Detection of Dyslexia In The Early Stage Using Machine Learning

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Abstract: It is a well-known fact that any two persons with disability are not alike and their articulation would not be similar. In this context teaching and rendering services for children with special needs particularly those who have hearing impairment and articulation disorder is quite a challenge. To provide clinical support services to the needy population, we have used MATLAB, a multi-paradigm numerical computing environment as a tool to achieve the aim and objectives of our project. The main aim of our project is to encourage students to achieve one of the primary milestone i.e., articulations of phonemes. To provide training in articulation of phonemes by continual therapy imparted through MATLAB and to promote interactive learning method during therapy sessions are the prime objectives. This Technical intervention would be very user friendly for therapist during the therapy session as they provide visual cues and also help giving feedback on improvement towards achieving the correct articulation to the children. These visual cues will encourage articulation disordered kid to learn in an easier way, unlike the traditional practice. Whole process was divided into three phases. Initially, the reliable and efficient microphone was selected for phoneme recording purpose based on frequency response characteristics. Where, the phonemes are recorded using different set of microphones; each microphone's frequency response characteristic was analyzed and appropriate microphone (SLM) was selected for articulation therapy. Secondly, a data base of normal was created using the recordings from the suitable microphone that was articulated by the native Kannada speaking children with the age range of 7-8 years and without any articulation disorder. Finally, Phonemes articulated by articulation disorder children of the age range of 7-9 years was recorded. Comparison of its frequency response characteristic with the reference of normal children was obtained. The Cepstrum algorithm was used for the analyzing the frequency response characteristic. Analysis of the compared phonemes are studied and scored. These scored data are provided as visual cues through MATLAB tool. This visual feedback not only helps the therapist to provide therapy in clinical sessions but also encourage the child in achieving the milestone towards correct articulation very quickly in an easier way.

Keywords: MATLAB; SLM; MICROPHONE; CEPSTRUM.

I. INTRODUCTION

The first description of Dyslexia appeared in 1896, authored by Dr. W. Pringle Morgan in Sussex, England. The word Dyslexia is derived from the Greek word 'dys' meaning difficult and the word 'lexis' meaning words. Originally Dyslexia was called 'reading blindness'.

Dyslexia is a learning disability that causes difficulties to read and understand written language. Dyslexia is caused by a phonological processing problem whereby children who are diagnosed with dyslexia have trouble manipulating the language. Dyslexic children also face problems learning in regular classes. If this is not identified early, the children will be lacking in their development thus losing their self-esteem. It affects from 10% to 17.5% of the population in the U.S.A., 8.6% to 11% in Spain, and has aconsiderable presence in web text. Competitive reading and writing are required in our education system; therefore, school failure is associated with dyslexia, even if dyslexia is not related to overall intelligence. Dyslexia, also known as 'reading disorder' is characterized by trouble with reading despite normal intelligence. Different people are affected to varying degrees. Problems may include difficulties in spelling words, reading quickly, writing words, "sounding out"wordsin the head, pronouncing words when reading aloud and understanding what one reads. Often these difficulties are first noticed at school. People with dyslexia have higher rates of attention deficit hyperactivity disorder (ADHD), developmental language disorders, and difficulties with numbers.

1.1 SYMPTOMS OF DYSLEXIA

The various symptoms of dyslexia include;
• Delayed speech.

• Difficulty in memorizing the alphabet.
• Difficulty in sound pronunciation.
• Difficulty in pronouncing multisyllabic words.
• Dysgraphia - Difficulty in writing.
• Poor reading.
• Spelling ability.
• Inability to rhyme.
• Difficulty learning to tie shoes.
• Difficulty in telling time on a clock with hands.
• Struggles with direction.
• Can't remember their phone number or address.
• Lower self-esteem.
• Poor grades despite considerable effort.
• Difficulty being organized.
• Letter and word reversals in writing.

1.2 PROBLEM STATEMENT

Dyslexia (pronunciation and talking) is the ability to physically move the tongue, lips, teeth and jaw to produce sequences of speech sounds, which make up words and sentences that can be easily understood, which others could interpret in order to express basic needs. Dyslexia disorders involve difficulties in articulating specific types of sounds. It often involves substitution of one sound for another, slurring of speech, or indistinct speech and it has become a major challenge in the 21st century. Dyslexia problems reduce speech intelligibility and communication. It also affects person's interpersonal communication, personality, social adaptive capability and learning ability. Hence Therapy sessions are necessary for Dyslexia correction. In specific it is more important for the children in the age group of 7-9 years, as it is a best time for detection and correction of Dyslexia disorder. The therapy sessions help children to become clear confident communicators so that they can become fully engaged in school and benefit from the curriculum, develop self-help skills and independence for activities of daily living, actively participate in life experiences, and build healthy social relationships. It also affects person's interpersonal communication, personality, social adaptive capability and learning ability. It often involves substitution of one sound for another, slurring of speech or indistinct speech.

In the sequence of therapy, language therapist subjectively utilizes clinical experience to individualized assessment, treatment, and training. But assessing and treating children with Dyslexia disorder is a major challenge for therapists, as it becomes difficult to analyse and select the proper strategy for correction of Dyslexia in certain situations in spite of clinical experience. Improper analysis of Dyslexia disorder may lead to wrong therapy strategy usage for correction of Dyslexia and unsuccessful results. Hence articulation assessment and training system that is therapist friendly (easy to handle and maintain) and which can support the therapists in analysis and correction of Dyslexia (correction factors and suggestions given through visual cues which gives the variations in the appearance of a graphic display which are intended to assist the therapist in selecting the therapy strategy for Dyslexia correction more efficiently) is the imperious demands of language therapist. Also there is a need for automatic speech processing techniques that can be used in a therapy system, which supports therapy sessions in the practice as well as tele-medical therapy sessions. Thus, using such a system Dyslexia disorders can be treated easily

II SAMPLE BLOCK DIAGRAM FOR DATA COLLECTION
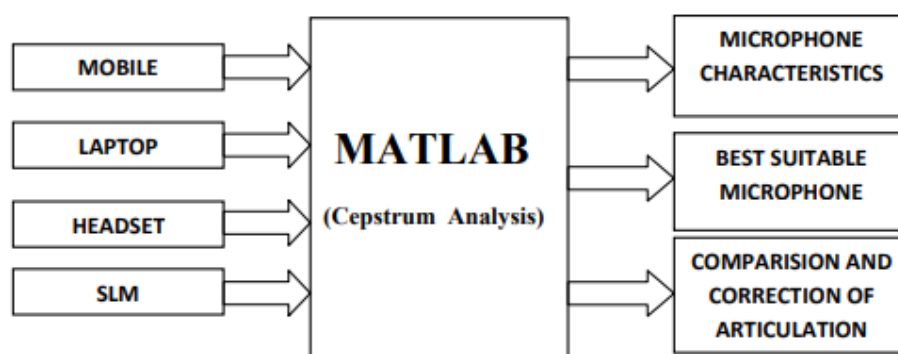
Explanation

. We record the data using any device like mobile, laptop, headset, or SLM device.
. We insert the recorded samples into the MATLAB software.
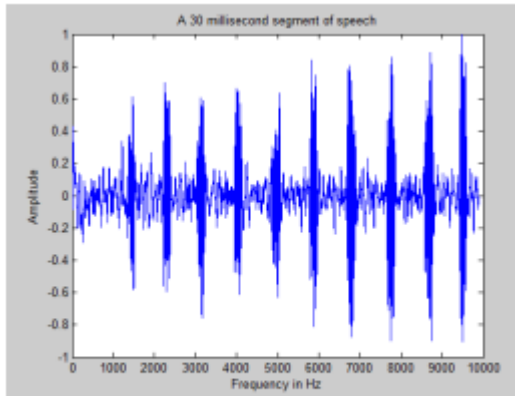. The comparison of the graph and the best suited is done depending on the output of the software.
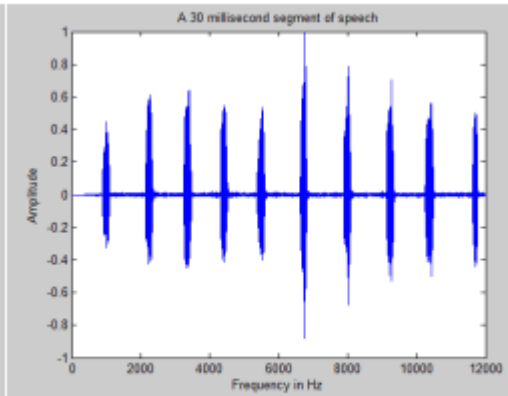

Figure 3.1.4 Laptop (Phoneme –a॥)
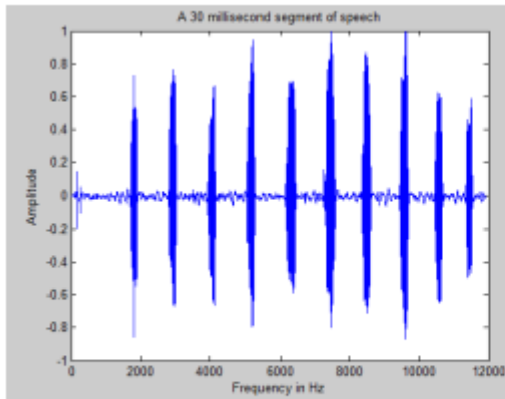

Figure 3.1.5 Mobile (Phoneme –a॥)
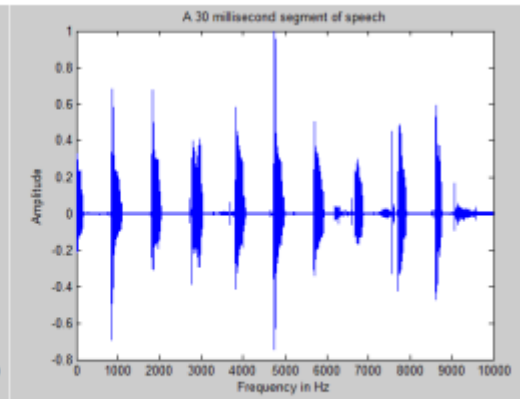

Figure 3.1.6 Headset (Phoneme –a॥)

Figure 3.1.7 SLM (Phoneme –a॥)

Step 1: Phonemes (26 Kannada phonemes) are recorded in Sound treated room with different microphones (Ex: Mobile, Laptop, Headset, SLM) for normal children of age group 7-8 years. These samples are stored in WAV format.

Step 2: One sample is selected out of 10 samples from the recorded phoneme using PRAAT tool.

Step 3: The frequency response of the recordings from different microphones are analyzed and compared to obtain the best suitable microphone based on its characteristics. The concept used in determining the frequency response is ― Pitch detection via cepstral method.
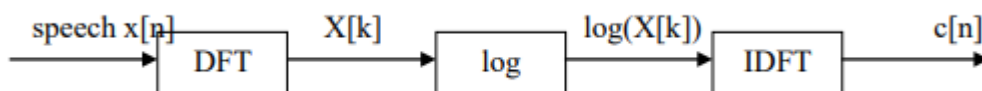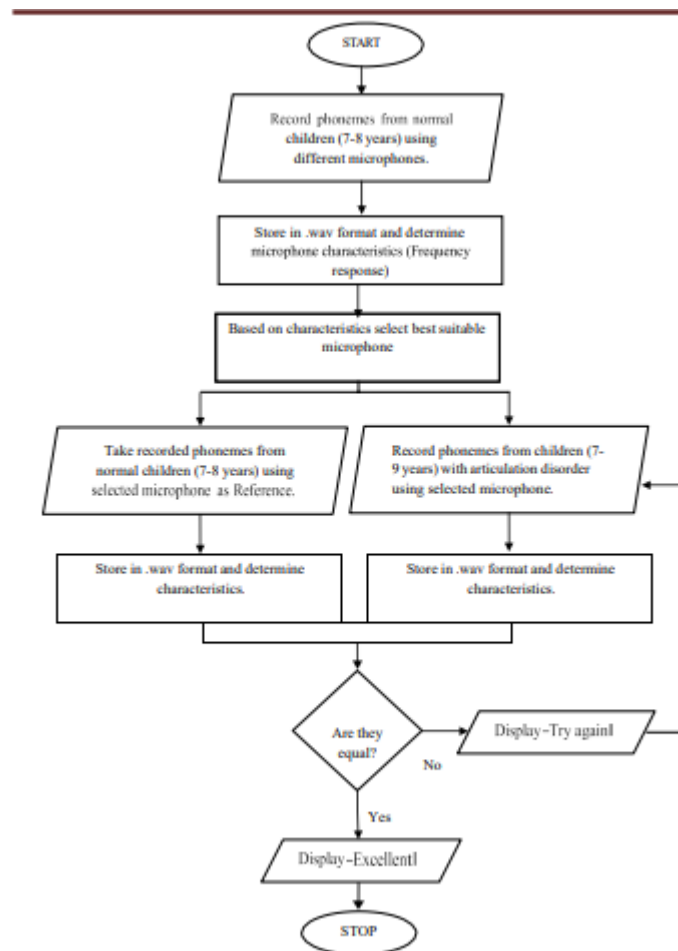
Step 4: From the selected microphone, phonemes (26 Kannada phonemes) are recorded from articulation disorder children (7-9 years). Due to early intervention delay the physical age of the normal kid usually don't match with that of hearing impaired and articulation disorder population. Hence the age range of the articulation disorder population for our project was considered to be 7-9years.

Step 5: The Step 1 and Step 2 were repeated for the recordings of articulation disorder children. While recording the phonemes special care was taken to educate the care taker how the child need to cooperate before recording.

Step 6: Out of 10 normative with 5 being boys and 5 being girls, the best microphone characteristic such as frequency response was selected and taken as a reference for further analysis.

Step 7: The frequency response of the phoneme recorded from the articulation disordered children was compared with the reference that was set in step 6. With the help of visual clues the suggestions were given, that are helpful for the therapists to guide the children to improve their articulation. A visual cue is just one visual that alerts the student on where to focus or where to respond. Thus therapists can use this system to guide articulation disordered children in clinical therapy sessions.

III FLOWCHART

The flowchart of the process is depicted in the Figure 4.2.1. The inputs to the program are audio file that contains the reference phoneme and the audio file that contains the phoneme articulated by the child with articulation disorder. After taking the inputs, the frequency response is determined for both the inputs. Then the frequency response of both the inputs is compared.
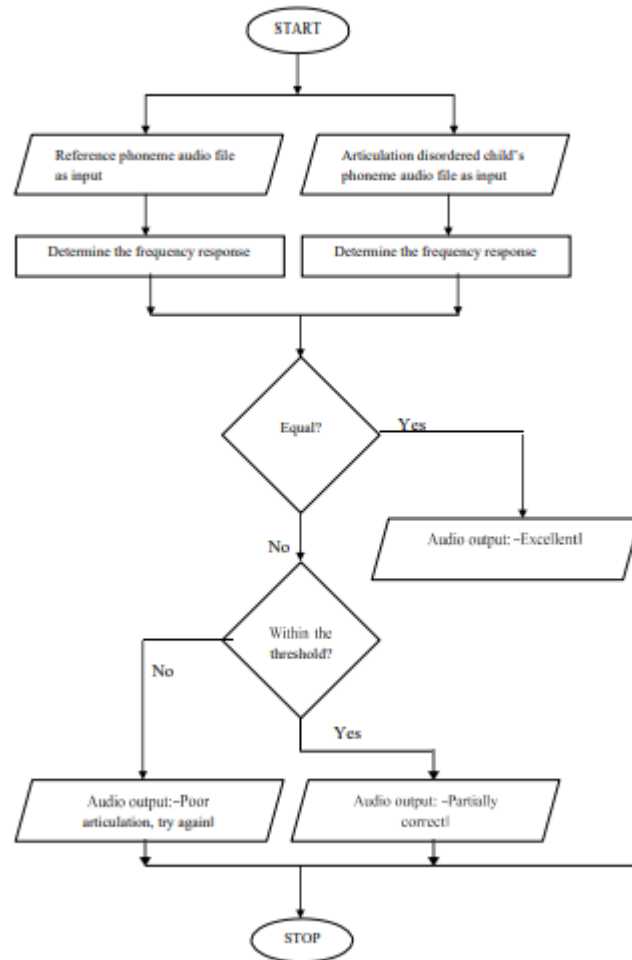
Based on the comparison results the instructions are provided using which the therapist can guide the child to correct the articulation if correction is necessary. The conditions and their respective output are: If the frequency response of phoneme articulated by child with articulation disorder is equal to the reference phoneme, then audio output: Excellent is given. If not equal, then one more condition is applied, which checks whether the frequency response of the articulation disordered child is within the range. If it is within the range then audio output: Partially correctis given else audio output: Poor articulation, try again is given.

IV ADVANTAGES

• Improved articulation quality assessment is provided as the tools used for extraction of sample and analysis of articulation is PRAAT and MATLAB respectively.

• These tools plays vital role in the field of speech processing compared to other such tools in the field.

• User friendly tool for therapist. Because better instructions are given, using which the therapist can guide the children to correct their articulation.

• Improvement in the ability to understand the guidelines by the children. Because of visual cues.

• Gives the better microphone selection strategy based on the frequency response characteristic. So this can be used in future developments

V APPLICATIONS

• Augmentative assistive communication device which helps the therapist to guide articulation disordered kids.

• Clinical therapy systems.

• Articulation assessment systems in schools.

VI RESULTS AND CONCLUSION

Results

The proposed idea was to determining suitable microphone for recording different phonemes by analyzing microphone characteristics. Comparing the recorded speech from children suffering from articulation disorder with the reference, then necessary instructions will be given to correct on their articulation by therapist.

Conclusion

As the proposed idea was to determine suitable microphone for recording different phonemes, SLM is selected as the best suitable microphone. It is because of its better frequency response, good sound quality and less noise. One can also choose headset for their work as it is cost effective compared to SLM. One more objective of our work was to compare the recorded speech from children suffering from articulation disorder with the normal. On comparison the necessary instructions will be given to correct the articulation. The audio output along with the message box is used to instruct the children and this helps the therapist by making their job easier. Thus the results satisfied the objectives of our work. This work will be helpful for the researcher in choosing the right microphone for recording and further studies. It can be used as a therapeutic tool by providing visual cues that helps in getting attention of the child while giving therapy. It provides improved articulation quality assessment. Since the tools used for extraction of sample and analysis of articulation are PRAAT and MATLAB respectively. It also helps to store data in the system that can be used in further case study. Hence it is a user friendly tool for therapists.

REFERENCES

[1] Ambra Neri, Catia Cucchiarini and Helmer Strik,―Feedback in computer assisted pronunciation training: technology push or demand pull?‖, A2RT, Dept. of Language and Speech, University of Nijmegen, The Netherlands {A. Neri, C. Cucchiarini, H. Strik}.

[2] Ikuyo Masuda-Kats use―Support system for pronunciation instruction and practice in special education classes for language-disabled children‖, Speech Communication: Paper 5pSCb37, 172nd Meeting of the Acoustical Society of America, Honolulu, Hawaii 28 November - 2 December 2016.

[3] R. Vijayalakshmi and S. Priya, ―An Interactive Speech Therapy Session using Linear Predictive Coding in MATLAB and Arduino‖, 2016 International Conference on Advanced Communication Control and Computing Technologies (ICACCCT), ISBN No.978-1- 4673-9545-8.

[4] Martin Russell, Robert W. Series, Julie L. Wallace, Catherine Brown and Adrian Skilling, ―the star system: an interactive pronunciation tutor for young children‖ computer speech and Language (2000) 14, 161–175 Article No. 10.1006/csla.2000.0139.

[5] Heather Campbell & Tara McAllister Byun, ―Deriving individual /r/ targets from the acoustics of children's non-rhotic vowels‖, Clinical Linguistics & Phonetics, DOI:10.1080/02699206.2017.1330898.

[6] Khaled Tawfik, ―Towards The Development of Computer Aided Speech Therapy Tool in Arabic Language Using Artificial Intelligence‖, Department of Computing & Information Systems, Cardiff School of Management, Cardiff Metropolitan University, April 2016.

[7] Hung-Yu Su, Chun-Hsien Wu and Pei-Jen Tsai, ―Automatic Assessment of articulation disorders using Confident Unit-Based Model Adaptation‖,1-4244-1484- 9/08/$25.00©2008 IEEE, ICASSP 2008.

[8] Yeou-Jiunn Chen, Jing- Wei Huang, Hui-Mei Yang, Yi-Hui Lin and Jiunn-Liang W―Development of Articulation Assessment and training system with Speech Recognition and Articulation training strategies selection‖, 1-4244-0728-1/07/$20.00 ©2007 IEEE, ICASSP 2007.

[9] Yeou-Jiunn Chen, Chung-Hsien Wu, Jiunn-Liang Wu, Hui-Mei Yang, Chih-Chang Chen and Shan-Shan Ju, ―An Articulation Training System with Intelligent Interface and Multimode Feedbacks to Articulation Disorders‖, 2009 International Conference on Asian Languages Processing, 978-0-7695-3904-1/09 $26.00 © 2009 IEEE DOI 10.1109/IALP.2009.1

[10] Zhou X, Boyce SE, et al, ―A magnetic resonance imaging-based articulatory and acoustic study of retroflex and ―bunched‖ American English /r/ ‖, JAcoustSoc Am. 2008;23:4466–4481. Y. E-WC.

[11] Jerad Lewis, ―Understanding Microphone Sensitivity‖, Analog Dialogue 46-05 Back Burner, May (2012).

[12] Lawrence R. Rabiner, Ronald W. Schafer, ―MATLAB exercises in support of teaching digital speech processing‖, 2014 IEEE International Conference on Acoustic, Speech and Signal Processing (ICASSP).

[13] Arnab Pramanik, Rajorshee Raha, ―Automatic Speech Recognition using Correlation Analysis‖, 978-4673-4805-8/12/$31.00©2012 IEEE.

[14] Qiang HE, Youwei ZHANG, ―A Speech Recognition and Speech Corpus System Based on Matlab‖, Proceedings of 2001 International Symposium on Intelligent Multimedia, video and Speech Processing, May 24 (2001), Hong Kong.

[15] Bartek Plichta, Best practices in the acquisition, processing, and analysis of acoustic speech signals‖, article 16, Volume 8, Issue 3 Selected Papers from NWAV 30,University of Pennsylvania Working Papers in Linguistics.

[16] Dagmawi Mallie, ―Voice processing using MATLAB as a tool‖, Technology and communication, Vaasan ammattikorkeakoulu VAMK, University ofApplied Sciences, 2014.