

Advanced Machine Learning Techniques To Assist Dyslexic Children For Easy Readability

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Abstract : “Dyslexia” is disorder normally occurred in children. In which they are unable to learn the things easily as like normal children. Such kids are considered as Dyslexic Children. Main objective of this paper is to assist such child for easy readability the paper focuses on reading disability of Hindi words. Children of age five to seven years are considered as target, which are having problem in reading. Here some of the software based techniques and some hardware based techniques are discussed. Total 600 sounds of Hindi two letters and three letters words are taken as an input. These audios are trained by using Dynamic Time wrapping algorithm. Their results are compared. After training whenever this system will be used as assistive system for dyslexic children. They should be easily read and recognize the word.

Keywords: K Nearest Neighbour, Dyslexia, Hidden Markov Model, K-Means, Dynamic Time Wrapping

1 INTRODUCTION:

“Dyslexia” word is used for learning disability in children. Children who are having dyslexia are normally facing difficulties in Reading, Speaking, Writing, recognizing alphabets and also other difficulties. Dyslexia is not disease. It’s a disorder with which person is born. Most of the time it runs in families. Main difficulty in dyslexia is difficulty in recognising phoneme. Most common issue with these children are they are having trouble in blending several sounds to make a word. These children cannot recognize common words as well. There are normally some issues children are facing. ADHD (Attention Deficit Hyperactivity Disorder) -Children with this disorder are facing problem in reading and other activities. In Executive functioning issue affects the functions like organization, thinking and working memory. Slow processing issue affects reading performance of kid .In this, children are facing difficulties in basic reading skills and getting meaning of it. APD (Auditory Processing Disorder)-It affects the child’s ability to sort through sounds he hears. Child faces the trouble in recognising difference between letters sounds. In visual Processing issue, children are complaining about blurry vision. They often reverse the letters while writing and facing difficulties to stay within lines. Dysgraphia is one of the issues which normally affect ability to spell, ability to form letters and numbers. Dyscalculia makes difficulties in mathematics. In Executive functioning issues which normally affects different areas of learning executive functions contains organizations, thinking and working memory. Slow processing speed is also one of the type which mostly affects reading performance of child. Children are facing difficulties in basic reading skills and getting meaning of it. The paper is focusing on reading disorder which occurs in dyslexic child. Children having dyslexia are in trouble to decode the words. Reading is nothing but ability to match sound with letters and then use that skill to read accurately and fluently. The paper focussing on dyslexic children having age between five to seven years.

2 PREVIOUS TECHNIQUES

There are number of techniques are designed for helping dyslexic children. Some of them are software based, some are hardware based. Both are discussed below

2.1 Software based techniques:

A. Assistive technology of reading inventions for children with reading impairment with one year follow-up [29]

Method: 35 children of aged between 10 to 12 years are participants. Here five minutes reading test is taken. Here data received from examination was analysed by content analysis. Also children are examined by sentence chain test, last non word, word reading test and which picture is correct test. For all these tests some application are used like prizmo program which capture text and reads loudly. Also TTS, Easy writer, Voice reader are used in this method. Two games are also developed like word puzzle; guess the word from few letters.

Drawback: Here to many applications are used which leads training less structured and sequential. Also traditional pedagogical instrument is used for examining reading test. Questionaries’ are not equipped as per described phenomenon

Solution: Reading concept is extended as gaming information not decoding words.

B. Using Gamification to motivate students with dyslexia [30]

Method: Class dojo is a platform in which teachers checks behaviour of child. Two main components are there first is awarding badges. Badges are either positive or negative depending on concentration, coping, handwriting, reading, independent work, self-confidence. Second one is reporting system which keeps records of awarded badges

Advantages: Here number of opportunities is there using gamification. Second one suggest exploratory approaches

Drawback: Its again traditional and time consuming method to assign badges

C. A multimedia English learning system using HMM to improve Phonetic awareness [31]

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Method: Here adaptive clustering algorithm is used. Goal is to reduce phone recognition time complexity and recognition rate. Here phonemes are classified into clusters. During phoneme recognition algorithm first recognize which cluster is belongs to and then input phoneme is recognize by involving all HMM in specifies clusters. Let $s_1, s_2, s_3, \dots, s_n$ are set of training patterns. Then feature extraction is done from those patterns. By using K means find out cluster of phoneme. Phoneme is recognised by HMM.

Workflow: Teachers records native speakers' pronunciation in database. Students press play key and start pronouncing words loudly. Systems are compared and factors like sound, tempo, volume, pronunciation. System gives results from that it is found out that pronunciation is poor or better.

Advantages: It promotes phonetic ability of student. Error correction

Future: It can be applied to learning environment Asynchronous learning and students can.

D. "Dyslexia baca" mobile app - The learning ecosystem for dyslexic children [32]

Method: This tool is used for the students who are having problem in recognising letters like 'p', 'q', 'b', 'd', 'm' and 'w' in Malay language .It contains method by using balloons to get students attention and clap after success.IT run on mobile with multisensory approach. It includes identifying and memorizing alphabate.

Drawback: It provides feedback from expert not to dyslexic students

E. Digital Notebook [34]

Method: Here it introduces formation of letters and sound. If children is writing correct letter then star will be given to that children. If children is writing wrong letter then, app will activate touch screen for exercise. Here handwritten recognition algorithm is used like KNN, NN to classify correct recognition and incorrect recognition.

Drawback: This tool is developed for only children having writing difficulties.

Future: In future, it can be used for children having reading difficulties. In which letters can be recognized by children by reading. Correct and incorrect classes will be done by KNN, NN

F. IASD: Integrated Assistive system for Dyslexia [35]

Method: This tool is developed for improving English language, phonological awareness, reading, and writing. Here, three approaches are used one is reading letter of alphabet, copying letter and read a paragraph loudly for two weeks. For this HMM techniques combined with game middleware for visualization of alphabet.

Advantage: More than 60% improvement is done on literacy of dyslexic child.

Disadvantage: Its time consuming learning and Need to implement complex HMM

F. Integrative Assistive System for Dyslexic Learners Using Hidden Markov.[36]

Method: This technique is developed for Aerobic language. It uses automatic speech recognition by using HMM. It helps children of age between 5 years to 10 years. Letters are introduced to children with correct writing style. By clicking on microphone icon children are recording their diction.t displays correct message or it asks to repeat for incorrect.

Drawback: This paper don not discuss any issues while using this app

Future: Success rate must be calculated after learning.

G. Automatic Detection of Off-Task Behaviors in Intelligent Tutoring Systems with Machine Learning Techniques [38]

This technique will automatically detects off tasks like irrelevant to learning, talking. Here LS(Least Square)machine learning algorithm is used to predict off task behaviour. Here 34 off tasks are found out. It contains tutoring software with animation and audio.

Drawback: Improving rate of children is less

H. The iLearn RW Game: Support for Students with Dyslexia in Class and at Home. In Games and Virtual Worlds for Serious Applications [38]

Method: This technique is used to resolve cognitive and behaviour difficulties .This technique is used for reading and writing. Gaming approach with interesting character. Game playing helps to visualize knowledge and improves performance. Nine different exercises like word segmentation, sentence completion are there. Here lesson planner is used to generate activities that children already know by using Machine learning and crowd sourcing.

Drawback: Effectiveness and model are not evaluated.

Future: Learning speed can be and rate of learning must be evaluated

I. Mobile Application to Support Dyslexia Diagnostic and Reading Practice [41]

Method: It consist of three stages

Phase 1: Identifying predictors, here features are classified by using decision tree.

Phase 2: Building Lexa: The application was created using the bootstrap framework, incorporating HTML, CSS, and Javascript. The application is not a replacement for the current tests to determine dyslexia. The application will be for the use of parents who fear their child is at-risk of developing dyslexia. It contains two tests Rise test, the child can hover over the animals to hear them play different tones. Then the child must click on the animal that makes the sound that appears to be going louder and then quieter. The results of their selection will be recorded. Then oddity test, On this page, the child can hover over each of the buttons, and the word will be read to them. Then the child must click

on the button containing the word that does not rhyme. The results of which button they choose will be recorded.

Drawback: The biggest challenge faced in the development of the prototype application was the creation of the sound.

Solution: To assess lexicon on cloud to be assessed by mobile devices.

J. Mobile Application to Support Dyslexia Diagnostic and Reading Practice [41]

Method: Here, some tests are taken. Assertive test: It finds number of failures in word recognition, Test of interference: It finds interference of environment, Test with dyslexic children, Usability test: It finds easiness, reliability, overview of tool.

Advantage: Here false positive is found out and overall reliability is improved.

Disadvantage: It must be assessed and monitored after relevant period time. Some of the Hardware based techniques are also discussed in the paper as given below.

K. A novel approach for lip Reading based on neural network [40]

Method: Recognition of spoken word on the basis of lip pattern. Here USB Camera is used for capturing video of person while speaking under frame rate distance from centre, lights, and frame per word. Here for classification of positive and negative samples haar cascade is used. Then intensity equalization is done by using value of pixel and lip boundaries. Next step is key point extraction is done p1,p2,p3,p4,p5. Where p1 is left corner point of lip, p2 is right corner point, p3 is middle point, p4 is upper middle point, p5 is lower middle point. Then edge tracking is done for matching lip movements with database. For word identification neural network is used

Advantages: Here key point recognition is automatic. Here neither frame tracking nor inter frame tracking is required. It's very important step in lip reading for practical application. Neural network leads to better performance due to handling large data, high speed also minimizes quantization errors

Drawback: At the stage of intensity equalization because of unbalance lightning, uneven illumination. A non-uniform intensity distribution is there

Solution: Here LVQ NN can be used to minimize quantization error

L DyslexML screening tool for dyslexia using machine learning [40]

Method: Here Children from native Greece and 32 children having learning and reading difficulties, which are diagnose as dyslexic by government agencies. Here large set of features are considered based on statistical properties. For classification native bays, SVM are used and performance is measure with mean, median saccade length, No of short and forward movement, No of fixation to screen. Two paragraphs are given to read. First is difficult and second is simpler. From these SVM, Native bayes and K means are used to

find performance of children. No of fixation to the screen is calculated. If distance between two fixation is more (900 pixel) then there is less deficiency and if its less (100 pixel) then that child is having more deficiency. Here SVM is giving 97 % performance.

Advantage:

Here parameters used are not only direct eye tracking parameters but also gives relation between word properties

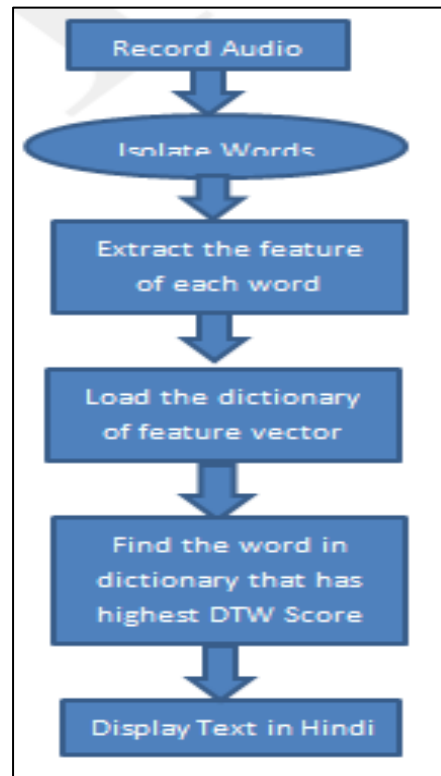
Challenges: DyslexML uses smaller feature set

Solution: Basics are set for developing screening tool that can reach larger population Comparative analysis of some techniques are shown in table given below

Table 2.1: Comparative Analysis

SR. NO	Paper Title	Technique	Advantage	Drawbacks
1	A Review: Translation of Text to Speech Conversion for Hindi Language [15]	Dataset is collected from Hindi to English dictionary. Speech recording by using PRATT software Mapping of word to Unicode and decimal equivalent 1540 Words	Efficient and effective, Produces natural speech	This paper gives TTS conversion for Hindi language only
2.	Marathi Text to Speech Synthesis [14]	Database Creation TEXT Processing Audio Processing	This system will give any Marathi word as a speech output	This paper gives TTS conversion for Marathi language only
3.	HINDI PDF TO SPEECH [13]	PDF data is taken as an input in Hindi language PDF may contain Hindi text written in English characters or Hindi text in devnagri	Lengthy process for getting input text	This paper gives TTS conversion for Hindi language only
4.	Development and Implementation of Hindi TTS [12]	1.Text analysis 2.Database Creation 3.Selection of Speech Unit	Audio and text database is stored in same file. So no need to take two different files as input.	This paper does not give mapping of devnagri script to English
5.	Design and Implementation of Konkani Text to Speech Generation System using OCR Technique [11]	Image acquisition, Image Reading, Convert into gray scale, Image Filtering, Count no of components of image, Extract text and resize letter. Write into text file Apply TTS	Input text is taken in the form of image. Therefore, it's lengthy process of TTS	This paper is useful only speech recognition for Konkani language
6.	A novel approach for lip Reading based on neural	1.Video acquisition 2.Face and mouth detection 3.Intensity equalization 4.Feature Extraction	Word identification is done by using neural network resulting in	This paper gives TTS system for Hindi language

	network	by using lip key points 5.Geometric feature extraction 6.Word id	better performance and high speed	
7.	Hidden Markov Model based Speech Synthesis	Text Analysis: Normalization of text, Phonetic Analysis, Prosodic Analysis, Speech Synthesis	It can synthesize speech with various voice characteristics such as speaker individualities, speaking styles, and emotions.	synthesis quality is intelligible but nowhere close to natural speech



3 PROTOTYPE MODEL:

Here total 30 audios are taken as input which are spoken by 20 different people. Therefore, our dataset contain total 200 words. Feature extraction from audio signals is done by MFCC and DTW algorithm finds DTW our best score.

A MFCC: Mel Frequency Cepstral Coefficients: Here energy of speech signal is increased to high frequency. The signal is segmented in to small fragments called as frames. Then frames are multiplies with hamming window to keep continuity in signal. Fast Fourier transform is used to convert time domain of signal into frequency domain. Discrete Cosine Transform is used to model features

B Dynamic Time Warping (DTW): This technique is normally used for measuring similarity between two sequences that may different in time or speed. As like, similarities in walking patterns would be detected. Suppose, in one video person is walking slowly and in other video same person is walking quickly. DTW can be used to get similarity. DTW has been used for multimedia, sounds, and graphics, any data that can be turned into a linear representation can be analysed with Dynamic Time Wrapping. A well-known application has been automatic speech recognition, to cope with different speeds of speaking. Generally, it is a method that allows a computer to get an optimal match between two given time series. With certain restrictions. That is, the sequences are "warped" non-linearly to match each other. Below figure shows flow of algorithm by using DTW technique.

Steps of DTW Algorithm:

1. Record audio using microphone
2. Training
 - a. Extract features(MFCC) from recorded samples
 - b. Create Dictionary of feature vectors
3. Operation
 - a. Isolate words from recorded audio
 - b. Extract features for each word
 - c. Load Dictionary of feature vectors
 - d. Find word in dictionary that has best dtw score
 - e. Display word with best score in Devanagari Script

```

File Edit View Bookmarks Settings Help
jigneshj@:~/FYP/codes$ python main.py dictionary2 tand2t1.wav
>> START_FRAME END_FRAME LENGTH_IN_SECONDS
>> 0 137 1380
>> 176 252 770
>> 322 393 720
>> 461 519 590
>> 583 667 850
>> 741 812 720
>> 874 945 720
>> 1022 1083 620
>> 1148 1232 850
>> 1301 1373 730
querying 10 words
शुद्धी का रस है शुद्धी का रस शुद्धी का रस शुद्धी का रस
jigneshj@:~/FYP/codes$
    
```

Figure 3.1: Output of DTW Algorithm

Our training dataset contains of 3 directories of words containing 10 words in each directory. Each word is spoken 5 times by 4 different people, thus there are 20 different samples for each word.

Table 3.1: Directory 1 Dataset and Results

Type of Sound	Number of Sounds	Correct Recognition	Accuracy
Known Audio	30	30	100%
Unknown Audio & Known Use	30	21	70%
Unknown user	20	5	22.2%

Table 3.2 : Directory 2 Dataset and Results

Type of Sound	Number of Sounds	Correct Recognition	Accuracy
Known Audio	30	30	100%
Unknown Audio & Known Use	30	22	73.33%
Unknown user	20	6	30%

Table 3.3 : Directory 3 Dataset and Results

Type of Sound	Number of Sounds	Correct Recognition	Accuracy
Known Audio	30	29	96.33%
Unknown Audio & Known Use	30	19	63.33%
Unknown user	20	4	22%

4 CONCLUSIONS:

Hence, Paper focuses on review of software, hardware tools to assist dyslexic children. Also machine learning algorithms used like K Means, K nearest neighbour, Adaptive clustering, LS Algorithm, Support vector machine, Human Markov Model. Normally machine learning algorithms are used for extracting features of speech and finding out accuracy and performance improvement in children. Therefore, work will be focussing on children of having age between five to seven years who are having problem to read Hindi language words. Machine learning algorithms will be applied design technique to assist dyslexic children. Here two and three letters Hindi words are taken as a input to train the system by using dynamic Time Wrapping algorithm.

Once the system got trained with the words. Dyslexic child will be given word to read. If child speak wrong word first time, he/she will be given another chance to read. If same thing is repeated three times then System will speak out the word along with some picture will get display, so that child will get to know that word..The word spoken by child. In this way same session will be repeated for 20 minutes for child for different words. Here speech recognition technique of machine learning will be used to recognize. Here Dynamic Time Wrapping technique gives around 90% to 100%, if system is tested with same user and 30% accuracy, if system is tested with new user

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