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Review: Mass Screening framework for children with dyslexia using IOT and computing analysis

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Abstract

Dyslexia is a medical disorder due to which children have difficulties in learning and reproducing the learnt concepts. In this context children are mostly considered to be not interested or negligent towards their studies. According to dyslexia association of India 10-15 % of children enrolled in schools suffer from some type of Dyslexia. Awareness on Learning difficulties and detection is a complicated. As detection of LD requires diverse features it requires proper guidance and intervention . The issues with explicit learning difficulties in kids have been a reason for worry to parents and educators.
Its challenging for the teachers and educationalists to differentiate students with LD and other students. This paper mainly analysis of the paper titled "Diagnosis of Dyslexia using Computing Analysis", Electroencephalogram (EEG) as a tool is used for understanding of brain process and related functions, Number of factors related to Dyslexia and "Power spectral density" is extracted using Gibson test for brain skills. And to identify differences in brain processing using EEG Technology in kids with dyslexia and non-dyslexic. Data sets are generated classifying Dyslexic and non dyslexic and were analysed using the K-means, Fuzzy and ANN classifiers. then the results obtained from these classifiers differentiate between the three different groups (dyslexic, non-dyslexic and disordered).
And the next paper "Spatial Blockchain-based Secure Mass Screening Framework for Children with Dyslexia", this paper was mainly focused in detection of symptoms of dyslexia at an age of 8-11 years, so that children can be assisted with various assisting tools and take technologic support so that children can take part in regular schools. This paper is based on Mobile Edge Computing, cloud computing.

Keywords: Dyslexia, Mobile Edge Computing, cloud computing, K-Means, ANN, Fuzzy logic, Electroencephalogram, Gibson test, Power spectral density.

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1. Introduction

Early diagnosis of Dyslexia is challenging, but it can help in addressing it with various assistive methods. Early diagnosis reduce stress and anxiety in children and also can help in getting exemption with foreign language etc[1]. In this paper two different papers on early diagnosis of dyslexia are reviewed. Both papers use different technologies for mass screening for dyslexia.

2. Literature review #1

Hassanin M. Al-Barhamtoshy[2] proposed framework for diagnosing Dyslexia using computing analysis techniques. Gibson test was used as an initial cognitive skill testing tool for determining the students with dyslexia[3] [4]. The severity or intensity of difficulty in learning may differ from

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one child to the other, such as problems in differentiating left to right, confusion with homophones and following set of sequential instructions[5], so Electroencephalography EEG is used to monitor the brain activity using metal electrodes and collecting signals that are compared with fMRI Functional Magnetic Resonance Imaging. The EEG signals collected then classified in to delta (δ), theta (θ), alpha (α), beta (β) and gamma (γ) bands the following table lists the frequencies

Table 1. EEG Bands and Description[5]

Bands Type	Frequency Ranges	Bands Description
Delta (δ)	0-4 Hz	Recognizing individuality during deep sleep phases.
Theta (θ)	5-7 Hz	Enhancing through sleep mode.
Alpha (α)	8-13 Hz	Performing through restlessness, in relaxation and mind inactivity conditions.
Beta (β)	14-30 Hz	Distinguishing when the mind is alert.
Gamma (γ)	36 – 40 Hz	Observing when the brain responds to specific things, or does complex tasks.

Gibson's test is used for testing brain skills like cognitive, motor skills, math, memory abilities, And EEG is used in understanding brain process and related functions and "Power spectral density" is used to extract features to recognize differences in brain EEG processing in kids with dyslexia [6] Seven key areas are considered for the matrices they are.

1. Speech and listening Metrics.
2. Metrics related to language processing like reading, spellings, vision.
3. Metrics on writing speed and quality of writing
4. Metrics on arithmetic ability, and managing time.
5. Cognitive abilities and memory metrics.
6. Personality, Behaviour, health and development Metrics
7. Metrics on other general characteristic .

80 children (40 boys and 40 girls)records of 7 to 13 age, were considered, which was analysed and proposed a computerized analytical model which included computing system, with dataset that differentiates into "non dyslexic(Normal)", or "Dyslexic", or ADHD or inattention etc". The proposed model uses 3 machine learning algorithms. For classification, they are K-means, ANN, and Fuzzy classifiers. Fig 1: The proposed architecture is

Figure 1: The proposed architecture is:

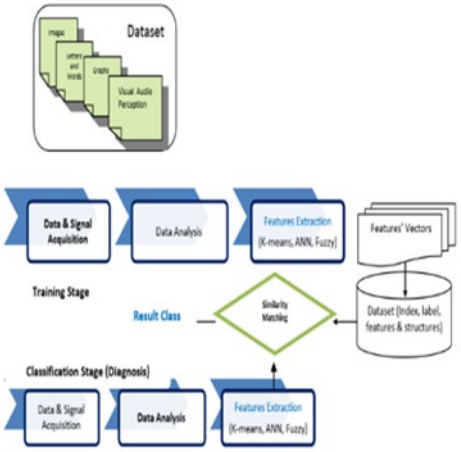


Fig.1 Hassanin M. Al-Barhamtoshy 's "Architecture using meta classifiers(K-means,ANN,Fuzzy)" [1]

2.1. Accuracy of the classification and automation

Out of 80 records by optimal filtering of data set, 13 records were non-dyslexic or healthy, 62 were positive that is dyslexic, and five overages of the sample. The correlation between each other of the three categories in the preprocessing stage is as follows.

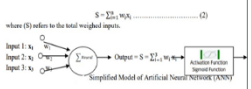
Table 1. Differences of mean and variance values of dyslexic, healthy and overage[2].

	Dyslexic	Healthy	Overage
Mean	33.432	55.197	49.224
Variance	79.806	8.869	110.120

If N is the positive integer represents the no of samples in the matrices then T(N) = k. F(N) for all k>=positive number for T(N) = F(N) {where T(N) is the time execution and F(N) is the insertion function }

The various data sets that were considered were, Healthy/Normal peoples, Dyslexia people, out of age all the three have been classified using ANN, Fuzzy Logic and K-Means. To assess the framework four basic tests were been done they are preprocessing analysis, Data representation, feature vectors extraction and clustering. From the below table gives a comparison of the accuracies of three classifiers K-Means, ANN, Fuzzy classifiers in the domain of Dyslexia diagnosis. The three clustering methods used are

Table 2. Comparison of K means, ANN, Fuzzy logic algorithms.

K-means	ANN	Fuzzy
➢ Data set with Description D and O set of observation centers . ➢ Select the center of clusters C. ➢ compute the distance , assign minimum distance between data item and center clusters. ➢ Recompute the cluster center. $o_i = (1/c_i) \sum_{j=1}^{c_i} d$	➢ The dataset items are feeding to the pre processing module which in turn clusters them into dyslexic group,For each Datum x_i to the weight w_i which distinguishes with other inputs .  ➢ Teaching and training ANN could take very long time that might be hours or even days before coming to an end.	➢ Fuzzy logic based on one supervised classification needs to define classes of indicators in data items fuzzily. ➢ The process of supervised classification using fuzzy logic depends totally on membership function where the process of supervised classification using fuzzy logic takes place in only two steps. ➢ It uses training samples to designate membership function, then, it uses this function to allocate these data items to fuzzy sets which counterpart classes of whole data items.

To evaluate the proposed system four main tests have been experimented such as preprocessing analysis, data representation feature vectors extraction and clustering. The comparison of the accuracy on the data set with respect to dyslexia diagnosis is illustrated below in Table 4

Table 4. Overall Evaluation Accuracy[2]

Metrics Type	Samples	Computing Models		
		K-means	ANN	Fuzzy
Healthy peoples (normal)	13	91.70 %	90.56 %	87.56 %
Dyslexic peoples	62	92.75 %	91.89 %	89.38 %
Outages	5	85.43 %	86.55 %	80.28 %
Total/Average	80	89.62 %	89.66 %	85.74 %

From the above tables it is evident the process of diagnosis is accurate up to 96% on an average with the three classifiers. The data set generated using multidisciplinary fields such as natural language processing ,eye traking , human computer interaction, linguistics, cognitive neuroscience is used to extract the features using different classifiers (K-means, ANN, or Fuzzy).

Table 5: *Comparison between the nine dyslexia indicators with respect to the three used classifiers.* [2][4][7].

Metrics Type	Samples	Computing Model		
		Average	STD	VAR
Processing speed (PS)	80	18.44	6.126	37.53
Working Memory (WM)	80	8.19	3.175	10.08
Auditory Memory (AM)	80	4.88	2.727	7.435
Visual Memory (VM)	80	5.67	2.16	4.68
Long term memory (LTM)	80	4.53	2.23	4.996
Visual perception (VP)	80	20.51	9.16	83.95
Auditing perception (AP)	80	11.47	5.24	27.43
Logic Resonance (LR)	80	5.59	2.20	4.86
Word Attack (WA)	80	11.39	5.15	26.52

2.2. Conclusion #1

Compared to other classification algorithms such as SVM [8] the positive prediction that is children with Dyslexia prediction was lower than predicting non-dyslexic children. In other words SVM was more accurate in detecting non-dyslexic children. In this above proposed model the accuracy is up to 96%. K- means computing model has shown better accuracy. One of the main draw backs of this model is the data set acquiring, which involved Not only Gibson's test but also EEG, where child has to go through medical intervention.

3. Literature review #2

"Spatial Blockchain-based Secure Mass Screening Framework for Children with Dyslexia " [9] gives a frame work to provide screening tests that are mostly independent of language which provides series of test that can be conducted by mobile edge computing and using IOT regarding the child's dyslexic interaction and their activity[10], [11]. It has given an insight on the method for processing the data in a secured manner.

The MEC layer is used to generate analytical metrics which are accurate and relevant that can be used concern teachers, doctors and policy-makers to guide them towards better assistance.

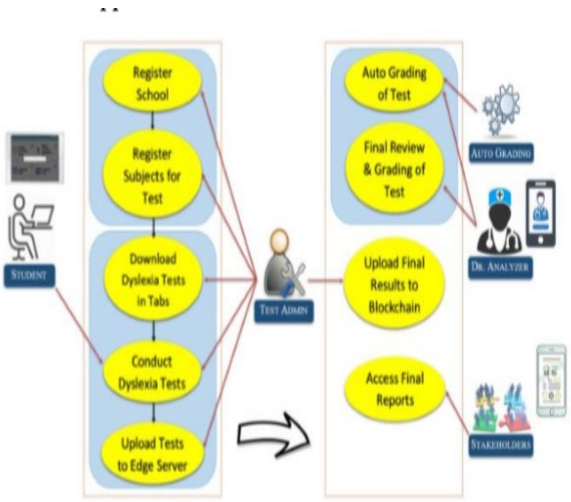


Figure 2. System design overview

1. The administrator registers the school and sets up environment for the IOT devices. After which the student can be registered then students takes the test from the Mobile / tablet.
2, The results are sent to backend intelligence over MEC/cloud/Internet from the client system which might be a tablet .
3. At the backend data analysis is done using auto-grading services.
4.Through a secure block chain process, special educators, experts, Phycologists analyse and propose final review. The final reports are then policy parents, educators or handlers and stakeholders. As per the authors the process is in two phases as depicted below.

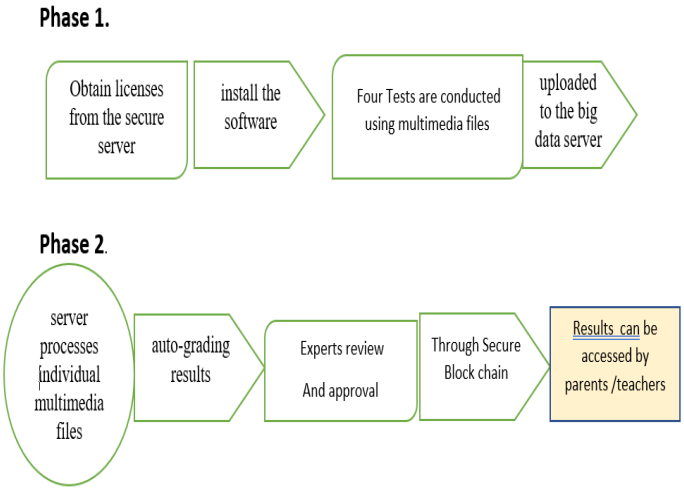


Figure 3. Various steps in generating results for LD detection

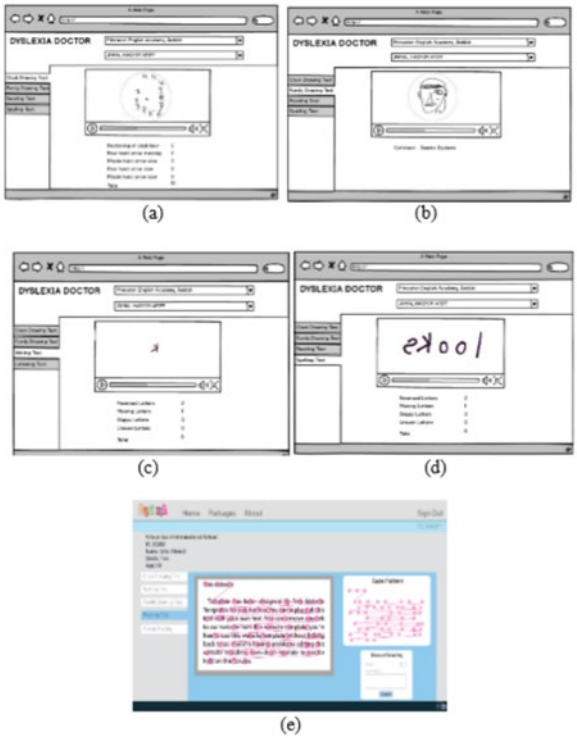
This paper mainly focuses on mass screening of dyslexia using Different clinically approved test modules which have been developed and tested by medical doctors who treat dyslexic patients[12].

Using Auto grading algorithms aided with mobile health framework recommend the classification of dyslexic subjects[13]. Once the tests, results are obtained from the diagnosis data, they are shared securely with mobile medical practitioners around the globe using Blockchain technology[14], to store test results to make them immutable and securely shareable with a various stakeholders.[15]

AUTO GRADING METRICS

Name of the Test	Name of Extracted Feature	No. of Test Instances	No. of Correctly Recognized Instances
Clock drawing	Positioning of Clock Hour	200	189
	Hour Hand arrow marking		187
	Minute Hand arrow size		182
	Hour Hand arrow size		178
	Minute Hand arrow size		181
Family drawing	Pupil and iris		165
	Eye brow present		175
	Forehead and hair		191
	Lips, nostril, chin, mouth and jaw		156
Writing/ Reading /Spelling	Reversed letters		191
	Missing letters		197
	Sloppy letters		183
	Uneven letters		188

Mobile



3.1 Conclusion #2

In this model the acquired data is processed and the finding are securely shared with the medical practitioners and the stake holders for further analysis.
This does not involve in prediction or diagnosis .

4. Drawbacks/Concerns

The above two methods of mass screening of dyslexia using medical tests (EEG) or Gibson's test or as in the next case a tab or MEC which uses mobile healthcare framework with multimedia Internet of Things (IoT) based environment, which captures multimodal user interaction data during dyslexia testing and share it via a mobile edge network, needs child's intervention and a series of tests . Which are similar to traditional intervention.

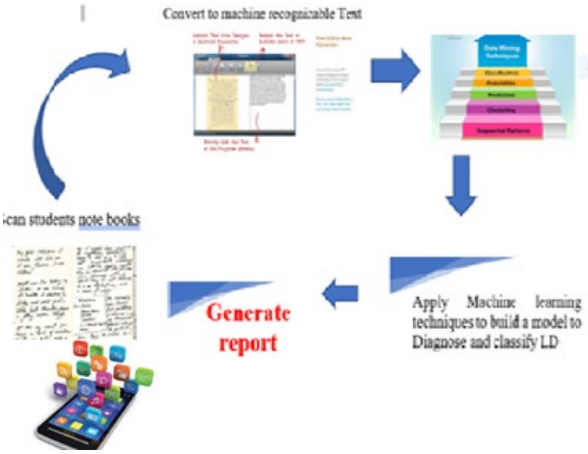
When parents or teachers observes a child with difficulties with studies. Child is suggested to undergo formal evaluation. Based on the parents request or school's recommendation for evaluation of difficulty in learning. With child parents' consent and based on the child's age, area of difficulty faced various tests the child needs to take. These tests are done to exactly determine the problem. All children facing difficulties may not be able to afford the testing and may lead to physiological stress on children.

Summarising the gist of the difference between the above both methods of mass screen are:

Paper 1	**Paper 2**
Diagnosis of dyslexia for age group 7 to 18 Years.	Mass screening of dyslexia .
Medical intervention or initial assessment using EEG and Gibson test	Initial assessment tests are taken using mobile or tablet using multimedia files .
Tests are conducted for nine different areas	Tests are conducted for three broad areas
The tests results are analysed using the classifiers K-means ,ANN, Fuzzy	The results of the tests are analysed using the K-means ,ANN, Fuzzy and the test results are sent to the stake holders using secure block chain technology.
Child under goes the medical tests directly.	Child goes through a set of multimedia based mobile tests .

5. Proposed model

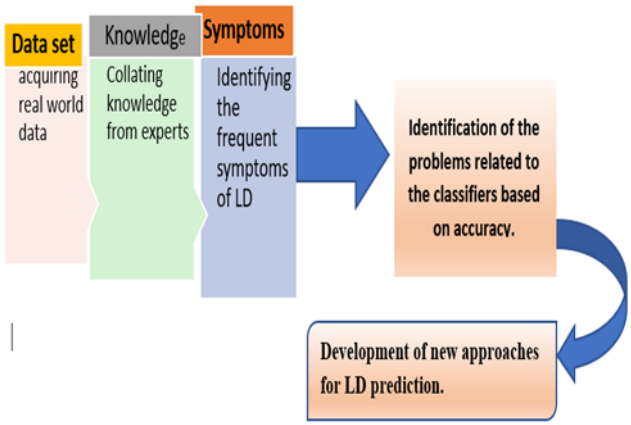
The processes of the assessment starts only with the intervention of psychologist to do assessment tests. Instead, to diagnose dyslexia or dyscalculia at early stages can start by analysing their writing and few mobile testing. So considering above two methods and combining the techniques, such as designing cognitive test which can be done on smart phones/ mobiles using MEC, scanning the students books. Then use the prediction model prescribed in [2] [16] [17]to have a system in schools that can predict dyslexia, and further based on the level it can be treated. The proposed system is Automated Prediction of dyslexia, Dyscalculia, Dysgraphia[18] in School going of age group 6 to 10 years using supervised machine learning Algorithm. Diagnosing Learning Difficulties with respect reading, writing, spellings, language processing in School going children [5] using supervised machine learning algorithm.



5. Contribution

- To determine the relevant parameters of LD using text mining along with pattern matching and using MEC.
- To determining the significance of each symptom of LD and identify their relationships between the symptoms
- To study existing machine learning algorithms, and to develop a new method for improving the accuracy of classifiers.
- To develop new model or to modify techniques to build new machine learning model Which involves building the model on training data. Then to test it with existing results based on the testing data.

Methodology to be incorporated



6. Conclusion

Both the above methods basically involves child intervention either medical or mobile tests. But it is not essential in most of the cases for the children to undergo the tests . An early diagnosis and support could yield good results. To develop a system which can do a preliminary diagnosis on Dyslexia, dyscalculia , and dysgraphia and generate a report without intervention of psychologists/psychiatrists or any medical. Which can be done at school level without the knowledge of the child. Which can help parents and children with Minimal learning difficulties and get the required help.

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