videonasoendoscopy, Nasopharyngoscopy, Lateral cephalogram of Nasopharyngography, cavum Fibroscope, and resonance Imaging. The indirect or unseeable procedures utilized by researchers for speech and VPD analysis ar mirror fogging take a look at, Nasometry, mechanicsand acoustic investigations[34]. The indirect objective evaluations may be applied by speech language pathologists to assess the various speech parameters. The studies reviewed have shown that the acoustic measures of speech were extensively studied by varied researchers and lots of studies have used acoustic measures to assess the speech of people with CLP. This is typically done with devices sort of a nasometer[35]which is placed between the mouth and therefore the nose so as to separate each airflows.This procedure is complicated-especially with kids.

Non-invasive methods exist [36,37], however, their application demands a lot of manual preprocessing since these methods can only be applied to sustained vowels or consonant-

vowel combinations. In the literature the segmentation is usually done manually which costs a lot of time and eff ort. In order to close this diagnostic gap we want to investigate, if a fully automatic evaluation system can be applied for such a task. Therefore, an automatic speech recognition system is used to segment the audio data into words. Cleft lip and palate (CLP) is a frequent congenital alteration of the face with a prevalence of about one in 750 to 900 births [38]. In this study they shows that the classification of hypernasality in children's speech on automatically segmented data is possible.They described the evaluation of several features regarding their suitability to classify hypernasal speech of children with cleft lip and palate. On word level, class-wise recognition rates of up to 66.6% and global recognition rates of 86.9% were achieved. First,they extracted pronunciation features based on phoneme confusion statistics. With these,they reached a CL of up to 64.1% and a RR of 86.9%. MFCC features were best in CL.They extracted them frame-wise and derived a word level decision from that. With a bootstrapping approach,they improved the annotation which led to rates of up to 66.6% CL and 83.1% RR. Finally,they studied the TEO on frame level. It was tested using separate classifiers for the frames belonging to diff erent vowels which were identified using a simple phoneme recognizer. The results showed, that the TEO's performance varied for diff erent phonemes and that it does not work as well in our scenario as in preceeding works with adult speakers and manually segmented consonant-vowel and consonant-vowelconsonant clusters[39].

2.4 ACOUSTIC MEASURE OF SPEECH:

The present study have bestowed numerous accoustic parameters by investigation parameters like nasalance,one third octave spectral analysis,voice low tone to high tone magnitude relation,perturbation measures to corelate with sensory activity analysis to derive two dimensional timbre severity index.

2.5 NASALANCE MEASURE OF SPEECH:

Nasalance measure is widely used to assess the nasality.Among the indirect evaluation procedures, the concept of nasalance measures was explored widely during 1970‟s.The concept was largely based on the previous works pioneered by Fletcher. who developed TONAR II. Many researchers conducted study to develop normative data for nasalance scores across different languages for various stimuli. In Indian context, normative nasalance values

were developed in Tamil[40]Kannada[41], Malayalam[42] and Hindi[43]. The normative data obtained was language specific and conflicting results were reported by various researchers on the influence of gender and stimuli on nasalance scores. While,in 1994,some reashers reported that girls were found to have higher nasalance than boys[44],they revealed that there was no gender based difference on nasalance scores. Some of the studies reported gender based difference on nasalance scores [45]. There were also contradicting findings by some investigators reported that there was gender based difference on nasalance scores[46] .

The result of gender on the nasalance distance and magnitude relation was explored by some reashers WHO conducted a study on a hundred twenty five German-speaking people (51 females and seventy four males) with CLP with a mean age of fourteen years. The aim of the study was to live nasalance values in numerous people with differing kinds of repaired CLP and to match the nasalance distance and magnitude relation measures across the gender.

2.6 ONE THIRD OCTAVE SPECTRAL ANALYSIS AND VLHR:

The spectrographic analysis[47]is one of the objective measures of speech. The spectrographic analysis has been used to explore the spectral and temporal parameters of speech of individuals with CLP [48]. However, there are other acoustic measures which are not explored much. The other salient acoustic parameters such as one third octave analysis and VLHR are not studied extensively in these children, but these parameters are considered as potential parameters for differentiating hypernasality from normal speech.

2.7 PERTURBATION MEASURES(JITTER AND SHIMMER):

The children with CLP do exhibit voice disorders. They exhibit hoarseness, strained, tensed voice quality, variations in pitch, restricted range of pitch and loudness[49]. It has been reported by some scientist at 1969,that increased respiratory effort can lead to vocal abuse which is most often seen in children with VPD, wherein they increase respiratory effort in order to build adequate intraoral pressure. Moreover, they need extra effort to attain normal intensity level due to acoustic damping in the nasal tract[50]. Specifically, it was noted that for nasalized vowels opening phase was reduced due to altered vocal cord vibrations as reported by Hamlet (1973).The authors attributed the results to the increased force during vocal fold adduction without vocal effort in the presence of nasalization.In 1985,two

researchers also reported that children and adults with hypernasal speech exhibited inappropriate vocal cord adduction and voicing during the production of voiceless stop plosives. various research studies[51]evaluated variations in vocal fold vibratory patterns in terms of changes in acoustic properties during speech production. The voice perturbations are one of the frequently used acoustic measures in objective analysis of speech parameters.In 1989,two researchers conducted a study on 10 children with VPD to investigate the voice perturbations of children in the age range of 8 to 12 years with perceived nasality and hoarseness. The speech samples considered were steady state vowels /i/, /a/, and /u/. The sentences dominated with nasal and oral consonants were recorded. The electroglottograph was used to derive the perturbation measures of the speech stimuli.

2.8 PREVIOUS WORK ON SPEECH AND HYPERNASALITY ON 90'S:

Year	Scientists	Paper	Contribution
1940/ 1952	**Sa**rang Afle,Sneh Joshi Surbhi Sharma	An Implementation of speech recognition for Desktop Application.	In 1940,the concept of speech analysis was started,the first speech analysis program was appeard practically in 1952 at bell lab.
1986	Syrdal,A.K.,and Gopal, H.S	"A perceptual model of vowel recognition based on the auditory representation of American English Vowel".	Vowel recognition based on the auditory representation of Americal English Vowel
1995	James Hillenbrand, Lura A.Getty,Michael J.Clark and Kimberlee Wheeler	"Acoustic characteristics of American English Vowel"	To find out acoustic characteristics of American English Vowel

1996	Behne,D. and Moxness,B. and Nvland,A.	"Acoustic phonetic evidence of vowel quantity and quality in Norwegian "	They find out acoustic phonetic evidence of vowel quantity and quality.
1996	D.A.Cairns; J.H.L.Hansen, J.F.Kaiser	Recent advances in hypernasal speech detection using the nonlinear Teager energy operator	By using the nonlinear Teager energy operator hypernasal speech has been detected**.**
1998	Pickett,J.M.	Acoustic of communication speech,The:Fundamental,Spee -ch perception theory and technology,Allvn &Bacon.	The research was about the acoustic of speech communication**.**
1998	Lohmander Agerskov	Speech outcome after cleft palate surgery with the Gotebory regimen including delayed hard palate closure.	. A child with delayed hard palate closure to see the speech outcome after cleft palate surgery
1999	M.Honda	Speech synthesis technology based on speech production mechanism.	Based on speech production mechanism speech synthesis were discussed**.**
1993	Okazaki K,Satoh K,Kato M,Iwanami	Spech and velopharyngeal function following maxillary	Cleft lip and palate patients speech and

	M,Ohokubo F,Kobayashi K.	advancement in patients with cleft lip and palate.	velopharyngeal function has been discussed.
1993	Haapanen ML, Veija M, Pettay M.	Speech outcome in cleft palate patients with simultaneous primary palatal repair and adenoidectomy.	Research has been done on speech outcome in cleft palate patients with simultaneous primary palatal repair and adenoidectomy.

2.9 PREVIOUS WORK ON SPEECH AND HYPERNASALITY FROM(2000-2018):

Year	Scientists	Paper	Contribution
2001	Rah DK, Ko YL, Lee C, Kim DW.	A noninvasive estimation of hypernasality using a linear predictive model.	This research has been done using non linear predictive model.
2002	Van Lierde KM, Van Borsel J, Moerman M, Van Cauwenberge P.	Nasalance, nasality, voice, and articulation after uvulopalatopharyngoplasty.	After UPPP surgery nasalance,nasality,voice and articulation has been detect.
2004	Greene JS, Zipfel TE, Harlor M.	The effect of uvulopalatopharyngoplasty	In this research paper UPPP's effect on the nasality

		on the nasality of voice.	of voice has been detect.
2005	Han D, Ye J, Lin Z, Wang J, Wang J, Zhang Y.	Revised uvulopalatopharyngoplasty with uvula preservation and its clinical study.	UPPP with uvula preservation and its clinical study has been revised in this thesis.
2008	Andreas Maier, Alexander Reub, Christian Hacker,Maria Schuster	Analysis of Hypernasal Speech in Children with Cleft Lip and Palate	Hypernasality in children with cleft lip and palate has been analyzed.

2013	Ling He,Qi Liu, Jing Zhang, Heng Yin.	Automatic evaluation of hypernasality and speech intelligibility for children with cleft palate	In children with cleft lip,automatic evaluation of hypernasality and speech intelligibility has been studied.
2014	Jing Zhang, Qi Liu, Ling He, Margaret Lech.	Automatic Evaluation of Hypernasality and Consonant Misarticulation in Cleft Palate Speech	In cleft palate speech automatic evaluation of hypernasality and consonant misarticulation has been studied.
2015	Jie Tan,Ling He, Margaret Lech,	Automatic evaluation of resonance and articulation	In cleft palate speech, automatic evaluation of

	Huaqing Hao.	disorders in cleft palate speech	resonance and articulation disorders has been studied.
2016	Thejaswi Dodderi Manjunath Narra, Sneha Mareen Varghese,Dessai Teja Deepak	Spectral Analysis of Hypernasality in Cleft Palate Children: A Pre-Post Surgery Comparison	Spectral analysis of hypernasality in cleft palate children has been studied.
2018	Sishir Kalita, S. Dandapat, S.R.Mahadeva Prasanna.	Intelligibility assessment of cleft lip and palate speech using Gaussian posteriograms based on joint spectro-temporal features	Using Gaussian posteriograms intelligibility assessment of cleft and palate has been study which based on joint spectro-temporal features.

CHAPTER-3

BASIC ACOUSTICS OF SPEECH SIGNAL

As considering the sector of speech recognition, this chapter describe however the speech signal is created and perceived by kinsmen. this {can be} a vital subject that needs to be thought-about before one can pursue and judge that approach to use for speech recognition.

3.1 THE SPEECH SIGNAL:

Human association isto be seen as a comprehensive figure of the approach from utterance to sound perception between the speaker and attender, See Figure a pair of.1

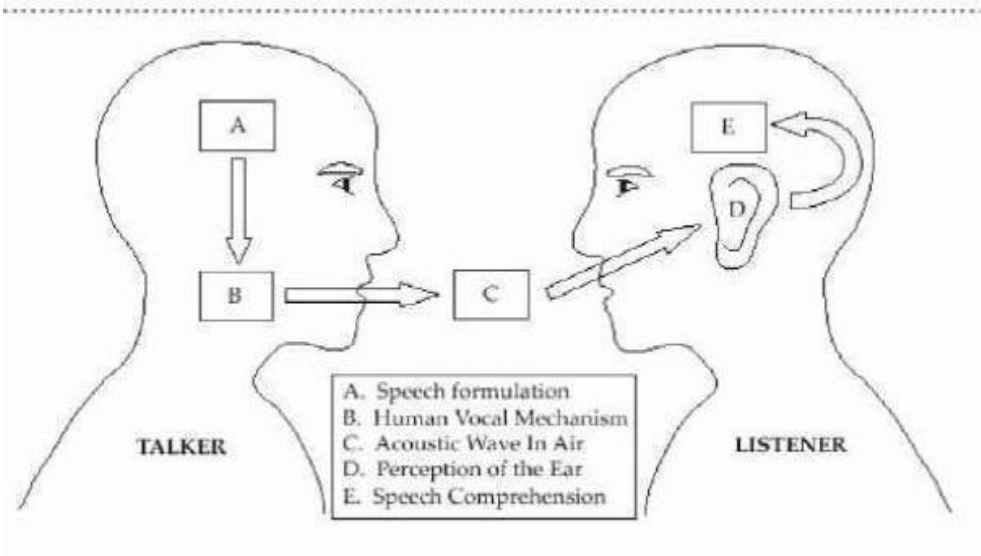


Fig 3.1 Schematic Diagram of the Speech Production/Perception Process

Five distinct elements, A. Discourse definition, B. Human vocal instrument, C. Acoustic air, D read of the ear, E. Discourse perception. The principal element (A. Discourse plan) is said with the definition of the discourse motion within the talker's brain. This descriptionis employed by the human vocal system (B. Human vocal component) to form the $64000 discourse wave shape.

During this exchange the wave will be influenced by outer sources, for example commotion, delivery a couple of a lot of confusingwave shape. At the purpose once the wave achieves the audience's listening ability framework (the ears) the audience percepts the wave shape (D. read of the ear) and also the audience's psyche (E. Discourse perception) begins making ready this wave shapeapprehend} its substance therefore the audience comprehends what the speaker is trying to let him know. One issue with discourse acknowledgment is to "reenact" however the audience procedure the discourse delivered by the speaker. There area unit somemoves creating place within the audience members head and hearing framework throughout the procedure of discourse signals. The discernment procedure will be viewed because the opposite of the discourse generation prepare. The essential theoretical unit for representational process a way to convey story significance to the framed discourse, within the psyche, is termed phonemes. Phonemes will be assembled in light-weight of the properties of either the time wave shape or repeat qualities and ordered in variedsounds delivered by the human vocal tract. Discourse is:

- Time-fluctuating sign,
- Well-organized correspondence handle,
- Depends on known physical developments,
- Composed of known, particular units (phonemes),
- Is distinctive for each speaker
- May be quick, moderate, or fluctuating in speed,
- May have high pitch, low pitch, or be whispered,
- Has broadly changing sorts of ecological clamor,
- May not have particular limits between units (phonemes),
- Has a boundless number of words.

3.2 SPEECH PRODUCTION:

To have the capability to check however the generation of discourse is performed one got to savvy the human's vocal system is constructed, see Figure a pair of.2. the foremost imperative components of the human vocal element square measure the vocal tract at the side of nasal depression, that starts at the velum. The velum may be a trapdoor-like

system that's utilised to outlinenasal sounds once needed. At the purpose once the velum is brought down, the nasal pit is coupled along with the vocal tract to arrange the desired discourse flag. The cross-sectional zone of the vocal tract is restricted by the tongue, lips, jaw and velum and shifts from 0-20 cm2.

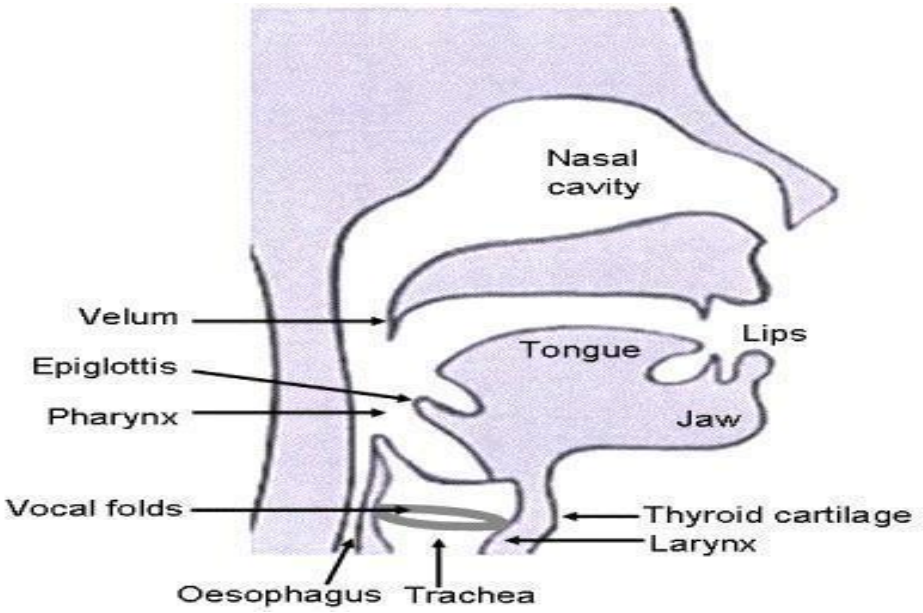


Fig 3.2 Human Vocal Mechanism

A standout amongst the foremost imperative parameter of sound is its return. The sounds area unit sequestered from one anotherby the help of their frequencies. At the purpose once the return of a sound expands, the sound gets sharp and bothering. At the purpose once the return of a sound reduction, the sound gets develop. Sound waves area unit the waves that happen from vibration of the materials. the foremost elevated estimation of the return that somebody's will deliver is around ten kHz. what is additional, the foremost bottom esteem is around seventy cycle per second. These area unit the foremost extreme and least esteems. This return interim changes for every individual. what is additional, the extent of a sound is communicated in dB (dB)[52]. Speaker Characteristics,

- Due to the distinctions in vocal tract length, male, female, and kids' discourse are distinctive.

- Regional pronunciations area unit the distinctions in reverberative frequencies, terms, and pitch.
- Individuals have full return examples and span styles that square measure special (enabling US to differentiate speaker).
- Training on info from one reasonably speaker naturally "realizes" that gathering or individual's attributes, makes acknowledgment of different speaker kinds rather more terrible.

3.3 IMPORTANT OF HUMAN ORGANS OF SPEECH:

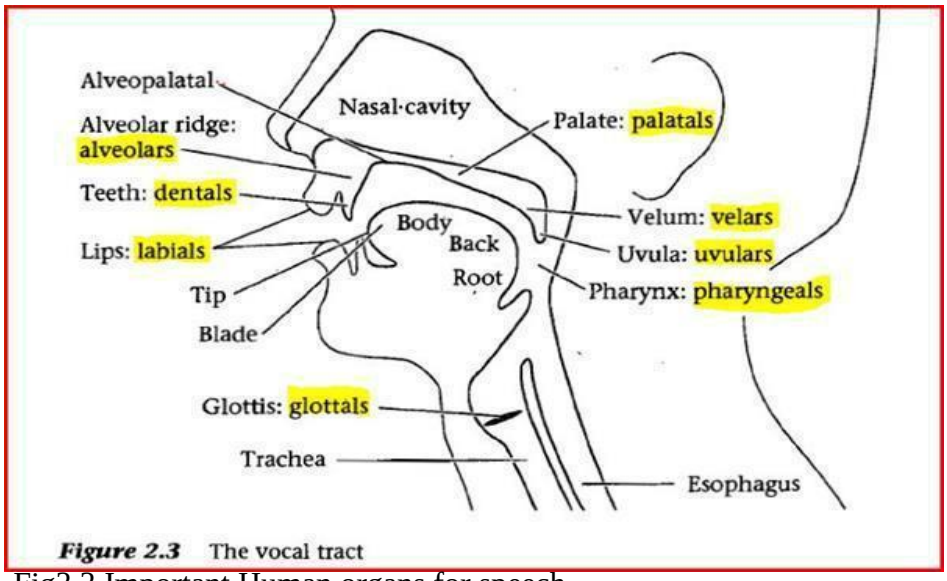


Fig3.3 Important Human organs for speech

Lips frame distinctive shapes, as an example, an oval, and developments keeping in mind the tip goal to form numerous sounds. Sounds is framed by utilizing the teeth to form the lips,in mix with the tongue, or to face air from obtaining off from the mouth. The tongue moves during the mouth and with a hefty portion of alternate organs, and also making shapes just like the lips, keeping in mind the tip goal to outline discourse. The flap is employed to create low-pitchedsounds. It makes nasal consonants by preventing air from traveling through the nose. The vocal organ is employed as an area of dominant the vibration created by the vocal harmonies, therefore on build numerous sounds. The alveolar edge helps United States of America to create numerous sounds, referred to as alveolar sounds, the tongue touches the sides found on this organ. laborious sense of style, almost like the alveolar edge, is that the organ

of discourse wherever the tongue touches and faucets the sense of style whereas articulating discourse. The versatile velum will withdraw and hoist therefore on separate the mouth from the nasal pit, creating discourse less nasally. At the purpose once the tongue hits the velum, it likewise makes a novel sound known asthe velar consonant.

3.4 BRIEF DESCRIPTION OF HYPERNASALITY:

Hypernasal speech (also hyperrhinolalia or open nasality; medically referred to as Rhinolalia aperta from greek rhinolalia: "nasal speech" and aperta: "open") could be a disorder that causes abnormal resonance during a human's voice thanks to accumulatedflow through the nose throughout speech. it's caused by associate open cavum ensuing from associate incomplete closure of the tongue and/or velopharyngeal sphincter muscle.

In traditional speech, timber is noted as nasalisation and could be a linguistic class which will apply to vowels or consonants during a specific language. the first underlying physical variable determinative the degree of timber in traditional speech is that the gap and shutting of a velopharyngeal passageway between the oral vocal tract and therefore the nasal vocal tract. within the traditional vocal tract anatomy, this gap is controlled by lowering and raising the velum or tongue, to open or shut, severally, the velopharyngeal passageway.

3.5 DIFFERENT TYPES OF CLEFT PALATE:

Plastic surgeons classify clefts by their involvement of the first surface,the secondary surface or each.Cleft palate classification guides the operating surgeon, dentist, medical specialist,speech therapist and every one others members of the cleft team in formulating Associate in Nursing applicable treatment set up.However it should be less complicated to think about a cleft of the surface as either “complete” or “incomplete”.

3.5.1Complete cleft palate: A complete cleft involves the whole primary and secondary surface.It extends from the flap all the means into the alveolar process. It involves each the first surface and secondary surface.

A complete congenital defect are often unilateral or bilateral. If the congenital defect is bilateral, each side could also be complete, or one facet could also be complete and therefore the different facet could also be incomplete.

3.5.2 Incomplete cleft palate: An incomplete cleft starts at the rear of the roof of the mouth with the flap and extends forward. it should or might not reach the incisive hiatus. In less complicated terms, it solely involves the secondary roof of the mouth because it doesn't extend all the method forward to incorporate the appendage.

3.5.2.1 Bifid uvula: The least severe of the unfinished clefts in look, a divided flap is that the most typical palatal cleft. it's conjointly stated as a "cleft flap." A divided flap seems as a cacophonic or forking of the flap. it's going to be terribly delicate, proved solely by atiny lownotch, or the flap could seem as 2 distinct entities. A divided flap in and of itself isn't problematic.

3.5.2.2Submucosal cleft: Asubmucosal cleft could be a cleft that's underneath the membrane that lines the roof of the mouth — thence the term "sub." as a result of a submucosal cleft is underneath the membrane, the sole physical indicator of its presence could also be a divided flap. despite the fact that not seen from the surface, the muscles of the surface aren't joined at the plane during a submucosal cleft.

3.5.2.3 Soft palate cleft:A cleft of the tongue runs from the tip of the flap and stops before or at the junction of the soft and surface. Not solely is it additionalobvious in its look than a submucosal cleft, it creates a similar speech issues as a submucosal cleft.

3.5.2.4 Soft and hard palate cleft: A cleft that involves each the arduous and taste bud can embody the complete taste bud and any a part of the surface up to the incisive opening. this can be the foremost public of the unfinished surface clefts.Similar to the isolated taste bud clefts,the combined soft and surface cleft is typically detected at birth as a result of feeding issues.Speech development are impaired[5].

3.6 SPEECH IMPAIRMENT OF CLEFT PALATE CHILDREN:

A surface|birth defect|congenital anomaly|congenital defect|congenital disorder|congenital abnormality} kids develops in a veryvertebrate once the 2 halves of the palate don't close and fuse within the middle.This kids faces social, communication and language issues. congenital abnormality may be a drawback with a varied variety of doable causes.Such as

1.In most cases the rationale of cheiloschisis and congenital abnormality is unknown.These conditionscannot be prevented.Most scientists believe that clefts square measure occur as a result of a combos of genetic and environmental factors.

2.Another potential reason could also be associated with a medication a mother takes throughout her physiological condition.Some medicine might cause birth defect and birth defect.Among them:anti-seizure/anti convulsant medicine,acne medicine containing Accutane and immunosuppressant,a drug usually used for treating cancer,arthritis AN skin problem.

3.Cleft palate might also occur as a results of exposure to viruses or chemicals whereas the craniate is developing within theuterus.

4.In alternative things,cleft palate is also a part of another medical condition.
Children with cleft palate are faces problems,like

1.Eating Problems: When separation or gap within the surface,food and liquids will pass from the mouth back through the nose.Fortunately,specially designed baby bottoles and nipples that facilitate keep fluids flowing downward toward the abdomen square measure on the market.

2Ear Infection: Children with congenital defect ar at inflated risk of ear infections,since they're a lot of vulnerable to fluid build up within thetympanic cavity.If left untreated,ear infections will cause hearing disorder.

3.Speech problems: cleft lip or birth defect kids conjointly be|is also also bother to speaking.These children's voice don't carry well,the voice mixed with a nasal sound,and that's why speech is also troublesome to understand[53].

4.Dental problems: Cleft palate youngsters area unit a lot of vulnerable to a bigger than average range of cavities and sometimes have missing,extra,malformed or displaced teeth requiring dental and odontology treatments.In addition, youngsters with birth

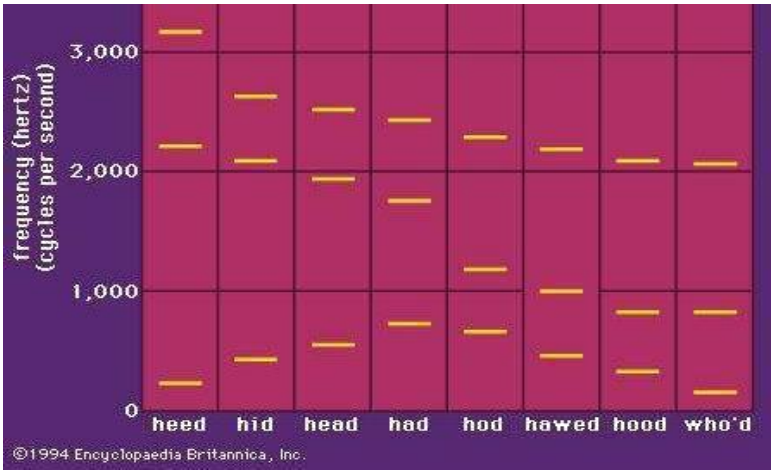


Fig.3.4(b)Schematic spectrogram showing frequencies of the first three formants of the vowel.

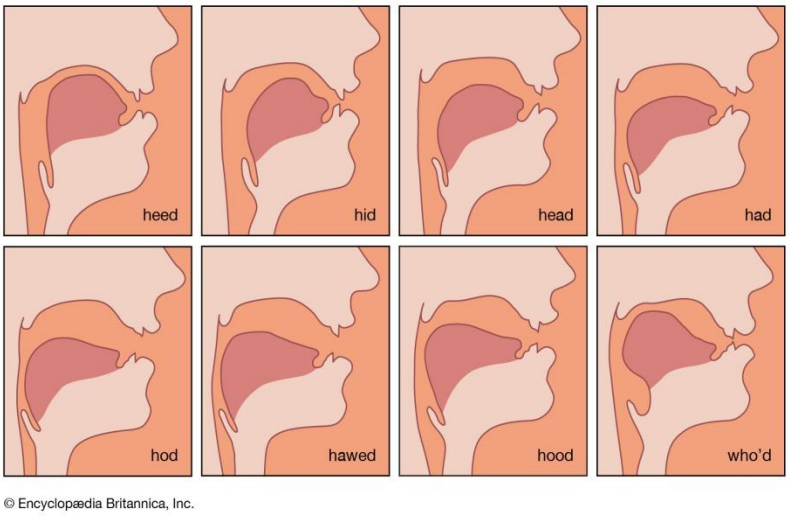


Fig.3.4(a) Tongue position for vowel sound.

defectomaly|congenital defect|congenital disorder|congenital abnormality usually have an appendage impact.The alveolus is that the bony higher gum that contains teeth.

3.7 ACOUSTIC FEATURES OF SPEECH:

The speaking voice is detected because the F0 (pitch) and its harmonics that area unit multiples of the F0. a number of the harmonic saree emphasised owing to the resonant characteristics of the vocal tract. These high energy harmonics area unit referred to as formants. whereas most voices have many formants, clinical analysis has typically been involved with F1 and F2.

F1 connected a lot of to tongue height, and F2 is expounded to the anterior-posterior position of the tongue.The frequencies of formants area unit influenced by 3 factors: the degree of constriction created by the peak of tongue; the gap from the cartilaginous structure at that this constriction happens and therefore the quantity of lip-rounding, lip-protrusion or lip-spreading gift. the connection or distance between F1 and F2 has been wont to describe the conventional production of vowels. For this study, pitch, intensity, period and formant frequencies area unit analyzed and bestowed the in terms of F0 (Hz), decibels, milliseconds and F1 (Hz) and F2 (Hz). Comparison of pitch for distinctive voice disorder, F1 and F2 is to seek out out articulation deviance and period to seek out .

3.8 ACOUSTIC PHONETICS OF VOWEL FORMANTS:

The resonant frequencies of the vocal tract ar referred to as the formants.The frequencies of the primary 3 formants of the vowel within the words heed,hid,head,had,hod,hawed,hood and who'd ar shown in fig.3.4(b) comparison with fig.3.4(a) shows that, no relationship between actual tongue position and formant frequencies. an honest inverse correlation between one among the label wont to describe the tongue position and therefore the frequency of the primary or lowest formants.This formant is lowest within thethus referred to as high vowels,and highest within the thus referred to as low vowels.When phoneticians describe vowels as high or low,they most likely are literally specifying the inverse of the frequency of the primary formant.

In several languages there's a robust tendency for front vowels to possess unfold lip positions, and back vowels to possess lip misestimation. As are going to be seen within the next section, this ends up in vowels that ar acoustically maximally distinct. Nasalized vowels, during which the mouth is lowered so a part of the airstream goes out through the nose, occur in severallanguages. French distinguishes between many nasalized vowels and vowels created with similar tongue positions however with the mouth raised. Low vowels in several types of English ar typically nasalized, particularly once they occur between nasal consonants, as in man.

CHAPTER- 04

ANALYSIS TECHNIQUE AND MATHEMATICAL TOOLS USED

4.1 INTRODUCTION:

Voice process thinks aboutered} both with the idea, planning and implementation of numerical procedures for process the separatesignal illustration and is specially thought of within the context of oral communication as very refined. Signal process functions are often enforced mistreatment digital techniques. the aim of such process is also to estimate characteristics parameters of a symbol or to rework or to rework a symbol into a kind that is in some sense additional fascinating. On the opposite hand, the on the market ability of high speed digital computers has fostered the event of progressively complicated {and sophisticated|and complicated|and complicated} signal process algorithms and resent advance in computer circuit technology promise economical implementations of vary complex digital signal process. In 1965, a revolution occurred when the evolution of latest purpose of readtoward digital signal process by the revealing of associate degree economical formula quick Fourier rework (FFT), for computation of Fourier rework (FT), was important because it reduced the computation time of the linear unit by orders of magnitude associate degreed was an inherently discrete-time thought.

SIGNAL PROCESSING

↓

INFORMATION → SOURCE→MEASUREMENT OR OBSERVATION →
SIGNAL REPRESTATION → SIGNAL TRANSFORMATION →
EXTRACTION AND UTILIZER OF INFORMATION

Fig.4.1 General problem of information manipulation

4.2 DISCRETE TIME SIGNAL:

A distinct signal or discrete-time signal may be a amount arrangement comprising of a succession of amounts. In different words, it's a amount arrangement that's a capability over a section of distinct whole numbers. every price within the sequence is thought as a specimen. Not like a continuous signaling, a discrete-time signal isn't a part of a continuing contention; be that because it could, it would arenoninheritable by testing from a uniform signaling. At the purpose once a discrete-time signal may be a grouping with reference

to systematically house times, it's a connected examining rate the testing rate isn't clear within the data succession, thus may beconnected as a special data issue

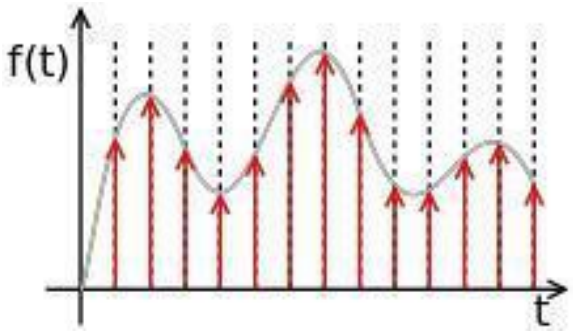


Fig.4.1 Discrete Time Signal

Discrete signals might have many origins, however will sometimes be classified into one amongst 2 teams,

(1) By getting values of associate analog signal [54] at constant or variable rate. This method is named sampling.

(2) By accumulating a variable over time. for instance, numbers of individuals taking an exact elevator daily. A digital signal could be a distinct-time signal that takes on solely a discrete set of values.

4.4 WINDOWING:

Windowing of an easy wave shape,cos(wt) causes its Fourier rework to own non zero values (commonly referred to as spectral leakage) at frequencies apart from ω. It tends to be worst (highest) close to ω and least at frequencies farthest from ω.

Mathematically, N represents the width, in samples, of a discrete-time window function.

Typically it is an integer power-of-2, such as 210 = 1024.

time-shifted forms of the n is an integer with values 0≤n≤N-1, So these are the

windows:

$$w(n) = w0\left(n - \frac{N-1}{2}\right)$$ where w0(n) is maximum at n=0

Some of these forms have AN overall dimension of N−1, that makes them zero-valued at n=0 and n=N−1. That sacrifices 2 knowledge samples for no apparent gain, if the DFT size is N. once that happens, an alternate approach is to exchange N−1 with N within the formula.

Each figure label includes the corresponding noise equivalent information measure metric (B), in units of DFT bins. As a suggestion, windows area unit divided into 2 teams on the idea of B. One cluster includes , 1≤B≤1.8 and also thealternative cluster includes B≥1.98 .The Gauss and Emperor windows area unit families that span each teams, tho' only 1 or 2 samples of every area unit shown.

4.4.1 WINDOW FUNCTION:

In signal process, a window work (otherwise referred to as associate degree iodization capability or decreasing capacity) could be a perform that's zero-esteemed outside of some picked interim. as an example, a perform that'sconsistent within the interim and nil in different places is thought as an oblong window, that describes the state of its graphical illustration [55]. At the purpose once another capability or a proof (information) is multiplied by a window work, the item is to boot zero-esteemed outside the interim: all that's left is that the "view" through the window. Uses of window capacities incorporate unearthly investigation, channel define and bar framing. A a lot ofbroad which means of window capacities doesn't expect them to be indistinguishably zero outside associate degreeinterim, as long because the results of the window times its competition is sq. indispensable that may be, that the capability goes adequately quickly toward zero.

4.5 THE FOURIER TRANSFORM:

Fourier rework is principle analysis tool of the many issues involving signal and LTI system as a result of Fourier rework of a wave {form|wave shape|wave|undulation} decomposes the wave form into a total of sinusoids of variousfrequencies i.e. the frequency domain illustration of a operate. graphically, Fourier rework of a wave form displays the amplitude and frequency of each of the determined sinusoid. Mathematically fourier transforms is stated as,

$$Z(f) = (a/T) \int_0^T x\, e^{-j2\pi ftdt}$$

here x (t) is the wave form to be decomposed, X (f) is the Fourier transform of x (t), j $=\sqrt{-1}$. To determine the amplitude of N, different sinusoids present is complex waveform the computation time is proportional to even with high speed computers. Computation of DFT (Discrete Fourier Transform) requires excessive machine time for large N.

4.5.1 THE DISCRETE FOURIER TRANSFORM(DFT):

The DFT illustration, with all its peculiarities, is very important for variety of reasons. The DFT X (k), will be viewed as a sampled version of the z-transform (or FT) of a finite length sequence. (1) The DFT has properties terribly similar (with modifications thanks to the inherent periodicity) to several of helpful properties of z-transforms and Fourier transforms. (2) The N price of X (k) will be computed terribly with efficiency (with time proportional to N log N) by a group of machine algorithms identified together because the quick Fourier rework (FFT). (3) The DFT is wide used for computing spectrum estimates, correlation functions and for implementing digital filters. For the special cases, if a symptom has solely a finite variety of non-zero values it's doable to develop a Fourier illustration, named because theDFT that corresponds to samples equally spaced in frequency of the linear unit of the signal.

4.5.2 FAST FOURIER TRANSFORM(FFT):

The FFT may be a quick process technique of consecutive combining increasingly larger weighted sums of knowledge samples thus on manufacture the DFT constant. the elemental principle primarily based upon is that of mouldering of DFT of a sequence of length N into in turn smaller DFTs. the way within which this principle is enforced results in a spread of various algorithms. the primary and well-known number two decimation-in-time (DIT) drives its name from the very fact that within the method of transcription the computation into smaller transforms, the sequence x (n) is rotten into in turn smaller subsequences. within the second general category of algorithms, the sequence of DFT coefficients X (k) is decomposed into smaller subsequences, thence the name decimation-in-frequency (DIF). The FFT could be a quickformula for economical implementation of the

DFT wherever the numbers of your time samples of the sign N square measure remodeled in to N frequency as mentioned below,Let x0, xN-1 be complicated numbers. The DFT is outlinedby the formula

$$X_k = \sum_{n=0}^{N-1} x_n e^{-i 2\pi k \frac{n}{N}} \qquad k = 0, \ldots, N-1.$$

As we defined in the multidimensional DFT article, the multidimensional DFT

$$X_{\mathbf{k}} = \sum_{\mathbf{n}=\mathbf{0}}^{\mathbf{N}-\mathbf{1}} e^{-2\pi i \mathbf{k} \cdot (\mathbf{n}/\mathbf{N})} x_{\mathbf{n}}$$

Transforms an array with a dimensional vector of indices $n = (n1, n2, \ldots, nd)$by a set of d nested summations (over $nj = 0 \ldots Nj - 1$for each j),where the division n/N, defined as $n/N = (\frac{n1}{N1}, \ldots . \frac{nd}{Nd})$ is performed element-wise.

This chapter involves discussion of study of speech sounds taking into thought their methodology of production. the extent of process is between the digitized acoustic wave form and therefore the acoustic feature vectors. The extraction of fascinating data is AN acoustic vector.

Speech analysis techniques provides a short scientific summary of the speech signal analysis techniques involved a selected specialise in variable resolution spectral analysis, i.e.- emphasis ,Variable resolution spectral analysis, Filter-bank analysis (Filter-bank speech analysis), Linear prophetical analysis (Linear prediction speech analysis), Cepstral analysis, Deltas and social control (Delta, acceleration and have normalization). Our goal in process the speech signal is to get a additional convenient or additional helpful illustration of the data carried by the speech signal. the desiredpreciseness of this illustration is determined by the actual data within the speech signal that's to be preserved. as an example, the aim of the digital process is also to facilitate the determination of whether or not a selected wave-form corresponds to speech or not. during a similar however somewhat additional difficult vain, we tend to may need to create a 3-way classification as is no matter a part of the signal is voiced speech, unvoiced

speech, or silence background noise. The endeavor of speech analysis technique is to investigate the speech signal and estimate the parameters helpful for the given speech process application. Since the parameter utilized in most of the speech processapplication that area unit derived from frequency-domain illustration, the most task is to reason the sound spectrum.

Before playing any style of digital process on speech signal, it's initial necessary to digitalize the analog signal. For this the speech signal is filtered by an occasional pass with a cutoff frequency of W cps, to avoid aliasing result. it'sthan digitized by Associate in Nursing analog –to-digital convertor at a frequence beyond the sampling rate of 2W cps. it's desirable to pick the cutoff frequency W, to be high enough to urge a lot of info within the digitized speech signal which could be helpful in a very given speech process application. the worth of cutoff frequency W, depend upon the speech process application and is often within the vary of 3-10 kc. The speech signal is non-stationary in nature, however it are often assumed to be stationary over short length for the aim of study. For the sake of validity of stationary assumption, it's necessary to decide on as short Associate in Nursing analysis segments as attainable. therefore in follow, the speech signal is analyzed frame-wise, with a frame-rate of 50-100 frames/sec, and for everyframe the length of speech phase is taken to be 20-50 m-sec

The short-time Fourier rework (STFT) of a speech signal has 2 components: the short-time magnitude spectrum and therefore the short-time section spectrum. it's historically believed that the short-time magnitude spectrum plays the dominant role for auditory perception at little window durations (20-40 ms). However, recent sensory activity studies have shown that the short-time section spectrum will contribute the maximum amount to intelligibility because theshort-time magnitude spectrum. so as to check spectral properties of speech signals, we have a tendency to shall notice it convenient to formally introduce the construct of a time varied Fourier illustration of a symbol.

4.6 SPEECH MATERIAL:

The experimental half consists of recording every of the word starting with vowel from the sentence.Each of this word ar attach with English vowel a/e/i/o/u.The recording

was exhausted a quiet area employing a mike interfaced with laptop at a rate of forty eight kHz and eight bit resolution. These digitized speech sounds area unit then down sampled to sixteen rate for the aimof research. the most effective recorded of those sounds is chosen for our work.

4.7 LINEAR PREDICTION CODING:

Linear prognostic cryptography (LPC) is associate equipment used for the foremost half in sound signal getting readyand speech handling for chatting with the spectral envelope of a complicated signal of speech in compacted form, utilizing the info of a straight discerning model. it's a standout amongst the foremost effective speech examination procedures, and a standout amongst the foremost useful techniques for cryptography nice quality speech at an occasional piece rate and provides surprisingly precise evaluations of speech parameters. Direct expectation could be a tight device for investigation of speech signals. Direct expectation models the human vocal tract as associateendless drive reaction (IIR) framework that makes the speech signal For vowel sounds and different voiced locales of speech, that have a powerful structure and high level of similitude overtime moves that square measure merchandise of their pitch amount, this demonstrating produces a **goodillustration** of the sound.

4.7.1 LPC ANALYSIS TECHNIQUE:

LPC begins with the front that a speech signal is created by a bell toward the finish of a tube (voiced sounds), with periodic included murmuring and popping sounds (sibilants and plosive sounds). Although evidently unrefined,this model is really a nearby estimation to the

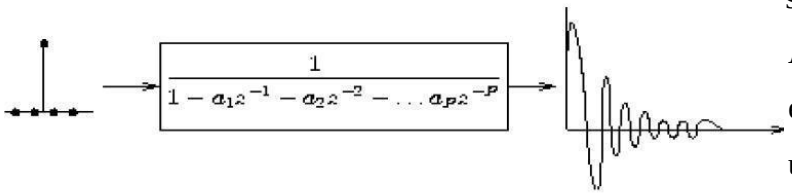


Fig. 3.5 **Linear prediction (IIR) model of speech**

truth of speech generation. The glottis (the space between the vocal folds) creates the buzz, which is described by its power (uproar) and recurrence (pitch). Murmurs and pops are created by the activity of the tongue, lips and throat amid sibilants and plosives. LPC dissects

the speech motion by assessing the formants, expelling their belongings from the speech signal, and evaluating the force and recurrence of the rest of the buzz. The way toward discharge the formants is named opposite separating, and also the staying signal when the subtraction of the sifted displayed signal is thought because the buildup. LPC integrates the speech motion by shift the procedure: utilize the excitement parameters and also the buildup to form a supply signal, utilize the formants to form a channel (which speaks to the tube), and runs the supply through the channel, transferral concerning speech.

4.7.2 LPC MODELING AND USING LPC ANALYSIS TECHNIQUE:

The physical mechanism of speech production as shown in fig.3.1can be represented by a mathematical model shown in Fig. 3.5 in LPC modeling of speech.

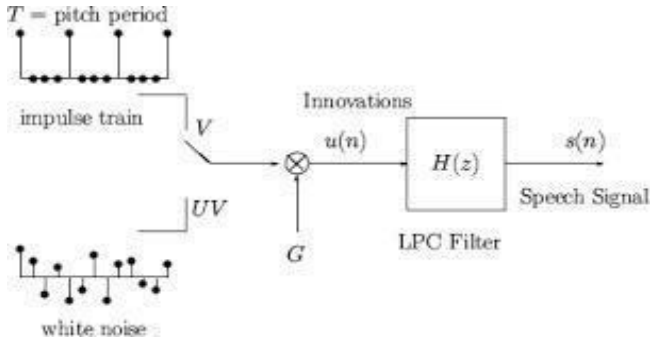


Fig.4.4 Mathematical LPC model of speech production

The higher than model is commonly known as the LPC Model. The model says that the digital speech signal is that the output of a digital filter (called the LPC filter) whose input is either a train of impulses or a racket sequence. the link between the physical and therefore the mathematical models is:

CHAPTER-05

ANALYSIS AND RESULT

5.1FEATURE EXTRACTION OF NORMAL AND DISORDERED SPEECH:

A flow chart may be a representation of a rule during which steps square measure drawn within the sort of totally differentshapes of boxes and therefore the logical flow is indicated by interconnecting arrows.In my thesis I actually have drawn a flow chart step by step.Record speech,separate vowel from the speech victimization WP,sampling and normalizing,analysis signal,extracts parameters and explained analysis square measure shown step by step in following flow chart.

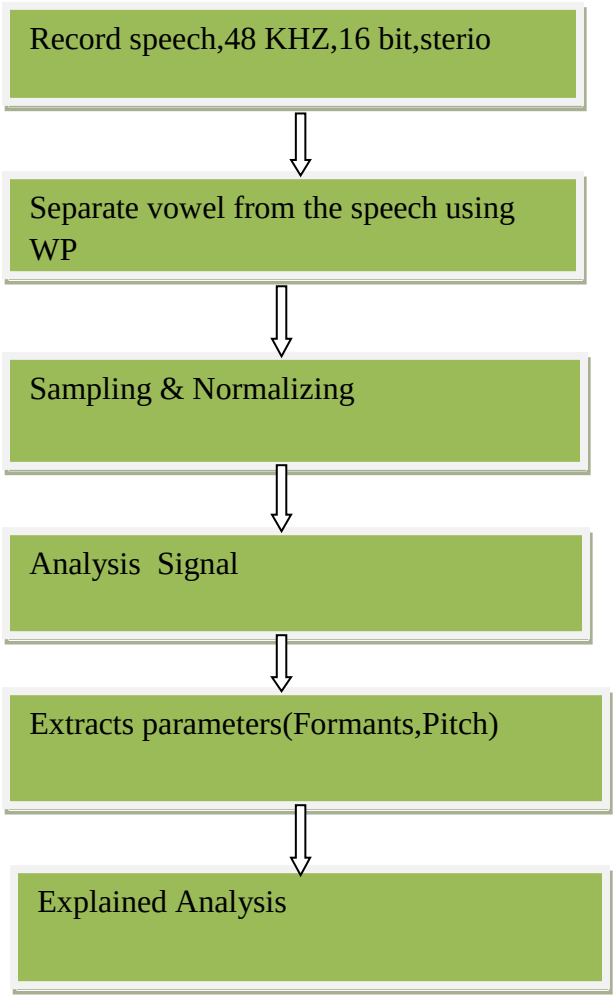


Fig.5.1 Working flow chart of speech analysi

5.2 DATA COLLECTION METHOD:

		For first part of the work	For second part of the work
1	Speakers	Healthy	Cleft producing hypernasal speech
2	Speech data	Isolated 5 short oral vowels /a I o e u/ Isolated 5 long oral vowels Isolated 3 nasal vowels/i e a/	Isolated 5 oral vowels/a I o e u/
3	Recording	48kHz and 16 bit	48kHz and 16 bit

The Vowels /i/ /e/ / during this case F1 is high frequency once comparison traditional vowel /e/ /i/ is that the half vowels oncesaying creating massive mouth gap - high F1 Lowering the tongue pushes the tongue into the tubular cavity area manufacturingthe next F1 , F2 during this case is high as a result of F2 front vowels become high and furthermore theses is on top of traditionalvowel frequencies as a result of , they nice effects congenital defect are tough saying for hypernasal patients. F3 of the vowels /e/ /i/ during this case is low as a result of F3 tuned in to front versus back constriction constriction within the back produces a high F3 constriction within the front produces a coffee therefore these vowels is that the portion of front vowels.

The vowel /a/ /o/ /u/ for F1 hyper nasal is incredibly slightly than frequency traditional vowels as a result of these vowels is that theportion back vowels pronunciation and build tubular cavity house for Somali saying thus F1 the realm of the rear or tubular cavitycavity. additional tubular cavity house F1 is lower , as a result of F1 is correlate with tongue height, that affects tubular cavityhouse to boot it's price to be mentioned once the hypernasal patient saying these vowels made with air that reason become additional peaks amplitudes energy of LPC result.

So F2 of Vowels /a/ /o/ /u/ square measure the vowels manufacturing from back additional backward tongue produces a lower F2 thus F2 is primarily tongue retraction front vowels is higher F2, back vowels is lower . conjointly vowel /u/ Lip miscalculationsupplements the retraction of the tongue by elongating the rima oris within the anterior dimension for many of the rear vowels (/u/ includes a lower F2 as a result of it's backward and has

lip misestimation. Thus, the shorter rima oris with the forward tongue position resonates at the next F2 frequency. what is more F3 vowels /a/ /o /u/ is that the opposite of F2 , back vowels is high within the case of F3.

5.3 LPC ORDER ANALYSIS:

Linear Predictive Coding (LPC): Linear prophetical committal to writing analysis tries to see the properties of the vocal tract filter. especially, it tries to see the formant frequencies, or peaks within the filter.

An LPC filter is expressed as a operate with a group of coefficients. the quantity of coefficients is termed the order of the filter. everycombine of coefficients defines a resonance of the filter. The order of the filter is fixed before the analysis.

5.4 USING LPC ANALYSIS TECHNIQUE:

Linear prediction could be a numerical operation wherever future estimations of a discrete-time signal ar evaluated as a linear operate of previous samples. This chapter discusses the acoustic characteristics of english sound units like hypernasal vowel from the experiment.
It conjointly explains regarding the primary 3 formant frequency ranges of vowels, result of congenital disorderyoungsters formant frequency values, acoustic of English language of sound units occurred because of the loudness/ intensity variation. the foremost necessary parameters that ar accustomed characterize the sound units ar formant frequencies. These frequencies ar measured by employing a changed LPC model.
This methodology relies on pre-filtering speech employing a time-varying adaptive filter for every formant before spectral peak estimation.This spectral peak peaking formula is embedded on the speech analyser tool.Therefore, formants ar extracted employing a speech analyser tool.The first 3 formant frequencies ar extracted for vowel characterization purpose.Because, F1 corresponds to the tongue height, F2 corresponds to the tongue length and therefore the graphical illustration of F1 vs. F2 and F2 vs. F1 corresponds to the position of the tongue form. Formant extraction is conducted on the steady state time of the vowel.

5.5 BLOCK DIAGRAM OF ANALYSIS OF DISORDERED SPEECH:

Here is the block diagram of analysis of disordered speech children.Here we have seen that how I work on this analysis of disordered child is given below:

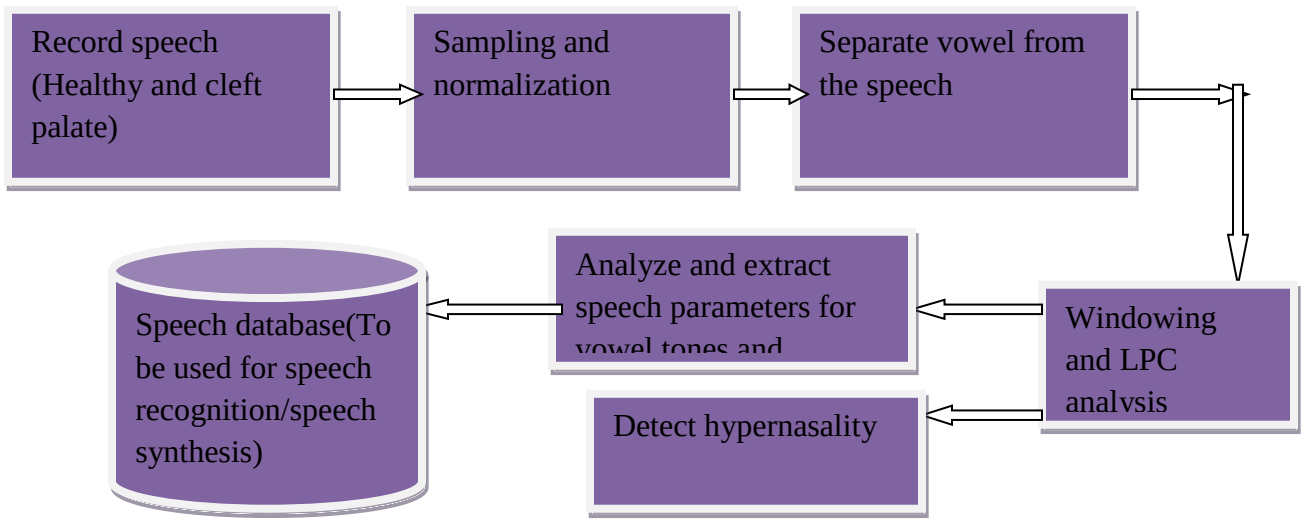


Fig.5.2 Block diagram of analysis of disordered speech

5.6 WORKING PROCEDURE:

In this experiment,I have taken 8 childrens voice sample.Among them one child is normal and another 7 childs are cleft lip/palate.I have chosen those words which have vowel a/i/o/u/e.

Here, I have taken three vowel a/i/u for the spectrogram and waveform.In this experiment I have compared the speech variation of the 7 children according to their depth of the hypernasal problem.I have analyzed disordered speech from the children to analyze their speech data.

5.7 SPECTRAL ANALYSIS OF HYPERNASALITY:

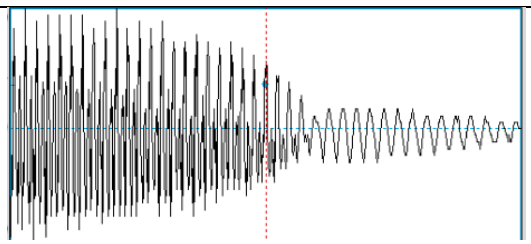
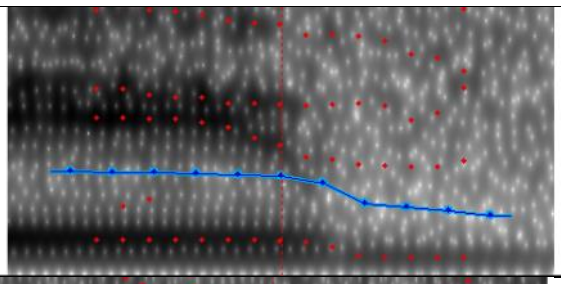
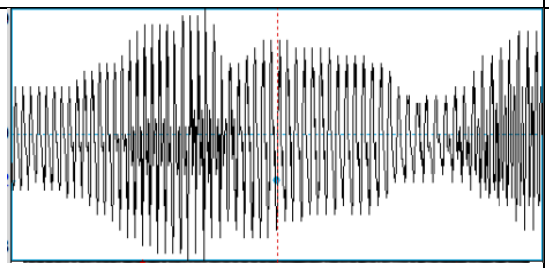
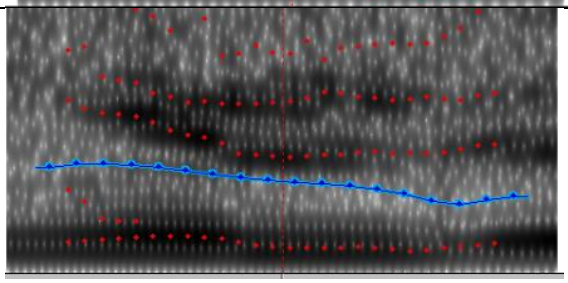
The speech samples were analyzed by a speech spectrograph, a machine that created attainable the visual examination of the 3acoustic properties of phone. These properties included: 1) frequency, that refers to the speed of vibration of the vocal folds throughout the assembly of a sound. phone square measure thought of to be primarily high frequency, low frequency, or a mixtureof both; 2) time, that refers to the quantity of milliseconds

necessary for the phone to be produced; and 3) amplitude, that refers to the energy with that the vocal folds vibrate throughout the assembly of a phone.

The spectrograph was able to show the acoustic properties of the speech samples on a graph called a sound pic or ikon. The frequency region on the ikon that was considerably amplified for a amount of your time was a formant frequency. the bottomformant of the ikon was 1st formant and was denoted by F1. successive higher information measure with a clear stretch of darkness was the second formant F2. The third higher information measure was the third formant F3, and so on. For this study, the primary 3 formants were the sole ones analyzed.

Hypernasality may be a disorder. Hypernasal formants ar time with big selection of traditional and affects vowels and vocalic consonants and become nearer the vowel formants.

Time variable spectral illustration that shows however the spectral density of signal varies with time. wont to establish phonetic sounds. Common format may be a graph with 3 dimensions. Horizontal dimension represents time, vertical axis is frequency and dimension indicates the amplitude of a selected frequency at a selected Time as shown by the subsequent figures:

Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		

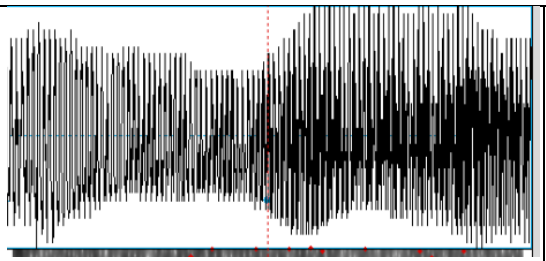
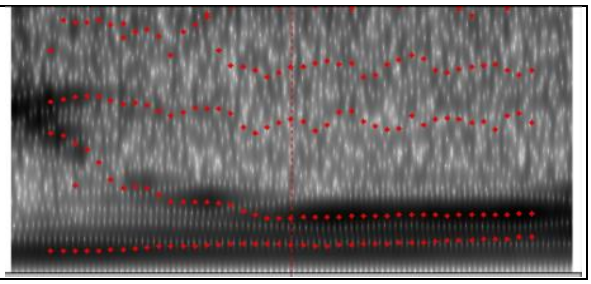
/u/		

Fig.5.4Normalized waveform and Spectrograph of a normal child with vowel /a/,/i//,/u/

From the Fig.5.2 we have taken three vowel /a/,/i/,/u/,then find out the normalized signal of the normal child and spectrograph from the normalized signal.As the child has totally normal voice,there is no hypernasal problem so the range of the voice quality was normal.

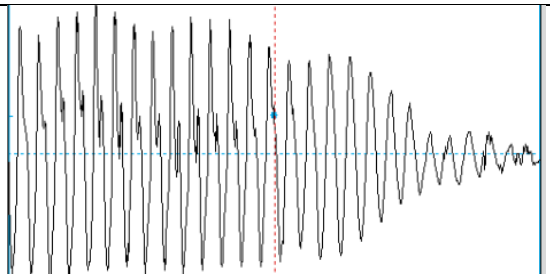
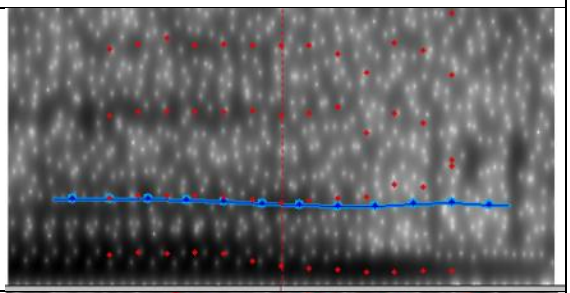
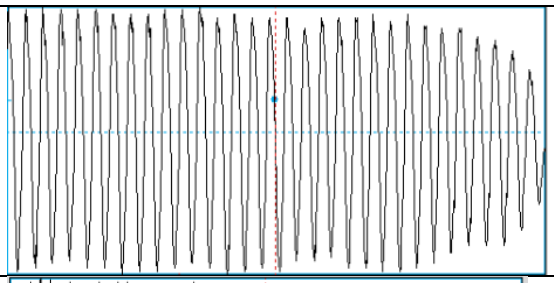
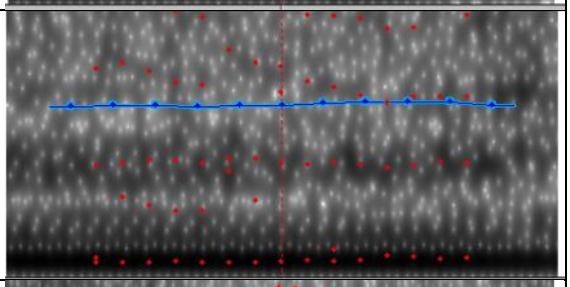
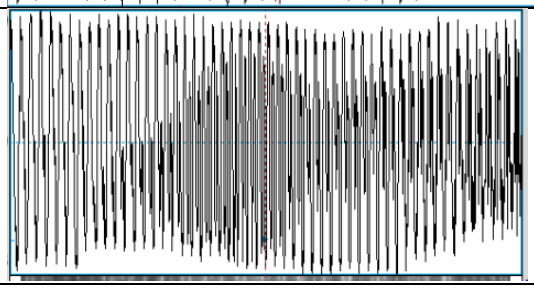
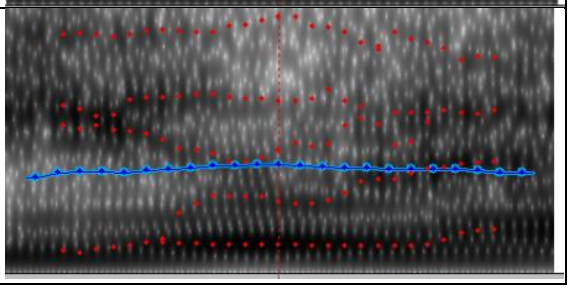
Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		
/u/		

Fig.5.5 Normalized waveform and Spectrograph of 2nd cleft palate child with vowel /a/,/i/,/u/

From this fig.5.3 it's been showen that 2d kid has slightly hypernasality.When the vowel soud area unit taken they was moderatley ok for listening,Frequency F1,F2 area unit but fig.5.2 childs frequency F1,F2 for the vowel /a/.For the vowel /i/ child-2 F1,F2 area unit buttraditional childs F1,F2,but kid-2 frequency vary is above traditional child for the vowel/u/.

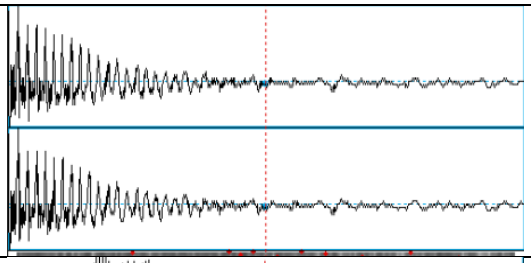
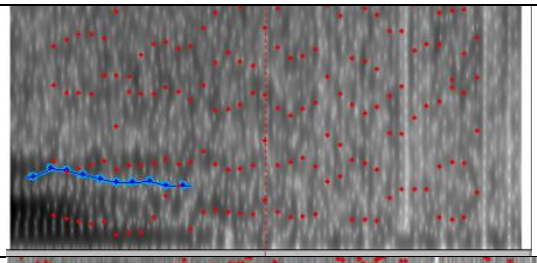
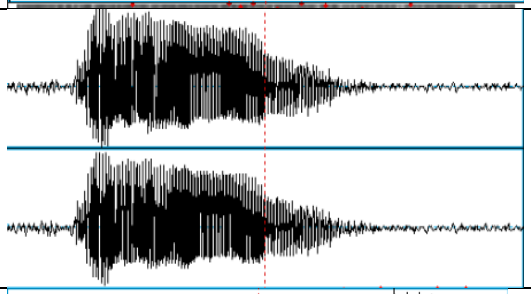
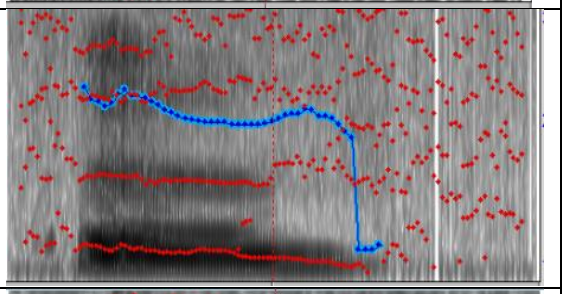
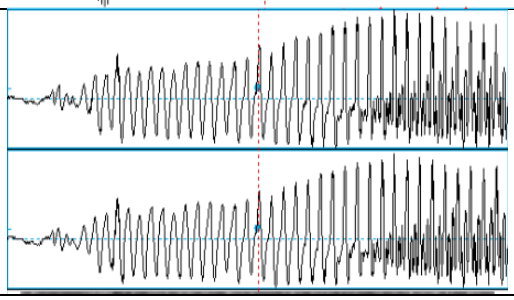
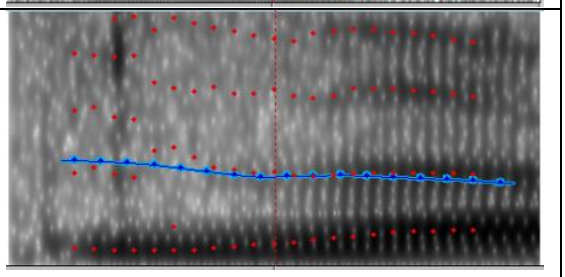
Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		
/u/		

Fig.5.6 Normalized waveform and Spectrograph of 3rd cleft palate child with vowel /a/,/i/,/u/

This spectrograph is belong that child whose hypernasal problem is more than Fig.5.3 child.His formant F1,F2 are less than normal child,Fig.5.2. child-3 has not clear speech because of his severe hypernasality.

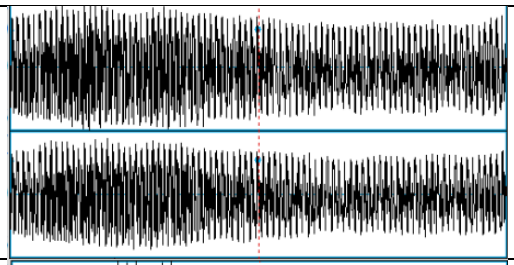
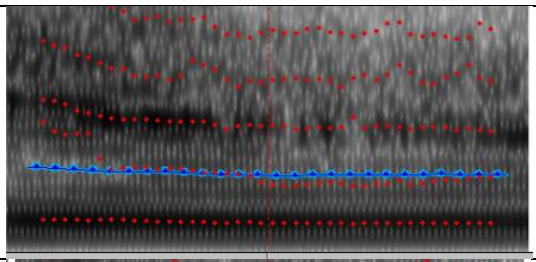
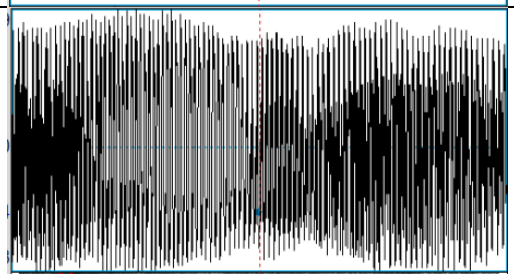
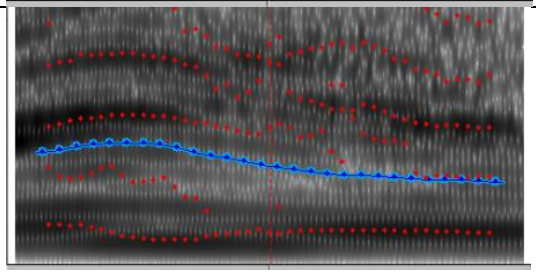
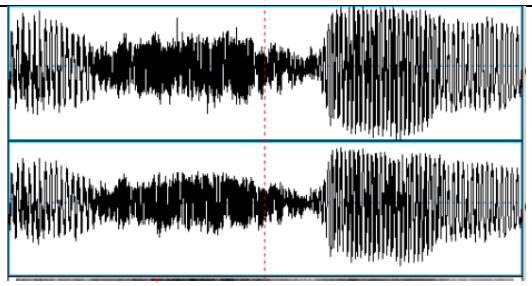
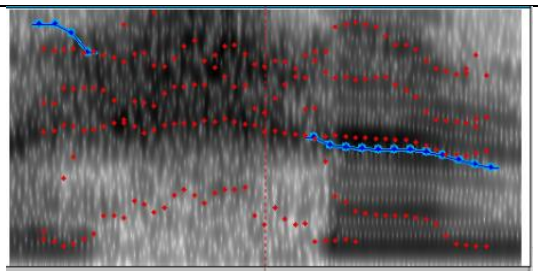
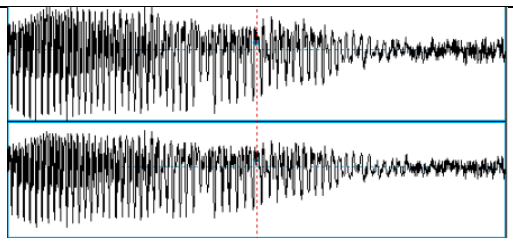
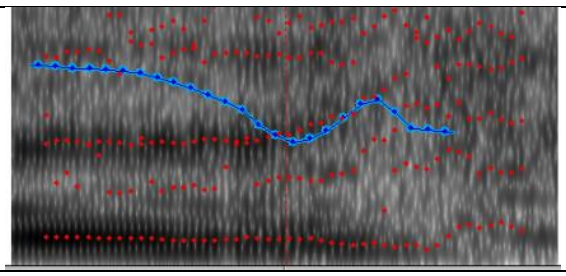
Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		
/u/		

Fig.5.7 Normalized waveform and Spectrograph of 4th cleft palate child with vowel /a/,/i/,/u/

As a cleft palate child,Fig.5.5 childs speech was not much clear as a normal child.Here normal child frequency is higher than the cleft palate child frequency F1,F2.For the vowel /a/ and /u/ there is shown 2 channal in normalized waveform.

Vowel	Normalized Waveform	Spectrograph
		

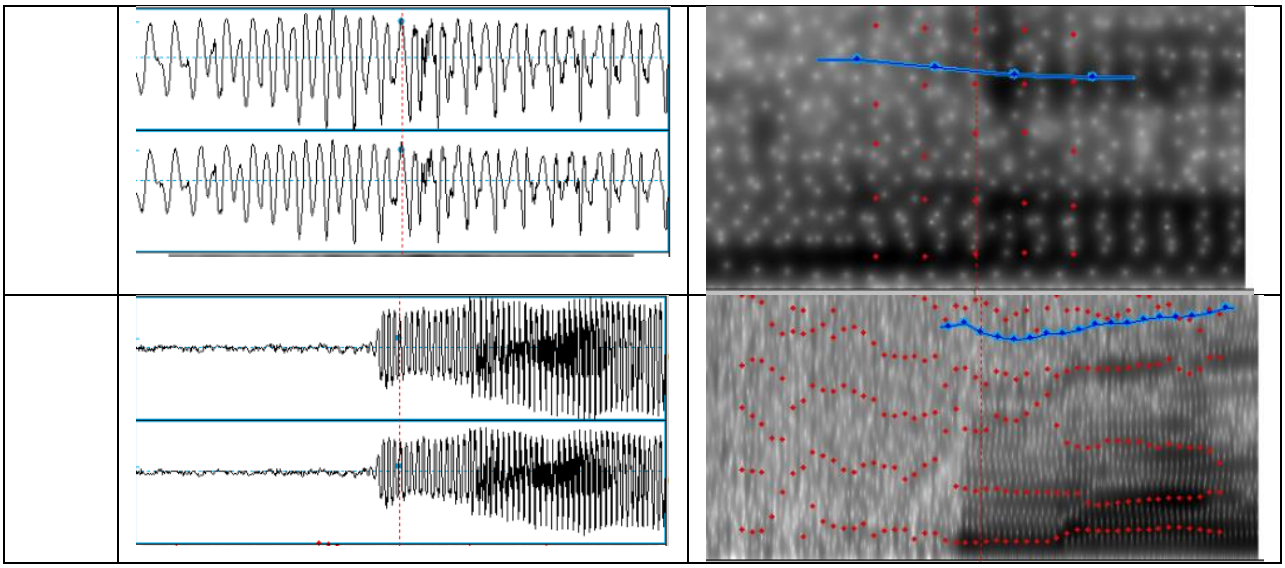


Fig.5.8 Normalized waveform and Spectrograph of 5th cleft palate child with vowel /a/,/i/,/u/

From Fig.5.6 we have showen that two channel has been made at all three vowel /a/, /i/and /u/.This child has severe hypernasal problem.As high energy harmonics are called formants,then most voice have a few formants,clinical research has for the most part been connected with F1,F2.

Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		

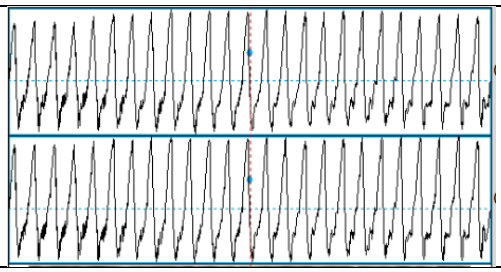
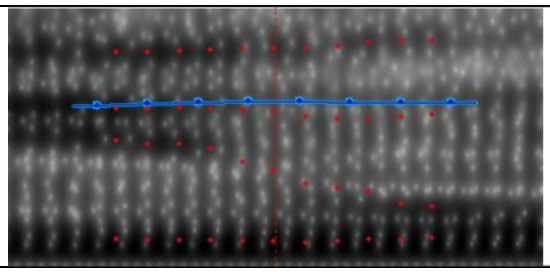
/u/		

Fig.5.9 Normalized waveform and Spectrograph of 6th cleft palate child with vowel /a/,/i/,/u/

F1 related more to tongue stature, and F2 is identified with the anterior-back position of the tongue.In the Fig.5.7 the child is more to speak because of his severe hypernasality.All the vowel were difficult to identify with this children.The spectral graph is different from others spectrograph which is shown in the above figure.

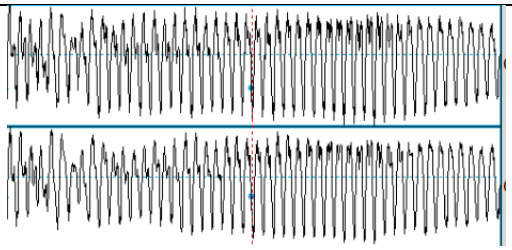
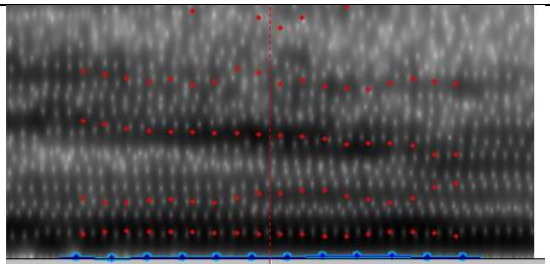
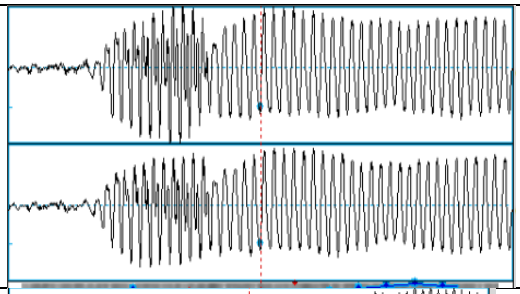
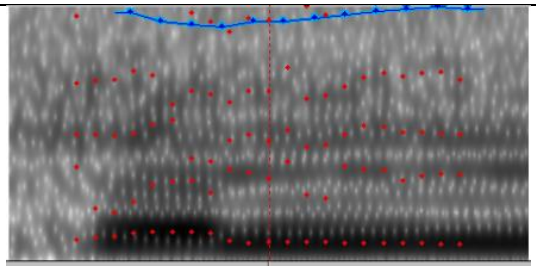
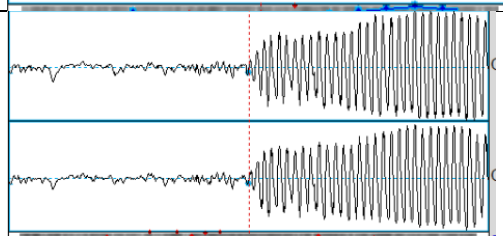
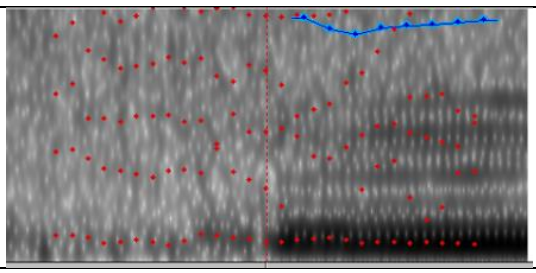
Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		
/u/		

Fig.5.10 Normalized waveform and Spectrograph of 7th cleft palate child with vowel /a/,/i/,/u/

The frequencies of formants square {measure} plagued by 3 components: the amount of adjustment created by the stature of tongue; the separation from the cartilaginous structure at that this narrowing happens and also the measure of lip-adjusting, lip-projection or lip-spreading gift. the connection or separation amongst F1 and F2 has been utilised to depict the standard creation of vowels.For this review formant frequencies ar analyzed and introduced in F0(Hz),decibels,miliseconds and F1(Hz) and F2(Hz).

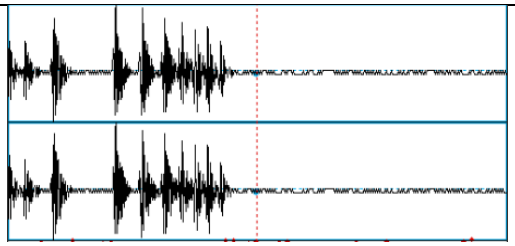
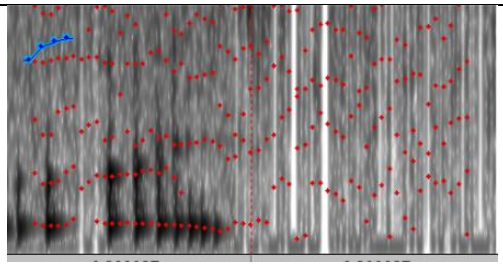
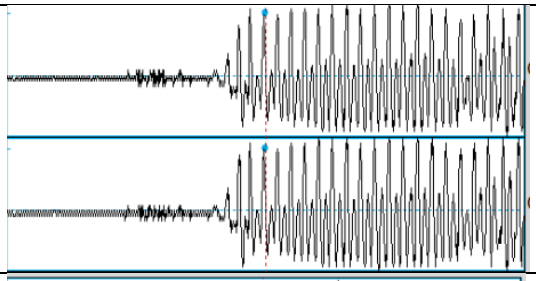
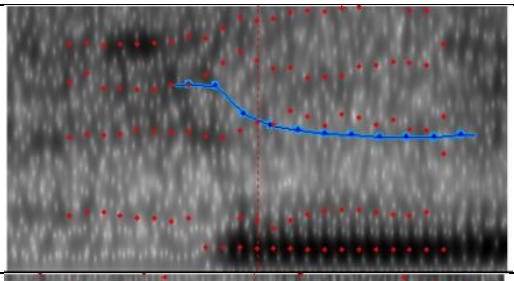
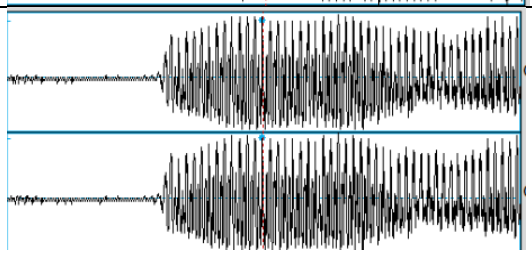
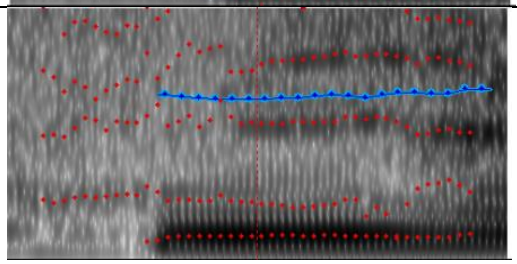
Vowel	Normalized Waveform	Spectrograph
/a/		
/i/		
/u/		

Fig.5.11 Normalized waveform and Spectrograph of 8th cleft palate child with vowel /a/,/i/,/u/

From the Fig.5.9 we have seen that this children is affected by severe hypernasality.While the speech was taken from this child it was more difficult to understand the vowel from his speech.By his voice tone,formants,pitch,frequency we can detect his level of hypernasality.To compare all the frequencies F1,F2 and spectrograph we can easily detect the percentage of problem.

5.8 RESULT:

In this Fig.5.12 we have analyzed two frequency formnats F1,F2 for the vowel /a/,/i/,/u/,/o/ and /e/.In this figure we have plot all the vowel which are spoken by some cleft palate children.

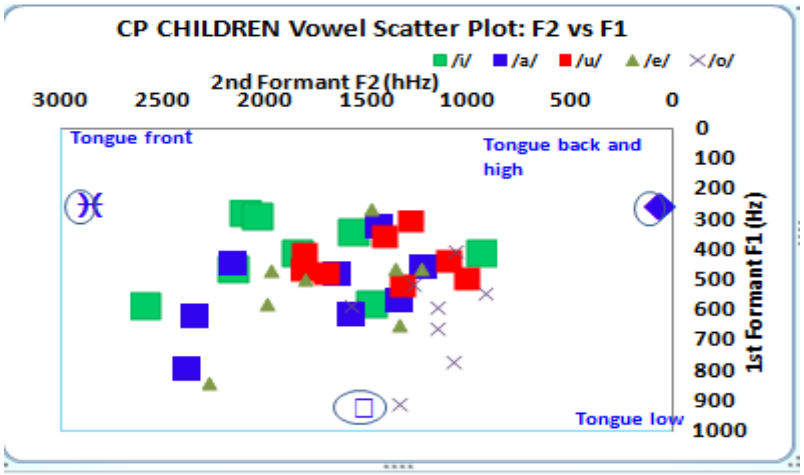


Fig.5.12 Vowel scatter for CP children: F2 VS F1

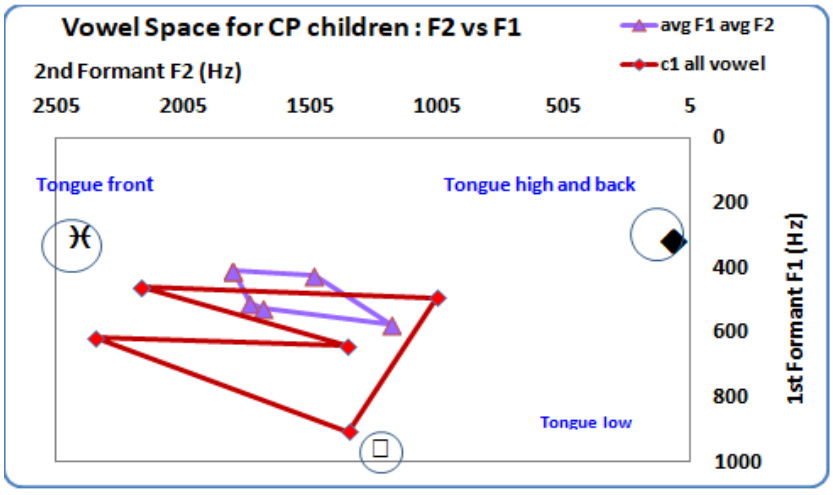


Fig.5.13 Vowel space for CP children: F2 VS F1

Hypernasality is thanks to escape of air through the nose throughout the assembly of vowels. it's totally different from nasal air emission that may be a term outlined for escape of air through the nose throughout the assembly of pressure-sensitive sounds (plosives, nasal stop, fricatives,

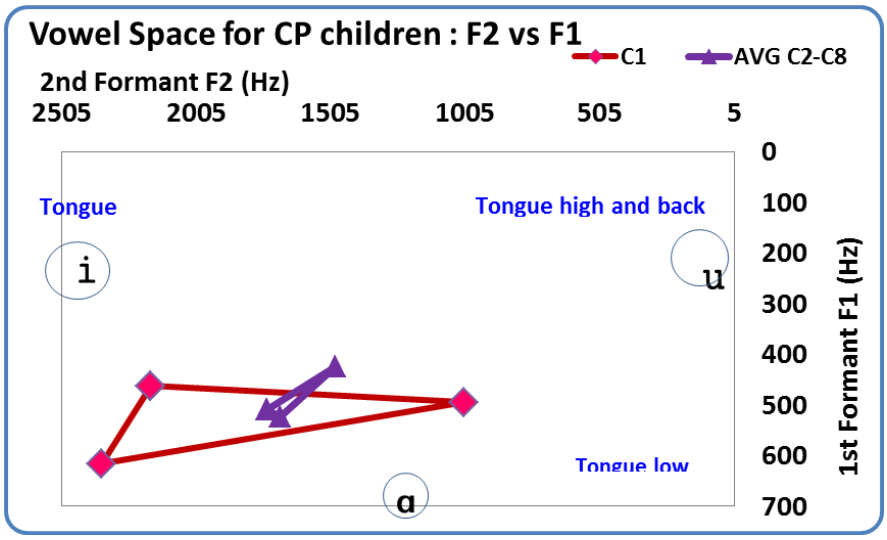


Fig.5.14 Vowel space for CP children: F2 vs F1

and affricates).For the Fig.5.13 we've got taken 2 frequency formant F1,F2 to making the vowel house graph of traditionalyoungsters between congenital disorder youngsters.From the figure,we have shown that standard youngsters vowel housespace is larger because of their swimmingly production of the speech.On the opposite hand,cleft palate youngsters area unit face issues once they created speech.There is outpouring of air through the nose throughout vocalization,that's why sentences and words don't seem to be clear to audience.This is the most reason for closness of vowel house space of congenital disorderyoungsters.

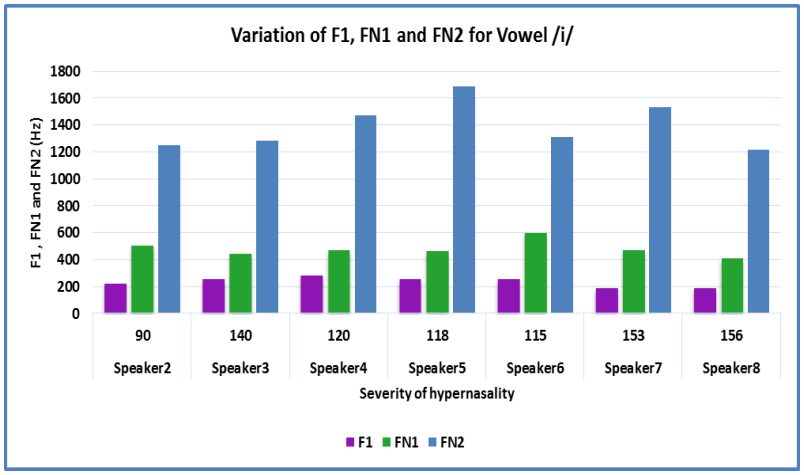


Fig.5.15 Variation of F1,FN1,FN2 for vowel /i/

From this chart fig.5.15 shown that formant variation of normal children between cleft palate children.This chart has been done for the vowel /i/.

5.9 Discussion and Overview:

Traditional there's additional distinction between frequencies hypernsal and traditional as shown figures on top of. we have a tendency to observe figures of hypernasal as appearanceadditional peak amplitude energy once scrutiny traditional figures feminine all vowels they not same thereupon amplitude peaks there's thereforeme vowels is that the portion of front vowels et al back vowels so we have a tendency to determined .

vowels /e/ /i/ is that the a lot of amplitude peaks than different vowels of back vowels like /a/ /o/ /u/ once pronounce as a result ofthe front vowels of /i/ and /e/ is that the most vowels impact cleft plate as a result of they manufacture Lip miscalculationsupplements the retraction of the tongue by elongating the rima oris within the anterior dimension for many of the rear vowels

However as we have a tendency to shown for the /e/ and /i/ there's additional peak of F1 and F2 severally as a result of F1 is concentration the world of the rear or tubular cavity cavity (more tubular cavity house F1 is lower and front vowels is high F1, F2 , that why accomplished F1 and F2 hypernasal and becomes creating additional peaks furthermore the behavior of this vowel is articulator characterised first off saying that why F1 and F2 Replete or fraught energy or amplitudes and F3 is become low the case of front vowels . its value to be mentioned feminine is middle voice for frequencies however totally different amplitude energy oncecomparison kid and male as we have a tendency to seen some frequencies of feminine scattered additional frequencies on top oftraditional.

Now a days most typical diseases is that the youngsters with birth defect or lip with hypernasality.Hypernasality is that theparameter that in the main happens on the kids with birth defect.A normal speech manufacture air flow out of the lungs,a vibration of the muscles of the vocal cords and control the quantity of resonant air allowed to flee the body through the mouth or nose,but hypernasal speech is that the sound that flows an excessive amount of air escaping through the nose whereas talking.Some boundletters and sound shouldn't have air escaping through the nose throughout speech,these are- “S” “B” and “k”.

At presents hypernasal speech of cleft palate children is being analyzed by different speech parameter by many researchers and works in these areas are currently being advance.

My work was on detect hypernasality among seven cleft palate children and I have also taken a normal children's speech to compare with them.From this research I got some cleft palate children whose have little bit hypernasal problem and also some children who has severe hypernasal problem.

CHAPTER-06

CONCLUSION AND FUTURE WORK

6.1 CONCLUSION:

A roof of the mouth|birth defect|congenital anomaly|congenital defect|congenital disorder|congenital abnormality} develops during afoetus once the 2 halves of the palate don't close and fuse within the middle. In most cases, a cheiloschisis is additionally gift. congenital defect causes issues with dental development, speech, hearing, eating, and drinking. a baby may expertise frequent colds, fluid within the ears, inflammatory disease, and issues with the tonsils and adenoids.A set of 5 universal speech parameters has been devised for the reportage these quite patients.These consists of (1) hypernasality,(2) hyponasality,(3) loud nasal ear emission/nasal turbulance,(4) consonant production error.Most of the youngsters with congenital defect area unit surffer from hypernasality.My space of labor was speech parameter variation of hypernasality of congenital defect youngsters.

Hypernasal speech may be a disorder that causes abnormal resonance in a very human's voice thanks to redoubled flowingthrough the nose throughout speech.It is caused by associate open bodily cavity ensuing from associate incomplete closure of the taste bud and/or In traditional speech, timbre is noted as articulation and may be alinguistic class which will apply to vowels or consonants in a very specific language. Hypernasality is mostly segmental into questionable 'resonance' effects in vowels and a few voiced or sonorant consonants and also the effects of excess nasal flowingthroughout those consonants requiring a buildup of oral gas pressure, like stop consonants (as /p/) or sibilants (as /s/). The latter nasal flowing downside is termed 'nasal emission',and acts forestall|to stop|to forestall} the buildup of gas pressure and so prevent the conventional production of the consonant.

In my work i have chosen some of cleft palate childrens speech to detect the abnorrmality of speech of hypernasality.It was difficult to produced specch and recorded them compare to the normal person voice speech.All members of the cleft palate team are becoming increasingly aware of the complex processes which interact to produce the speech and resonance difficulties associated with cleft palate.

6.2 FUTURE WORK:

In this study,the detection of hypernasality of congenital anomaly youngsters has been done.The vowels area unit extracted from the congenital anomaly youngsters for the experiment.There area unit ton of labor has been done previous.Still there also aresome works to be tired future for developing this space.

While functioning on this field,I have seen that timbre detection in youngsters is tougher than in adult's speech,though I Hve worked with children's speech.In future, we are able to work on adults speech.As our knowledge set is comparatively little,and I have faces numerous issues.so,in future these issues ought to be overcome.Various styles of speech parameters may be used for the longer term work.More details may be other to the longer term work.Future work would be testing the strategy on larger and differing types of speech info.

In this work,I have made comparison between normal children with cleft palate children to detect the hypernasality.In future work this could be done accurately, data collection method and voice synthesis should be done carefully,details should be taken carefully for the better result.

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