SMART EDUCATIONAL TOOL FOR IDENTIFICATION, REDUCING THE IMPACT OF ADHD AND SKILL ENHANCEMENT IN PRIMARY SCHOOL STUDENTS

Project ID: 24-25J-325

Individual Project Proposal Report

IT number – IT21186424

Student Name - N.G.S.S.M Bandara

BSc. (Hons) in Information Technology Specializing in Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

August 2024

SMART EDUCATIONAL TOOL FOR IDENTIFICATION, REDUCING THE IMPACT OF ADHD AND SKILL ENHANCEMENT IN PRIMARY SCHOOL STUDENTS

Project ID: 24-25J-325

Individual Project Proposal Report

IT number – IT21186424

Student Name - N.G.S.S.M Bandara

Supervisor: - Ms. Wishalya Tissera

Co Supervisor: - Dr. Dharshana Kasthurirathna

BSc. (Hons) in Information Technology Specializing in Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

DECLARATION OF THE CANDIDATE AND SUPERVISOR

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or Diploma in any other University or institute of higher learning, and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to the Sri Lanka Institute of Information Technology the nonexclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic, or another medium. I retain the right to use this content in whole or part in future works (such as articles or books).

NAME	STUDENT ID	SIGNATURE
N.G.S.S.M Bandara	IT21186424	Shehan.

Name of supervisor: Ms. Wishalya Tissera

Name of co-supervisor: Dr. Dharshana Kasthurirathna

The above candidate has carried out research for the bachelor's degree dissertation under my supervision.

Signature:  Date: 2024.08. 23

Supervisor: Ms. Wishalya Tissera

ABSTRACT

The overall vision of our project is to transform the approach to supporting learners with ADHD in the rapidly growing area of ed-tech. It is our desire to create a mobile application that employs profile machine learning, photo recognition, and real-time analysis to diagnose distinct categories of ADHD and then offer personalized educational assistance. Within the framework of this new job, I am mainly expected to identify ways in which ADHD impacts students' performance and then eliminate it.

I am responsible for interpreting big academic and behavioral data sets through the advanced properties of CNN and RNN. One of the critical components of our collections is numerous records of students' actions, such as not doing their homework, or forgetting objects that they need in class, which are obvious signs of ADHD related issues. These studies help to simplify the process of identification of subtypes, which in turn makes its possible to apply more effective teaching strategies.

In addition to simply recognizing students, I observe their activities in real time, see when they became quiet and alert the teachers. This proactive method ensures that the solutions reached are not only customized to each students' needs, but also by the time the solutions are in place, it is timely as well.

Secondly, I am involved in the development of the AI teachers which are integrated in the application. Being founded on individual learning technologies, those teachers were deliberately built to complement the educational tendencies and the brain-disposing schemes of every learner. As these teachers provide feedback at all times and modify the approaches as they go along, they are a step beyond conventional teaching and quite a step toward what can be termed as innovative, meaningful, and practical education. It is anticipated therefore that our project will bring a huge impact. Their ultimate goal is to create a teaching appliance for kids with ADHD that can be easily produced on a large scale and would assist the child in performing better in school and improve his or her behavior with the help of such approaches as machine learning and user-centered design. Overall, with our project, we may succeed in making a big difference in schools and make choices in academics available to many children a reality.

Key Words- Machine Learning, Behavioral Analysis, Real-time Data Analytics, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Personalized Learning.

ACKNOWLEDGMENT

Without the constant support of our supervisors, Ms. Wishalya Tissera and Dr. Dharshana Kasthurirathna, Instructor, Sri Lanka Institute of Information Technology, I would not have been able to complete this research. By offering essential comments and helping us through our blunders, they have helped me make my project a success and generate more efficient outcomes. I'd also like to thank our panel members for giving us invaluable advice in helping me comprehend the research's flaws and proposing ways to improve the research's functionality.

I'd also like to express our gratitude to coordinators, the course's comprehensive design and analysis lecturer, for giving us the required assistance throughout this project module enabling me to address the flaws we encountered effectively. Finally, I'd like to express my appreciation to everyone who helped me complete this study, whether directly or indirectly. Your invaluable help and suggestions inspired me to achieve this task.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	Description
ML	Machine Learning
SDLC	System Development Life Cycle
CNN	Convolutional Neural Networks
RNN	Recurrent Neural Networks

1. INTRODUCTION

1.1.Research Background

ADHD is a common childhood behavioral disorder that occurs in 3-5% of children in school going age worldwide. It is generally described as inattention, hyperactivity, and impulsivity and presents many academic and social problems. The learners are usually left out of mainstream education, or they pale out significantly with traditional forms of learning as their needs are not usually understood in public or mainstream education facilities.

Despite these advances, however, there is a critically important role for technologies that can address the diverse nature of the problems associated with ADHD as it is expressed in educational settings. Currently, the strategies mainly cannot meet the demands of responding to changes or even provide differential learning assistance approaching the particularity of students in actual time.

Previous studies have applied machine learning and data analytics to improve learners' outcomes; however, the requirements of students with ADHD have only being partially met. Previous works have incorporated to some extent the behavioral analysis into their designs but, most of the time this component has not been fully integrated as an actively learning system and more importantly has not been developed as a holistic, real-time, mobile solution that can serve as a long-term supportive companion.

Hence the importance of our proposal as a project to contribute to this necessary innovation of an application that uses modern approaches such as machine learning, natural language processing, and real-time behaviors analysis to help therapists with this processes. ADHD subtypes we, and my specific role, involve the collective of these technologies in an effort to diagnose and even fine-tune the potential remedial measures. Based on the rich behavioral and academic data including a variety of ad hoc markers like students' tendency to forget their homework and other necessities at school, our goal is to achieve higher levels of accuracy in ADHD subtype identification. This approach not only brings better specification of interventions but also makes sure that they are timely changed to meet changing student needs.

That is why working on this application, we propose a set of procedures that would allow an educational technology application to adapt complex data analysis methods to

provide students with individual educational support in real time. In positive framework, this project is a way toward having educational equity and inclusion and flourished, transformative tools that turn the students with ADHD educational process into a constructive, enjoyable, productive educational path.

1.2.Literature Review

This paper provides a critical analysis of the current state of education interventions on Attention Deficit Hyperactivity Disorder (ADHD) as well as an evaluation of the possibilities of technology. This kicks off by defining ADHD and noting that it is prevalent in approximately 5-10% of school going children around the world; it also ensues by noting the resultant difficulties that children with the disorder have in schools. Classroom practices do not seem to provide sufficient assistances to meet the multiple needs of these learners, thereby arguing for better solutions.

The review then examines current technologies used in educational settings, including behavior modification instruments and helpful learning appliance. Although these technologies have provided such advantages, they are not very open to modulating themselves in accordance with the cognitive and emotional changes of the students, which could be vital when learning ADHD. Such a gap points to the need to develop sufficiently flexible approaches to learning that will be sensitive to the particular learning styles and will be ready to assist the learner on the spot.

As such, the review will concentrate on the developments that occurred in the past few years, and it will be based on the use of machine-learning algorithms in the context of personalized education-enabling technologies. It also talks about the major advancements that have been made with technologies that use real time data analysis, artificial intelligence and natural language processing to enhance support provision to learners with learning difficulties such as ADHD. However, to date there is still a significant gap in the practical applications that will integrate real-time behavioral analysis with set of personalized interventions designed for ADHD needs.

To address these gaps, the present study aims to develop a new application based on CNN and RNN to perform the structure and feature learning for the comprehensive behavior assessment of ADHD and subtype identification. This endeavour does not just seek to advance accurate diagnosis as well as change the nature of the interventions applied. Through developing an own, changeable, widely-arbitrated mobile platform, this project aims at providing target-oriented educational material and actions that are based on continuous behavioral and academic feedback.

Last but not least, the review posits that the technologically mediated approaches are optimal for enhancing the teaching-learning processes to fit student's with ADHD. As a result, through offering information, which is focused on how to support learners with ADHD, our project is going to significantly influence ideas of educational equity and inclusion, making it possible to enhance learning environments for children who have such disorder.

1.3.Research Gap

Features	**Research A**	**Research A**	**Research A**	**Proposed system**
Identification System	✓	✗	✗	✓
Personalized Learning Activities.	✓	✗	✓	✗
Real time Feedback	✓	✗	✓	✓
Progress Monitoring	✓	✓	✓	✓

1.4. Research Problem

ADHD is one of the most prevalent disorders in school-going children, which has adverse effects in cases of learning ability. The strategies that are used in conventional classrooms and the technologies that have previously been developed are unable to address the current requirements of these students since engagement cannot be improvised or 'custom-built' in real time. This research fills this gap by proposing a mobile application that incorporating higher order thinking and real time behaviour analysis as the basis of the educational assistance provided. Here are main objectives of this project: Promote the overall improvement in the academic achievements of children and their better integration into the educational process, based on such issues as data protection, accuracy of the algorithm, and user-friendliness of the interface.

1.5. Aim and Objectives

1.5.1. Aim

The goal of my function is to create a mobile application that uses a variety of state-of-the-art machine learning novelties to recognize ADHD subtypes and include customizable educational interventions as soon as the subtype is identified. Some objectives are to improve subtype classification algorithms, to apply a feedback system to modify strategies during a learning process, and to increase the possibility of tools' customization by educators and parents. This way, the interventions provided cater to the needs of every struggling learner with ADHD and at the same time are flexible. Furthermore, the project is developed from concepts which are applicable to various formal and informal education contexts and is further refined and improved through the use of data collected as well as through stay collaboration with interested stakeholders to cater for real education needs.

1.5.2. Main Objective

Development to mobile applications which are artificially intelligent and famous for identifying various sorts of ADHD, dictating unique learning approaches for scholars, and monitoring how students are behaving at all times. It is designed to assist students

with ADHD carry out their academic obligations and monitor their behavior enabling tutors and caregivers to fine tune the app to suit the child.

1.5.3. Sub Objectives

1) Subtype Identification: Develop machine learning algorithms to classify ADHD subtypes based on behavioral and academic data.
2) Personalized Learning plan: Create algorithms that generate individualized learning plans to improve academic performance.
3) Behavioral Monitoring: Implement real-time AI tools to track and respond to student behavior and engagement.
4) Develop AI-driven tutors that can be tailored by teachers and parents to meet the specific needs and preferences of individual students with ADHD, ensuring personalized and effective educational support.

2. RESEARCH METHODOLOGY

2.1.Methodology

Individual Component

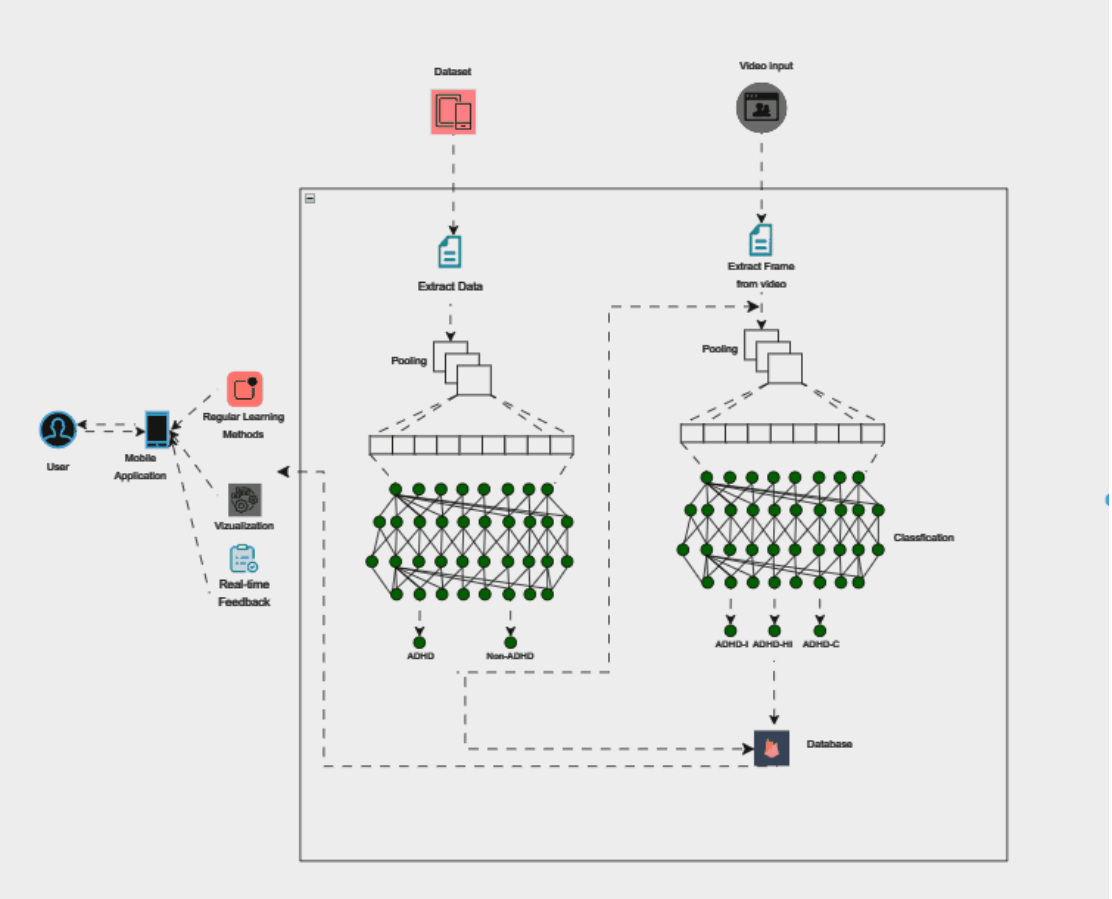

Figure 1

2.2.Research Area

This research is at the intersection of Educational Technology, Machine Learning and Special Education focusing on building computational tools for improved support of students with Attention Deficit Hyperactivity Disorder in education. The project seeks to innovate within educational technology by using machine learning algorithms on real-time data to create adaptive learning environments. These classrooms shift in response to the dynamics that characterize teaching strategies that can improve academic performance and promote social integration among ADHD students. The objective is to create an inclusive education system which responds adequately to

varying needs of disabled learners advancing both technology integration and special education practices.

2.3.Software Architecture of the Research

The SDLC architecture is going to be used for the suggested program. Each step is further broken down into its component parts at this point. At each successive step, testing and implementation will be carried out. Both the software and the hardware will be impacted. This method is broken down into five stages: planning, designing, testing, building, and delivering the finished product. The following is an explanation of each stage of the software development life cycle (SDLC): planning, analysis, design, implementation, and maintenance. Therefore, I decided that this should be the software architecture for this study [1].

- Planning - At this point, we have compiled a list of all the prerequisites necessary to accomplish our objective.
- Analysis - At this stage, both the preliminary analysis and the system analysis are brought to a successful conclusion. In the first step, the problem must be declared, and in the second stage, the problem must be diagnosed, and in the third stage, data must be collected and evaluated. In the first stage, objectives and goals must be studied.
- Design - At this time, the user will be familiar with the insights provided by the work.
- Implementation - Currently, the program is in the process of being created.
- Maintenance - At this point, the performance of the system is being evaluated on a consistent basis to ensure that it will not become outdated.

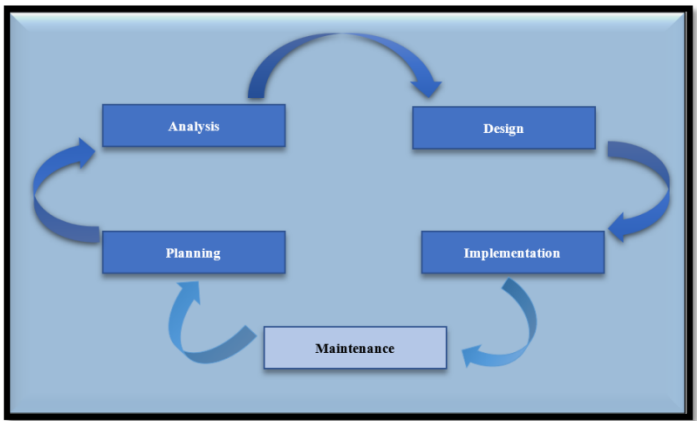

Figure 2. SDLC Methodology Life Cycle

2.4.Requirement Gathering and Analyzing

2.5.Technology and Tool selection

2.5.1. Technologies:

- Python: Python is a powerful programming language popularly used in web development, big data analytics, and machine learning.
- Flutter: High performance and rapid development are amongst the key features of the Google-developed UI toolkit for creating natively compiled mobile and web applications from a single code base.
- Node.js: NodeJS is an event driven, non-blocking, I/O platform that utilizes Google's V8 JavaScript Runtime engine to create lightweight network services that can handle hundreds of concurrent events.
- AWS (Amazon Web Services): This cloud service provider has been leading in providing cloud computing solutions which are both scalable and cost effective.
- TensorFlow: TensorFlow is a robust open-source machine learning library developed by Google to enable efficient creation of machine models.
- SpaCy: Spacy is an industrial-grade natural language processing NLP library built on Cython designed specifically for high throughput text processing tasks.
- JWT (JSON Web Tokens): JWT tokens are essentially JSON objects securely transmitted between parties often used for authentication purposes in web applications.

2.5.2. Tools:

- Visual Studio Code: A flexible code editor with support for numerous languages and tools, suitable for front-end and back-end development.
- Android Studio / Xcode: Integrated development environments used in Android and iOS applications' development specifically required for testing and deploying mobile apps.
- Postman: A tool that helps in the API development and testing making it easy to test and manage backend services.
- Git / GitHub: The version control system, it is also a platform for sharing codes cooperatively, which includes CI/CD capabilities, issue tracking, as well as code review functions.
- TensorBoard: A machine learning model visualization tool that was designed alongside TensorFlow for further analysis purposes.
- AWS Services : Scalable storage capacity available through cloud services accessible on-demand computing power as well as an easily deployable application platform
- Firebase : This is another platform known for building web-apps as well as apps with features of analytics crash reporting among other user engagement indicators.

3. PROJECT REQUIREMENTS

3.1.Functional Requirements and Non-Functional Requirements

3.1.1. Functional Requirements

- The system must accurately classify ADHD subtypes using machine learning algorithms based on behavioral and academic data analysis.
- The application must provide real-time feedback to students and educators based on data collected through continuous monitoring of student activities and behaviors.
- The system must allow educators and parents to customize learning strategies and interventions to meet the specific needs of individual students.
- The application must securely collect, store, and manage user data, ensuring compliance with data protection regulations (such as GDPR for users in the EU).
- The user interface must be intuitive and accessible, designed to accommodate users with various disabilities and ensure ease of use for students, teachers, and parents.
- The system should integrate seamlessly with existing educational platforms and tools used in schools to enhance its utility and adoption.
- The application must be scalable, capable of handling an increasing number of users and data volume without degradation in performance.
- The system must include capabilities for monitoring student progress and generating reports that can be used by educators and parents to track improvements and areas needing attention.

3.1.2. Non - Functional Requirements

- **Performance**: The functions implemented in the frame of the application should ensure short response times and to process real time data.
- **Reliability**: Availability is high to allow the system to run without interruption by the natural calamities.
- **Usability**: The interface must be simple to use so that everybody has access to it; they do not have to be technologically oriented.

- **Accessibility**: Such standards as the Web Content Accessibility Guidelines version 2 (WCAG 2) are observed. where one is required for the provision of access to users with disability.
- **Scalability**: The system is required to maintain its operability over more users and larger amounts of data for the service.
- **Security**: To do this, there is the need to ensure that the relevant data has some form of security measures put in place, such as encryption and also routine security audits.
- **Maintainability**: The development of updates and modifications must be possible without a great amount of system shutdowns and must be designed in a modular structure.
- **Interoperability**: It is crucially important for them to be easily integrated into current learning technologies and systems.

4. BUDGET PROPOSAL FOR THE RESEARCH

Description	Cost (LRK)
Data gathering	5000.00
Internet Cost	10000.00
Documentation	4000.00
Implementation and Testing	10000.00
Total	**29000.00**

Table 1. Budget

5. GANTT CHART

No	Assessment / Milestone	Start Date	End Date	2023-2024													
				April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	April	May
1	**Project discussion workshop**	29-Apr-23	29-Apr-23														
2	**Topic evaluation**	15-May-23	30-Jul-23														
2a	Select a topic	15-May-23	20-May-23														
2b	Select a supervisor	20-May-23	23-May-23														
2c	Topic Evaluation form submission	23-May-23	25-Jun-23														
2d	Project charter submission	20-Jun-23	30-Jul-23														
3	**Project proposal report**	30-Jul-23	25-Aug-23														
3a	Project proposal presentation	25-Jul-23	02-Aug-23														
3b	Create Project Proposal - individual	02-Aug-23	25-Aug-23														
3c	Create Project Proposal - group	02-Aug-23	25-Aug-23														
4	**Develop the system**	25-Aug-23	20-Feb-24														
4a	Identifying functions	25-Aug-23	01-Sep-23														
4b	Database designing	01-Sep-23	12-Sep-23														
4c	Implementation	12-Sep-23	30-Dec-23														
4d	Unit testing	01-Jan-24	30-Jan-24														
4e	Integration testing	30-Jan-24	20-Feb-24														
5	**Progress Presentation - I**	01-Jan-24	06-Jan-24														
5a	Project Status document	01-Jan-24	06-Jan-24														
5b	Create presentation document	01-Jan-24	06-Jan-24														
5c	Progress Presentation – I (50%)	06-Jan-24	06-Jan-24														
6	**Research Paper**	18-Oct-24	18-Mar-24														
6a	Create the Research Paper	18-Oct-24	18-Mar-24														
7	**Progress Presentation - II**	22-Mar-24	29-Apr-24														
7a	Create presentation document	22-Mar-24	29-Apr-24														
7b	Progress presentation – II (90%)	29-Apr-24	29-Apr-24														
8	**Final Report Submission**	14-Apr-24	14-May-24														
8a	Final Report Submission	14-Apr-24	14-Apr-24														
8b	Application assessment	01-Apr-24	14-May-24														
8c	Project status document	14-May-24	14-May-24														
8d	Student logbook	10-Apr-24	14-May-24														
9	**Final Presentation & Viva**	14-Apr-24	25-Apr-24														
9a	Create final presentation	01-May-24	25-May-24														
9b	Final report submission	25-May-24	25-May-24														

6. CONCLUSION

From my study, I have designed a mobile application that incorporates the use of machine learning and real time analytics for students with ADHD. This tool increases diagnostic precision a great deal, provides distinguishable educational interventions that are individual and immediate. The advances in knowledge include better differentiation of ADHD subtypes and the increased understanding of learning disability and the availability and the accommodation of education for those with learning disability and other specific needs.

REFERENCES

L. Sandathara, S. Tissera, R. Sathsarani, H. Hapuarachchi, and S. Thelijjagoda, "Arunalu: Learning Ecosystem to Overcome Sinhala Reading Weakness due to Dyslexia," in 2020 2nd International Conference on Advancements in Computing (ICAC), 2020, DOI: 10.1109/ICAC51239.2020.9357268.

K. Charoy-boon, N. Kruesang, A. Anuntachai and N. Raksadawan, "Writing Test with Image Processing Technique," 2023 23rd International Conference on Control, Automation and Systems (ICCAS), Yeosu, Korea, Republic of, 2023, pp. 1711-1716, doi: 10.23919/ICCAS59377.2023.10316932.

S. Rosenblum and G. Dror, "Identifying Developmental Dysgraphia Characteristics Utilizing Handwriting Classification Methods," in IEEE Transactions on Human-Machine Systems, vol. 47, no. 2, pp. 293-298, April 2017, doi: 10.1109/THMS.2016.2628799.

SMART EDUCATIONAL TOOL FOR DYSGRAPHIA IDENTIFICATION, INTERVENTION, AND SKILL ENHANCEMENT IN PRIMARY SCHOOL STUDENTS

Project ID - 24-25J-325

Project Proposal Report

W.A.S. Heshan – IT21183768

B. Sc. (Hons) Degree in Information Technology Specializing in Information Technology

Department of Information Technology

Sri Laka Institute of Information Technology

Sri Lanka

July 2024

SMART EDUCATIONAL TOOL FOR DYSGRAPHIA IDENTIFICATION, INTERVENTION, AND SKILL ENHANCEMENT IN PRIMARY SCHOOL STUDENTS

Project ID - 24-25J-325

Project Proposal Report

Supervisor - Ms. Wishalya Tiserra

Co-Supervisor - Dr. Dharshana Kasthurirathna

B. Sc. (Hons) Degree in Information Technology Specializing in Information Technology

Department of Information Technology

Sri Laka Institute of Information Technology

Sri Lanka

July 2024

DECLARATION

We declare that this is our own work and this proposal does not incorporate without acknowledgement any material previously submitted or a degree or diploma in any other university or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Heshan W.A.S.	IT21183768	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisors:

---------- .....

Ms. Wishalya Tiserra 08/23/2024

ABSTRACT

Dysgraphia, a neurological disorder that affects writing abilities, poses significant challenges for primary school students, impacting their academic performance and self-esteem. Early detection and intervention are critical for mitigating the effects of dysgraphia, yet traditional methods of identification and support are often inadequate and delayed. This research presents the development of a comprehensive mobile application designed to detect and assist students with dysgraphia. The application integrates a Detection System powered by Machine Learning (ML) to analyze handwriting patterns and identify dysgraphia early. Following detection, students engage in Interactive Tracing Activities tailored to their specific needs, helping to improve fine motor skills, letter formation, and overall handwriting proficiency. To ensure effective learning, the application provides Real-Time Feedback, offering instant corrective guidance and progress tracking as students practice. Additionally, the platform fosters a Collaborative Community where teachers, parents, and specialists can share insights, resources, and support, creating a holistic and inclusive learning environment. By combining advanced technology with educational best practices, this mobile application aims to revolutionize the way dysgraphia is identified and managed, ultimately empowering students to overcome their writing difficulties and succeed academically.

Keywords – Dysgraphia, Machine Learning, Handwriting Analysis, Real-Time Feedback, Interactive Learning, Collaborative Community, Educational Technology

Table of Contents

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Description
ML	Machine Learning
SDLC	System Development Life Cycle

1 INTRODUCTION

1.1 Background & Literature Survey

Dysgraphia therefore is a specific learning disability that has to do with written language with the primary symptoms being in the areas of handwriting, spelling and organizing written work. This hampers learning especially in the primary school going children as it becomes very difficult for them to learn and this pulls down their performance, their frustration and even their self esteem. Dysgraphia can be detected early in the child's development and if diagnosed early enough the effects can be managed and prevented from impairing the student's performance. However, conventional approaches to dysgraphia diagnosis are frequently insufficient, based on teachers' or delayed professional observations. These methods can lead to late diagnosis and therefore early intervention which is detrimental on the effectiveness of the disability on the education of the child.

As the technology progresses, there is increasing possibility to improve the means of the early identification and intervention for students with dysgraphia. The combination of Machine Learning and Image Processing in educational tools provides a perfect solution to using real-time data to diagnose learning disabilities. Therefore, with the help of these technologies, it will be possible to create a less subjective, more effective and accurate system for diagnosing dysgraphia and effective treatments.

Machine Learning for Dysgraphia Detection:

The application of Machine Learning in educational diagnostics has gained significant traction. ML algorithms can analyze handwriting patterns, identifying subtle signs of dysgraphia that may be missed by traditional assessments. For instance, research by J. Zhou et al. [1] demonstrated that convolutional neural networks (CNNs) could effectively classify handwriting samples, distinguishing between typical writing and dysgraphia-affected writing with high accuracy. These ML models assess various features such as stroke order, pressure, and letter formation, providing an objective and early identification method that is more efficient than manual assessments. Mitigate climate-induced challenges, setting the stage for the proposed research.

Real-Time Feedback in Educational Applications:

Real-time feedback is a crucial component in educational tools, especially for students with learning disabilities like dysgraphia. Immediate feedback allows students to recognize and correct mistakes as they happen, which is essential for developing better writing habits. According to a study by S. Kumar et al. [2], implementing real-time feedback in writing tools led to significant improvements in handwriting quality among students with learning difficulties. By integrating this feature into a mobile application, students can receive instant guidance on their handwriting, helping them improve continuously and reducing frustration associated with the learning process.

Interactive Tracing Activities for Skill Development:

Interactive tracing activities have been widely recognized as effective in improving fine motor skills and handwriting in children. Research by A. Sharma and P. Ghosh [3] shows that gamified tracing exercises, when combined with adaptive learning algorithms, can be particularly beneficial for students with dysgraphia. These activities help reinforce muscle memory and proper letter formation through repetitive practice. By embedding these interactive tracing exercises within a mobile application, the platform can provide personalized and engaging learning experiences tailored to each student's specific needs.

Collaborative Community in Educational Technology:

The role of collaborative communities in educational technology cannot be overstated. A study by D. R. Brown et al. [4] highlights the benefits of creating a supportive network of teachers, parents, and peers for students with learning disabilities. Such communities enable the sharing of strategies, resources, and emotional support, which are vital for the effective management of dysgraphia. A mobile application that includes a collaborative community feature can facilitate this interaction, providing a platform for users to exchange best practices, discuss progress, and seek advice from experienced educators and parents. This collaborative approach not only enhances the learning experience for students but also empowers educators and parents to take an active role in their child's development.

1.2 Research Gap

The proposal report points to research that is lacking concerning challenges of diagnosing and addressing dysgraphia in learner's at a tender age in the primary school. However, there are a few limitations experienced in the current use of educational technology in handling dysgraphia:

1. **Lack of Automated Detection Systems for Dysgraphia:**

Typically, the diagnosis of dysgraphia has been done through conventional assessments by teachers and experts. Such assessments are often time-consuming, observer biased and imprecise and this slows down the identification and management of the condition. The current set of educational tools in the region has a serious issue in that they lack automation based on the principles of ML that can diagnose dysgraphia by reading writing. As a consequence, opportunities for early and precise diagnosis of the illness are missed.

2. **Limited Use of Real-Time Feedback in Learning Applications:**

Current educational applications for students with learning disabilities often fail to provide real-time feedback during writing activities. This delay in feedback prevents

students from recognizing and correcting their mistakes immediately, which is crucial for improving their writing skills. The lack of real-time, interactive feedback systems in existing tools highlights a gap in the effective support available to students with dysgraphia.

3. **Absence of Personalized Interactive Tracing Activities:**

While tracing activities are available in a variety of educational programs, many of them lack the customization needed to meet the unique needs of kids who struggle with dysgraphia. Current resources frequently offer a one-size-fits-all solution without taking into account the unique difficulties that every kid encounters. This discrepancy highlights the need for more flexible tracing exercises that can accommodate each student's individual learning style and level of motor skill development.

4. **Inadequate Collaborative Support Systems:**

The collaborative community features that link educators, parents, and students are not well integrated into the educational platforms that are already in use. Working together is crucial to assessing progress, exchanging methods, and creating a supportive environment for dysgraphia pupils. The lack of a strong community aspect in current tools restricts stakeholders' capacity to work together to address the issues that students confront, which leaves a vacuum in the comprehensive support system required for managing dysgraphia effectively.

5. **Challenges in Integrating Advanced Technologies in User-Friendly Applications:**

While cutting edge technologies such as machine learning and artificial intelligence are being investigated for educational reasons, there is still limited integration of these technologies into user-friendly applications for dysgraphia detection and intervention. There is a need to close this gap in the development of user-friendly, accessible apps for parents, teachers, and students so that technological breakthroughs become useful, everyday resources for helping dysgraphia students.

1.3 Research Problem

The research problem addressed in this proposal revolves around the challenges associated with the early detection and intervention of Dysgraphia in primary school students. Despite the availability of various educational tools, several key factors contribute to the persistence of this problem:

Problem Statement:

Dysgraphia, a specific learning disability that affects a student's ability to write, presents significant barriers to academic achievement and overall development. Traditional methods of diagnosing dysgraphia are often manual, time-consuming, and dependent on subjective judgment, which may result in inconsistencies in diagnosis and delayed intervention. These delays can lead to long-term academic struggles and hinder a student's ability to keep pace with their peers.

In the current educational landscape, the lack of advanced technology solutions exacerbates the problem, as machine learning and image processing techniques are minimally integrated to automate and improve the accuracy of dysgraphia detection. Additionally, the lack of real-time feedback mechanisms in existing interventions limits the effectiveness of skill improvement strategies, further impeding student progress.

Moreover, the isolation of students, teachers, and parents in managing dysgraphia without a collaborative platform reduces the potential for comprehensive support, making it difficult to tailor educational interventions to the unique needs of each student.

Research Problem:

Manual and Subjective Identification: The reliance on traditional, manual methods for identifying Dysgraphia is inefficient and can lead to inconsistencies in diagnosis, delaying critical interventions.

Lack of Technological Integration: The absence of machine learning and image processing in current Dysgraphia detection tools limits the accuracy and objectivity of the diagnosis process, leading to potential misidentification and inadequate support for students.

Delayed and Ineffective Interventions: Without real-time feedback and personalized learning plans, students with Dysgraphia may experience prolonged difficulties in improving their writing skills, impacting their academic performance.

Isolation of Stakeholders: The lack of a collaborative platform for students, teachers, parents, and individuals with past experiences of Dysgraphia hinders the ability to provide a well-rounded, supportive educational environment, which is crucial for effective Dysgraphia management..

2 OBJECTIVES

2.1 Main Objective

The main objective of the proposed research is to develop a mobile application that leverages machine learning and image processing techniques to identify Dysgraphia in primary school students and provide real-time feedback to enhance their writing skills. The project also aims to create a collaborative platform for students, teachers, parents, and individuals with past experiences of Dysgraphia, fostering a supportive environment for effective learning and intervention.

2.2 Sub Objectives

1. **Data Collection and Preprocessing:**

Develop a system capable of collecting handwriting samples from primary school students and preprocessing these samples for accurate Dysgraphia detection. This includes standardizing the data and preparing it for analysis.

2. **Feature Extraction and Machine Learning Model Development:**

Implement machine learning models to analyze handwriting features such as stroke consistency, pressure, and letter formation. Develop models to predict Dysgraphia with high accuracy based on these extracted features.

3. **Image Processing for Tracing Activities:**

Design and integrate image processing techniques within the mobile application to create tracing activities. These activities will serve as practice exercises for students, allowing the system to analyze and provide real-time feedback on their writing.

4. **Step-by-Step Writing Skill Development Plan:**

Develop a structured, step-by-step plan for writing skill development that progressively challenges students to improve their writing abilities. The plan will provide incremental exercises that build on each other, ensuring a gradual and effective enhancement of writing skills.

5. **Collaborative Platform Development:**

Develop a collaborative platform within the application to enable interaction and support among students, teachers, parents, and individuals with past experiences of Dysgraphia. This platform will facilitate the sharing of strategies and experiences, enhancing the overall effectiveness of the intervention.

3 METHODOLOGY

3.1 System Architecture

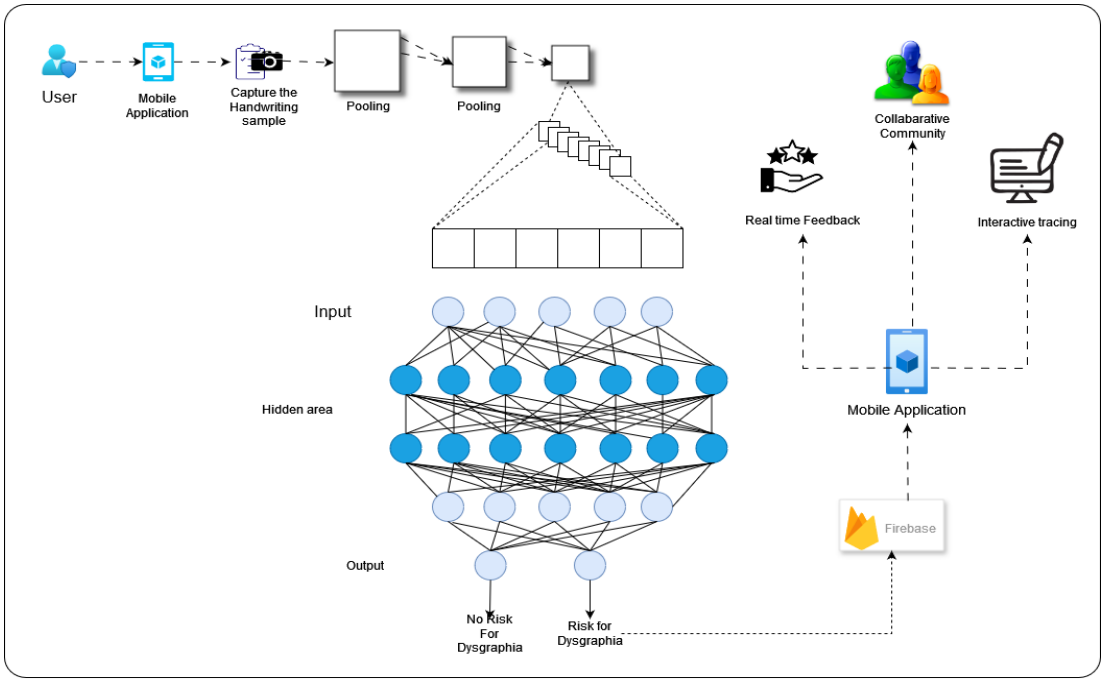

Figure 3.1 – System Architecture Diagram

Data Acquisition and Integration:

Handwriting Data Collection: Handwriting samples are collected from primary school students using digital devices such as tablets or smart pens. These samples include various writing exercises, such as letter formation, word spacing, and sentence construction, which are critical for identifying Dysgraphia.

Preprocessing of Handwriting Data: The collected handwriting data is preprocessed to standardize the format and remove noise. Preprocessing includes steps such as resizing, binarization, and normalization to prepare the data for analysis by machine learning models.

Real-time Data Integration: The system continuously integrates new handwriting data as students complete exercises within the mobile application. This real-time data integration allows for ongoing analysis and immediate feedback, ensuring that the system adapts to the student's progress.

Feature Extraction: Machine learning models are developed to extract key features from the handwriting data, such as stroke consistency, pressure patterns, and letter formation accuracy. These features are critical indicators for identifying Dysgraphia in students.

Model Training and Optimization: The machine learning models undergo training using labeled datasets that include both Dysgraphic and non-Dysgraphic handwriting samples. Optimization techniques, such as feature selection and hyperparameter tuning, are applied to improve the model's accuracy in detecting Dysgraphia.

Step-by-Step Writing Skill Development Plan: Based on the analysis of the handwriting data, the system generates a step-by-step writing skill development plan. This plan provides students with progressively challenging exercises designed to improve their writing abilities. The plan is adaptive, adjusting based on the student's performance and progress.

User Interface and Visualization:

The mobile application provides an interactive and intuitive interface for students, teachers, and parents. Students engage with writing exercises through a user-friendly interface that offers visual cues and real-time feedback to enhance their writing skills. Teachers and parents access a dashboard that displays the student's progress, areas of difficulty, and recommended exercises. The dashboard also includes visualization tools for tracking development over time, enabling informed decision-making about further interventions.

Collaborative Development Environment:

The development environment, including the machine learning model code, data processing scripts, and interface components, is hosted on GitHub. This integration facilitates collaborative development, version control, and transparency in code sharing among the research team and other stakeholders.

By integrating handwriting data collection, real-time data analysis, and machine learning models, the proposed system offers a comprehensive solution for the early detection of Dysgraphia and the enhancement of writing skills in primary school students. The use of GitHub supports collaboration and transparency, contributing to the overall reliability and effectiveness of the Dysgraphia identification system.

3.2 Software Solution

The Software Development Life Cycle (SDLC) is a proven methodology for developing robust and reliable software, ensuring that the final product meets the needs of its users, including students, teachers, and parents. This systematic approach is essential in delivering a high-quality, accurate, and timely solution for Dysgraphia identification and writing skill development. The SDLC provides a comprehensive plan that outlines the organization, creation, and maintenance of the mobile application designed for this purpose. Each stage of the SDLC is interconnected, with the output of one stage serving as the input for the next, ensuring a seamless workflow throughout the development process. As illustrated in Figure 3.2, the SDLC is divided into several key stages, each playing a critical role in the development and enhancement of the proposed system for Dysgraphia detection and intervention in primary school students.

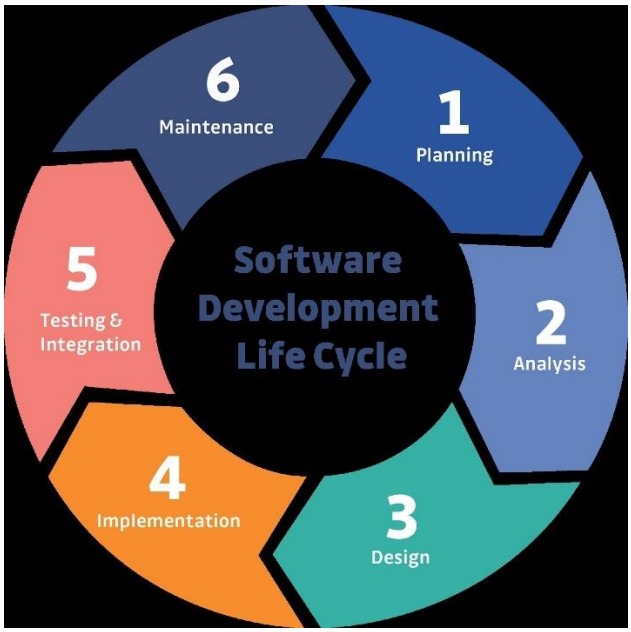

Figure 3.2 – Stages of SDLC Model

3.2.1 Requirement Analysis

1. **Data Collection and Preprocessing:**

The system requires the physical collection of student writing samples, which will then be digitized by capturing images of the papers. These images will serve as input for further analysis. Requirements include high-quality imaging equipment to ensure clear and accurate captures, as well as secure storage protocols for the digital images. Constraints may include variability in image quality depending on the equipment used and potential challenges in maintaining consistency in image capture across different settings.

2. **Feature Extraction and Model Development:**

The system will utilize Convolutional Neural Networks (CNN) to classify the handwriting samples based on the captured images. Requirements include access to robust machine learning libraries and frameworks capable of handling image data. Additionally, sufficient labeled data is needed to train the CNN model effectively. Constraints may involve the need for significant computational resources for training and the challenge of obtaining enough labeled samples to ensure model accuracy.

3. **User Interface and Visualization:**

The application must provide a user-friendly interface that allows teachers and parents to view the results of the handwriting analysis. Visualization tools should display the classification results and provide insights into the student's writing abilities. Requirements include compatibility across devices and platforms, as well as an intuitive design. Constraints may involve balancing detailed analysis with a simple, accessible interface.

4. **Real-time Feedback and Progress Monitoring:**

Real-time data processing and feedback mechanisms are essential for the system to provide immediate responses to students during writing exercises. Requirements include integration with real-time data streaming capabilities and a reliable notification system. Constraints may involve dependence on consistent internet connectivity and the potential need for optimizing responsiveness to ensure immediate feedback.

5. **Collaborative Platform Development:**

The system should include a platform for communication and collaboration among students, teachers, parents, and individuals with experience in Dysgraphia. Requirements include secure messaging features, easy-to-use sharing options, and the ability to upload and discuss writing samples. Constraints may include ensuring the security of shared data and maintaining user privacy.

3.2.2 Feasibility Study

1. **Technical Feasibility:**

The project is technically feasible due to the availability of required resources, such as imaging equipment and machine learning frameworks, and the expertise in CNNs and image processing. Current advancements in these areas support the successful implementation of the system.

2. **Operational Feasibility:**

The system is operationally feasible with effective procedures for collecting and digitizing handwriting samples, and proper training for users. Integration into educational environments is achievable with minimal disruption.

3. **Economic Feasibility:**

The project is economically feasible, with development costs justified by the long-term benefits of early Dysgraphia detection, leading to improved student outcomes and potential cost savings in educational support.

3.2.3 System Design and Implementation

The system design and implementation of the proposed research involve a structured approach to leverage image processing and machine learning techniques for the identification of Dysgraphia and the enhancement of writing skills in primary school students. The key phases of the system design and implementation include data collection, data preprocessing, feature extraction, and model selection.

1. **Data Collection:**

Objective: Collect handwriting samples from primary school students.

Methodology: Gather physical writing samples from students, then capture high-quality images of these samples using digital cameras or scanners.

Tools: Use imaging devices and digital storage solutions to ensure accurate and consistent data collection.

2. **Data Preprocessing:**

Objective: Clean and preprocess the captured images for analysis.

Methods: Convert images to grayscale, resize them for consistency, and apply reduction techniques to enhance image quality.

Tools: Utilize image preprocessing libraries and algorithms within the chosen machine learning framework.

3. **Feature Extraction:**

Objective: Identify and extract relevant features from the preprocessed images for input into the CNN model.

Methods: Focus on extracting features such as stroke patterns, letter formation, and spacing. Use convolutional layers in CNNs to automatically identify the most significant features.

Tools: Implement feature extraction using CNN architectures within a machine learning framework.

4. **Model Selection:**

Objective: Choose a CNN model suitable for classifying handwriting samples and identifying Dysgraphia.

Methods: Experiment with different CNN architectures and optimize them through techniques like hyperparameter tuning and cross-validation. Evaluate models based on accuracy, precision, and recall.

Tools: Use deep learning frameworks such as TensorFlow or PyTorch to implement and evaluate various CNN models.

3.2.4 Testing

Testing is a crucial phase in ensuring the reliability and accuracy of the proposed system for Dysgraphia identification and writing skill development in primary school students. The testing process will involve several stages, each designed to validate

different aspects of the system's functionality and performance. The testing phases are as follows:

Unit Testing:

Individual components, like image preprocessing and feature extraction, are tested in isolation to ensure they work correctly.

Component Testing:

After unit testing, components are integrated and tested together to ensure they function cohesively.

Integration Testing:

This phase focuses on testing the interactions between different system parts, such as data collection and real-time feedback, to identify any integration issues.

System Testing:

The entire system is tested comprehensively to ensure it performs as intended, accurately detecting Dysgraphia and supporting writing skill development.

User Acceptance Testing:

The system is tested by end-users—students, teachers, and parents—to ensure it meets their needs and expectations.

These testing stages will be repeated as needed to refine the system until it performs effectively and reliably.

3.2.5 Deployment and Maintenance

1. **Software Installation:**

Install the required software components, including image processing libraries, machine learning frameworks, and database management systems. Ensure all software elements are compatible and function properly within the deployment environment.

2. **Data Integration:**

Integrate the system with the database containing student handwriting samples, ensuring continuous data flow and synchronization. Implement protocols for regular updates to maintain the system's effectiveness.

3. **User Training:**

Provide training sessions for teachers, parents, and administrators to familiarize them with the system's interface and features. Address any questions or concerns raised during the training phase to ensure smooth adoption.

4. **Real-time Feedback System:**

Implement the real-time feedback mechanism to analyze handwriting data as it is collected. Ensure the system provides immediate and actionable feedback to students during writing exercises.

5. **Testing in Real-world Environment:**

Conduct thorough testing in actual school environments to identify and fix any issues. Ensure that the system operates reliably and efficiently under real-world conditions.

6. **Gradual Rollout:**

Consider a phased rollout strategy, starting with a small group of schools before expanding to a broader audience. Monitor system performance closely during the initial deployment stages to make necessary adjustments.

3.3 Work Breakdown Chart

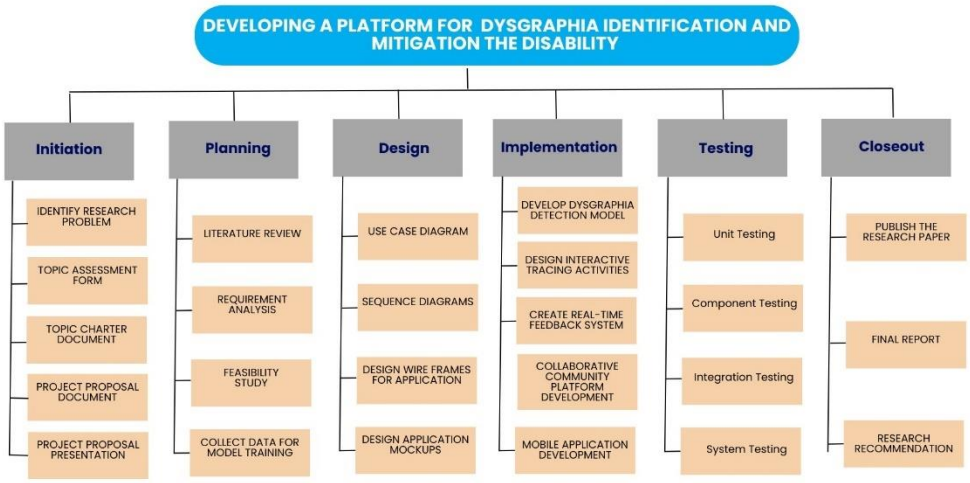

Figure 3.3 – Work Breakdown Chart

4 PROJECT REQUIREMENTS

4.1 Functional Requirements

- Implement CNN models capable of analyzing handwriting features to identify Dysgraphia in students.
- Provide real-time feedback to students based on their handwriting analysis.
- Develop a collaborative platform for students, teachers, and parents to share information and progress.
- Design an intuitive user interface for students, teachers, and parents to access and interact with the system.

- Include tools for visualizing student progress and identifying areas for improvement.

4.2 Non-Functional Requirements

- The system should provide real-time feedback with minimal latency.
- Ensure the system is scalable to accommodate increasing numbers of users and handwriting samples.
- The system must be reliable, with minimal downtime and accurate analysis.
- Implement strong security measures to protect student data and user privacy.
- The user interface should be intuitive, requiring minimal training for effective use.
- The system should be maintainable, allowing for easy updates, bug fixes, and improvements.

4.3 User Requirements

- Students, teachers, and parents should find the system easy to use and navigate.
- Users expect immediate feedback on handwriting exercises and clear visualizations of progress.
- Provide accessible information and guidance on improving writing skills and managing Dysgraphia.

4.4 System Requirements

- Ensure compatibility with existing educational tools and infrastructure.
- The system should integrate seamlessly with image processing libraries, machine learning frameworks, and databases.

4.5 Software Requirements

- Utilize image processing libraries (e.g., OpenCV) for digitizing and analyzing handwriting samples.
- Implement CNN models using frameworks like TensorFlow or PyTorch.
- Employ a database management system for efficient data storage and retrieval.

4.6 Personal Requirements

- Trained system administrators should be available for deployment, maintenance, and troubleshooting.
- Teachers and parents should receive adequate training to effectively use the system.
- Experts in machine learning and data analysis may be required for model development, validation, and optimization.

5 GANTT CHART

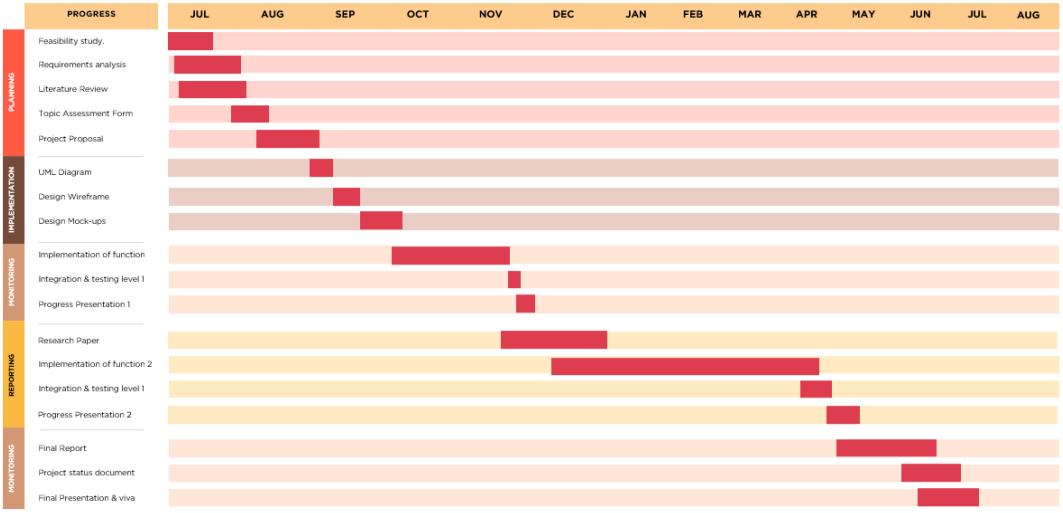

Figure 5.1 – Gantt Chart

6 COMMERCIALIZATION

6.1 Target Audience and Market Space

1. Target Audience

Primary Schools:

The system is designed for primary schools that aim to provide early detection of Dysgraphia in students. Teachers and school administrators are key users who will benefit from the system's ability to identify students with Dysgraphia and provide tailored support.

Parents:

Parents of primary school students are another crucial target audience. The system allows them to track their child's writing progress and collaborate with teachers to support their child's learning.

Educational Therapists:

Professionals who specialize in educational therapy and learning disabilities will find the system valuable for diagnosing Dysgraphia and creating effective intervention plans.

2. **Marketplace**

Education Sector:

The primary marketplace is the education sector, particularly primary schools and special education centers. The system aims to make a significant impact by improving the early detection and intervention of Dysgraphia, thereby enhancing student outcomes.

EdTech Industry:

The system also has potential in the broader EdTech market, where it can be positioned as a specialized tool for learning disability detection and support, expanding its reach to a wider audience within the educational technology space

6.2 Budget

REQUIREMENT	COST(LKR)
COST OF DEPLOYMENT	4000/-
TESTING AND QA	1 500/-
TRAVELLING COST	3 000/-
COMMERCIALIZATION	7 500/-
OTHER	4 000/-(ANNUAL)
TOTAL COST	16 000/-

Figure 6.2 - Budget

REFERENCE LIST

[1] J., Zhou; H., Tang; Q., Zhang, "Handwriting Analysis for Dysgraphia Detection Using Convolutional Neural Networks," *IEEE Transactions on Neural Systems and Rehabilitation Engineering,* Vols. vol. 28, no. 1, pp. 133-141, 2020.

[2] S. Kumar, V. Patel, and M. Agarwal, "Real-Time Feedback Systems in Educational Technologies: Enhancing Learning Outcomes for Students with Learning Disabilities," *IEEE Access,* vol. vol. 7, pp. pp. 8967-8975, 2019.

[3] A. Sharma and P. Ghosh, "Interactive Tracing Activities for Motor Skill Development in Children with Dysgraphia," *IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE),* pp. pp. 250-255, 2019.

[4] D. R. Brown, L. A. Smith, and M. T. Clark, "Collaborative Learning Environments for Students with Learning Disabilities: A Case Study," *IEEE Transactions on Learning Technologies,* Vols. vol. 13, no. 4, pp. pp. 748-757, 2020.

Smart Educational Tool for Early Detection of Learning Disabilities in Primary School Students / Identifying dyscalculia, reducing its effect and skill enhancement

Project ID: 24-25J-325

Project Proposal Report

Jayathilaka P.A.D.S.L – IT21183454

B.Sc. (Hons) Degree in Information Technology

Department of Information Technology

Sri Lanka Institute of Information Technology

Sri Lanka

July 2024

Identifying dyscalculia, Reducing its Effect and Skill Enhancement

Declaration

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted or a degree or diploma in any other university or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Jayathilaka P.A.D.S.L	IT21183454	

Signature of the Supervisor

.....

Ms. Wishalya Tissera

Date

.....

08/23/2024

Abstract

This Dyscalculia, a specific learning difficulty that impacts a child's ability to grasp and work with numbers, often goes undetected in primary school children due to its subtle symptoms. This research introduces a mobile application designed to identify and support children who may be at risk of dyscalculia. The app features a range of interactive activities tailored for primary school students, which assess their numerical and arithmetic skills. These activities serve both diagnostic and therapeutic purposes.

At the core of the app is a Recurrent Neural Network (RNN) model that analyzes key performance indicators such as accuracy, time spent on tasks, and types of errors made. This analysis helps determine if a child might be at risk of dyscalculia. If a risk is identified, the app provides a personalized learning experience by compiling activities that change based on the child's performance using Reinforcements Learning (RL) to reduce dyscalculia and develop mathematical abilities. The app also continuously tracks the child's progress, offering real-time feedback to both the child and their educators. This ongoing assessment ensures that the intervention remains effective and allows for timely adjustments to the learning activities. The data collected during these sessions is used to refine the RNN model, improving the accuracy of dyscalculia detection.

Ultimately, this research seeks to offer an accessible and effective tool for the early detection and intervention of dyscalculia, with the goal of enhancing educational outcomes for at-risk children.

Keywords – Dyscalculia, Recurrent Neural Network (RNN), primary School Children, Real-Time Feedback, Numerical and arithmetic skills, Reinforcement Learning (RL), Progress tracking

.

Table Of Contents

List of Figures

List of Tables

1.0 Introduction

1.1 Background

Dyscalculia is a learning disability that specifically impacts a person's ability to understand and work with numbers, causing challenges in arithmetic and numerical reasoning. This condition is fairly common, affecting about 5-7% of the population, but it is often not diagnosed, particularly in young children. Early detection is vital because if dyscalculia goes unnoticed, it can lead to long-term academic difficulties, lower self-esteem, and math-related anxiety.

Traditional methods for diagnosing dyscalculia usually involve extensive psychological assessments, which can be time-consuming and often need specialized professionals. These challenges make it hard to detect dyscalculia early, especially in schools where resources might be limited. Additionally, the interventions currently available are not always tailored to the individual needs of each child, which can reduce their effectiveness.

With the rise of mobile technology and a better understanding of learning disabilities, there is a great opportunity to use these tools to develop more accessible, efficient, and personalized ways to identify and manage dyscalculia. Mobile apps can provide a platform for interactive and engaging activities that not only help diagnose dyscalculia but also offer targeted interventions customized to the child's learning needs.

Recent advancements in artificial intelligence, particularly in machine learning and neural networks, have opened new possibilities in educational technology. Recurrent Neural Networks (RNNs), which excel at processing sequential data, are especially suited for analyzing patterns in a child's performance across different activities. By training these networks on data from children with and without dyscalculia, we can develop models that accurately identify those at risk.

Moreover, reinforcement learning, a branch of machine learning, shows potential in creating adaptive learning experiences. By adjusting the difficulty and nature of tasks based on a child's responses, reinforcement learning can provide a personalized learning journey that addresses specific weaknesses, making interventions more effective.

This research project aims to integrate these technological advancements into a mobile application that not only identifies dyscalculia in primary school children but also offers personalized intervention strategies. The app is designed to be both diagnostic and therapeutic,

providing real-time feedback and continuous progress tracking to ensure that each child receives the most effective support.

1.2 Literature survey

The identification and mitigation of dyscalculia, a specific learning disability that affects mathematical abilities, have increasingly benefited from advancements in digital technologies. Integrated educational management systems that incorporate comprehensive learning monitoring, trend analysis, and personalized learning insights have emerged as transformative tools in supporting primary school children with dyscalculia. The advancement of these systems has been significantly influenced by the integration of data analytics, real-time monitoring technologies, and mobile applications. This literature survey synthesizes key studies that highlight the transformative impact of these technologies on the overall management of dyscalculia, particularly in relation to monitoring key learning indicators, trend analysis, predictive analytics, and mobile-based interventions.

Continuous and accurate monitoring of learning indicators is crucial in dyscalculia management. Studies have demonstrated that tracking key metrics such as number recognition, calculation speed, and accuracy allows for more comprehensive assessments of students' learning progress. For instance, the study by **Mukherjee et al. (2024) [1]** explored the capabilities of real-time educational monitoring systems, focusing on their application in managing learning disabilities such as dyscalculia. Their research demonstrates how continuous monitoring of vital learning indicators, including calculation accuracy and number recognition, can enhance student management and improve educational outcomes. The integration of real-time data tracking allows for more accurate and timely educational interventions, showcasing the potential of advanced educational management systems to revolutionize learning disability management.

Identifying patterns in learning data is essential for early detection of potential learning difficulties in students with dyscalculia. **Giri et al. (2020) [2]** highlighted the significance of sophisticated trend analysis algorithms in educational monitoring systems. By analyzing longitudinal learning data, these systems can detect deviations from expected learning progress, which may indicate underlying learning challenges. This proactive approach allows for timely educational interventions, thereby improving student outcomes and reducing the risk of prolonged learning difficulties.

Providing students and educators with detailed insights into learning trends is a key component of effective dyscalculia management**. Dehghani (2019) [3]** explored the use of predictive models to generate personalized learning reports, offering actionable insights into the progression of various learning indicators. This personalized approach not only aids in better educational management but also empowers students to take an active role in their learning. By using predictive analytics, these systems can forecast potential learning challenges and recommend targeted interventions, thereby improving the overall learning experience for students with dyscalculia.

Real-time alerts are vital in ensuring that educators can respond promptly to critical changes in students' learning progress. **Upathissa et al. (2023) [4]** investigated the application of automatic alert systems in educational settings. Their research highlights the effectiveness of real-time alerts in notifying educators when learning indicators deviate from expected levels. This proactive approach enhances student safety and facilitates timely educational interventions, demonstrating the critical role of automated alert systems in modern educational management.

The application of fuzzy logic in dyscalculia assessment has shown promise in providing more accurate and nuanced evaluations of students' learning abilities. **Mukherjee et al. (2024) [1]** discussed the integration of fuzzy logic into mobile applications designed to assess dyscalculia. By considering multiple learning parameters simultaneously, fuzzy logic systems can offer a more detailed understanding of a student's learning profile. This approach supports personalized learning interventions and ongoing monitoring, thereby improving educational outcomes for students with dyscalculia.

This expanded literature survey incorporates additional research on the development and application of digital technologies in the management of dyscalculia, highlighting their potential to enhance student engagement and provide personalized educational support. The integration of comprehensive learning monitoring, advanced trend analysis, personalized learning insights, real-time alert systems, and predictive analytics into a unified platform represents a significant advancement in the management of dyscalculia among primary school children. By addressing the gaps in current educational systems, these technologies offer a more effective, student-centered approach to managing dyscalculia, ultimately leading to improved educational outcomes and a better learning experience for students with this learning disability.

1.3 Research Gap

In early education, there's a research gap in identifying and intervening in dyscalculia among primary school students. Current diagnostic methods are often too broad, focusing more on general learning disabilities than specifically on dyscalculia. Additionally, existing intervention strategies aren't personalized enough, failing to account for the varying levels of risk and severity seen in children. This shortfall leaves educators and parents with limited tools to make informed decisions about early intervention.

Despite advances in educational technology, the development of tools specifically targeting the early detection of dyscalculia is still largely unaddressed. Most solutions either focus on identifying dyscalculia or on providing general educational support, but very few combine both functions in a single system. This has resulted in delayed diagnoses and interventions that often come only after the child's academic performance has already suffered.

The key gap lies in the lack of a comprehensive mobile application that can both accurately identify dyscalculia in its early stages and provide targeted interventions to address it. Existing apps usually offer either diagnostic tools or remedial activities, but not both, which limits their effectiveness in managing the condition. Moreover, there is a shortage of adaptive systems that can adjust the difficulty and nature of interventions based on the child's ongoing performance, which is crucial for effective learning support.

In the broader educational tools landscape, there is a clear need for an integrated solution that addresses both the identification and mitigation of dyscalculia. This research gap underscores the need for a holistic approach that not only diagnoses but also actively supports children through personalized, ongoing interventions.

Moving forward, researchers should focus on developing an all-in-one mobile application to fill this gap, ensuring that children receive timely and effective support. Addressing these needs will improve educational outcomes for children with dyscalculia and provide a more comprehensive solution for educators and parents.

The following table shows you those comparisons which I have mentioned above.

Application References	Identification System	Performance based Activities	Dyscalculia mitigation activitis	Progress Monitoring
Research A	✗	✗	✓	✓
Research B	✓	✗	✗	✗
Research C	✓	✗	✗	✓
Proposed System	✓	✓	✓	✓

Figure 1 Research Comparison

Research A - Ganitha Piyasa: Effective Lesson Delivery Method for Graphical Dyscalculia Students.[4]

Research B - Detection of Dyscalculia Using Machine Learning.[2]

Research C - Unraveling Dyscalculia: Identifying Mathematical Learning Difficulties in Early Education.[1]

1.4 Research problem

Dyscalculia is troublesome to identify in primary school children and requires effective early intervention, yet this remains a perennial endeavor for educators. Given that identifying and supporting dyscalculia is an area where early diagnosis and specific guidance are needed, the fact that existing solutions either cut it too broadly by targeting general learning disabilities or lack integrated capabilities to facilitate both case detection & reduction of harm. This inadequacy in present tools also causes delays with interventions and limits instruction for children who are having difficulty understanding certain mathematical concepts, which has the effect of holding them back academically as they advance through their education.

There is a significant unmet need for an end-to-end mobile application that can, firstly efficiently diagnose children with the disability of dyscalculia early enough to address it in time and secondly support individualized learning interventions. Without these types of tools, educators and parents have little in the way to adequately support children at risk — a missed opportunity on addressing early opportunities that could go a long way towards improving learning outcomes for students.

Consequently, the problem remains a holistic resolution lacking early dyscalculia identification and intervention strategies tailored to individual needs; this key support missing from schools for those children with such requirements. To solve this issue, a holistic mobile application needs to be developed that can detect dyscalculia and deliver focused games related activities for the children so they may be able to receive appropriate interventions on an individual basis making it faster, more effective at preventing underachieving in those kids.

2.0 Objectives

2.1 Main objective

To develop a mobile application that identifies dyscalculia in students, provides targeted activities to improve their mathematical skills, and tracks their progress, utilizing machine learning to enhance the accuracy of identification and effectiveness of interventions.

2.2 Specific objective

- Identification of Dyscalculia:- Develop cognitive and arithmetic tests within the app to identify students at risk of dyscalculia.
- Machine Learning Integration:- Implement machine learning models to analyze test results and classify students based on dyscalculia risk.
- Personalized learning activities:- The nature of the activities should be changed according to the change in the ability of each child.
- Progress Monitoring:- Design a system within the app for students, parents, and educators to monitor progress over time.

3.0 Methodology

The main aim of this research is to create a mobile application that can recognize dyscalculia in primary school children, give them activity-purposed educational interventions and follow-up their progress. The approach for this study includes different phases such as data collection, system design and development, testing & evaluation.

3.0.1 Requirements Gathering and Analysis

First, we conduct a thorough literature review to identify the most effective indicators of dyscalculia in children. This is done through studies of diagnostic tools and intervention methods currently used in educational settings. In addition, data will be collected from primary schools and institutions with children diagnosed with dyscalculia. Surveys, interviews, and collaboration with educators and experts will provide insight into common difficulties students face, as well as current gaps in identification and intervention methods.

3.0.2 Development of Diagnostic Module

The next step involves designing and developing the mobile application diagnostic module. This module is based on a series of interactive mathematical programs designed to assess specific cognitive skills commonly affected by dyscalculia. Tasks will address different components of number sense, basic operations and space. These task related performance data will be processed to find out patterns and indicators of dyscalculia. It will be structured in a way that it checks the answers of students and matches them with previous benchmarks to give an early diagnosis.

3.0.3 Creation of Personalized Intervention Activities

After assessing a student as being at-risk of dyscalculia, the application will produce an individualized intervention activity. These activities will be aimed at resolving the particular issue in which the child lacks behind. They will be adaptive given what we know about educational theory and existing research on learning disabilities, scaling to more or less complex activities as a student advances. The intention is to develop interactive exercises which target mathematical skills…but also foster intrinsic motivation and encouragement.

3.0.4 Machine Learning Integration for Enhanced Accuracy

Machine learning algorithms are integrated into the system to improve the accuracy of dyscalculia detection and the effectiveness of interventions. By analyzing the performance data collected over time, the application's predictive capabilities are improved and interventions are tailored more precisely to the child's needs.

3.0.5 Progress Tracking and Feedback Mechanism

The app includes a powerful progress tracking system that continually tracks how the child is doing. This system will track an enormous amount of data about every activity done, and teachers & parents will get instant feedback. The feedback loop will consist of visual reports as well as dashboards that show high-level areas for improvement and continued issues. This will help educators to target the right kind of support or intervention as needed.

3.0.6 Testing and Validation

A select group of primary schools will also be the target for piloting against this developed application. The validity of the diagnosis, efficacy at performing interventions and utility will then be assessed during this stage. The app will be similarly refined in response to feedback from educators, parents and students. Once this testing phase is done, all the issues will be handled and tweaks in functionality to enhance user experience will also be made.

3.0.7 Evaluation and Reporting

After the test phase, a deep analysis of how well that app works will be performed. This assessment will assess the validity of the underlying diagnosis, effectiveness of such tailor-made interventions on students' mathematical abilities and usability measures. The evaluation will be structured, with documented results to inform revisions of the app prior to wider dissemination.

Summary of technologies, techniques, architectures and algorithms shown in the table (Table 3.1) below.

Technologies	• Python • Node JS • AWS • Flask • Flutter • TensorFlow
Techniques	• Machine Learning Techniques • Real-Time Feedback Technique • Real-Time progress Monitoring • Data Collection and Labeling
Algorithms	• RL • RNN
Architectures	• Client-Server Architecture

Table 1 Technologies, techniques, architectures and algorithms used.

3.1 System Diagram

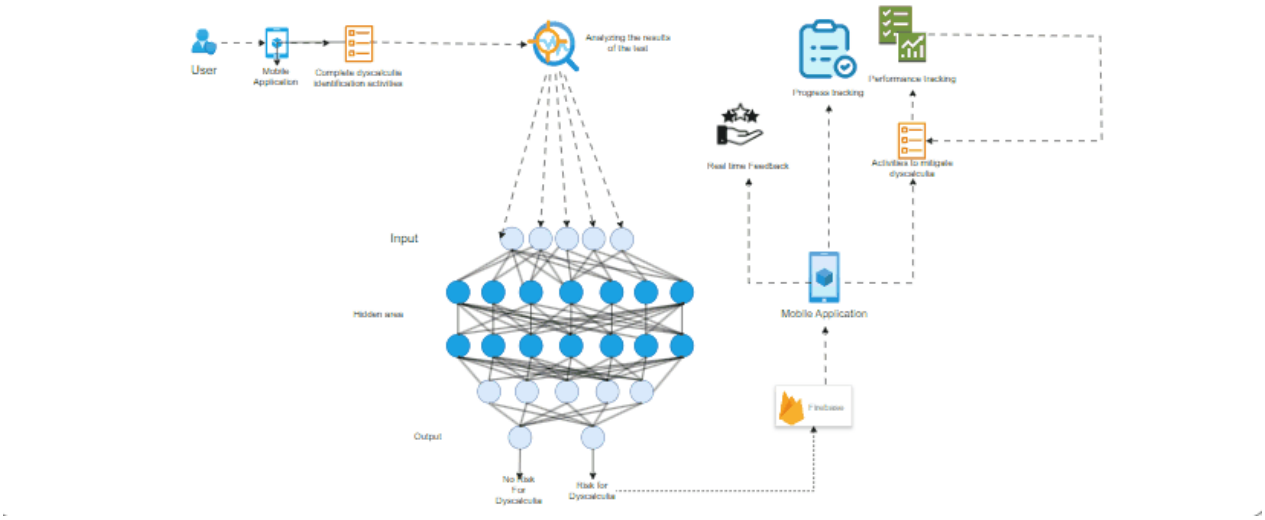

Figure 2 System architecture for the component

4.0 Project requirement

A service, function, or feature that a firm or client needs and that is articulated in order to make explicit and communicate the required capabilities is referred to as a project need. You must comprehend the type of need being expressed.

4.1 Functional requirements

- The system should identify children with dyscalculia with high accuracy.
- ·The system should be able to adjust the questions according to the child's performance.
- Provide Real-Time Feedback to Support Continuous Improvement.
- The system should be able to monitor the child's progress.

4.2 Non Function requirement

1. **Network coverage** - The app should be easily connected and function when the devices are connected to mobile data or Wi-Fi.
2. **Usability** - The app should be easy for a customer to use. That means it should be user-friendly for farmers or users whether they are educated or not.
3. **Availability** - The required sufficient data should be available in the app. If not it will be worthless and useless.
4. **Scalability** - The app should run fast and return results. It should be less time-consuming. Even with higher workloads, this should perform well.
5. **Security** - The system and its data should be protected against attacks such as information disclosure, theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide.

6. **Reliability** - The app should be able to function under stated conditions for a specified period of time. The farmers could be able to trust the app and could totally depend on the app without any doubt.

4.3 System requirement

- Ensure compatibility with educational platforms and tools commonly used in primary schools.
- The system should integrate seamlessly with student information systems, learning management systems, and data analytics frameworks**.**

4.4 System requirement

Primary School Students

- The student is supposed to use an app for interactive tasks that are aimed at assessing mathematical abilities. The app identifies potential signs of dyscalculia by the performance of such tasks. In return, personalized activities designed for fun and mastery of mathematical skills will be given, depending on the results.

Teachers and Educators

- The application allows teachers to monitor the progress of students. The app gives teachers a detailed performance report for each student, outlining areas of strength and those which need improvement. The teacher is also recommended further action or intervention that specifically applies to a student's need.

Parents and Guardians

- Parents will use the application for ongoing monitoring of the child's progress over time. He or she will, therefore, be able to check summaries of activities, performance metrics, and areas of concern. The application will also provide insights and tips for parents on how they can support their child to learn at home, thus ensuring collaboration in improving the mathematical skills of his or her child.

4.5 Expected Outcomes

The expected outcome of this research is to develop a holistic mobile application that would accurately diagnose dyscalculia in primary schools and provide interventions to improve the mathematical skills of the students. It will enable early diagnosis so that the challenges can be addressed by educators and parents before they escalate. In this way, the application will help a student to overcome difficulties with his or her progress being tracked in real time and activities tailored to increase performance. Additionally, it will empower teachers with insightful information, thereby enabling focused support. In the end, the application will facilitate better educational outcomes for students, allowing them to realize their fullest potentials in mathematics, but at the same time minimizing the discrepancies in long-term learning outcomes.

5.0 Description of personal and facilities

5.1 Gantt chart

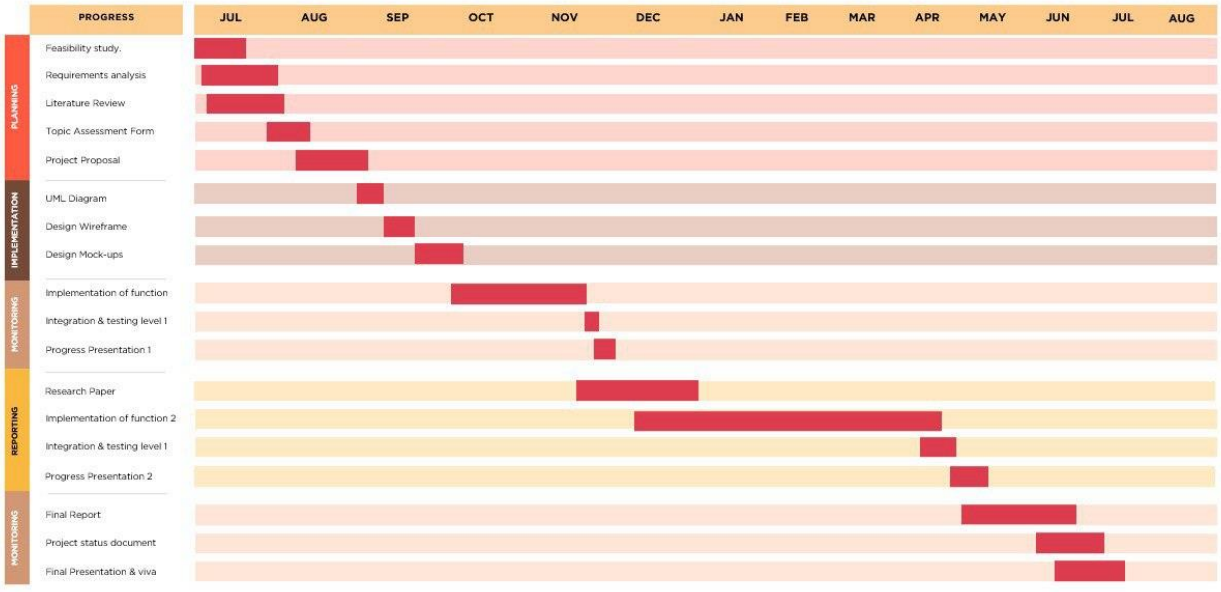

Figure 3 Gantt chart

5.2 Work Breakdown Chart

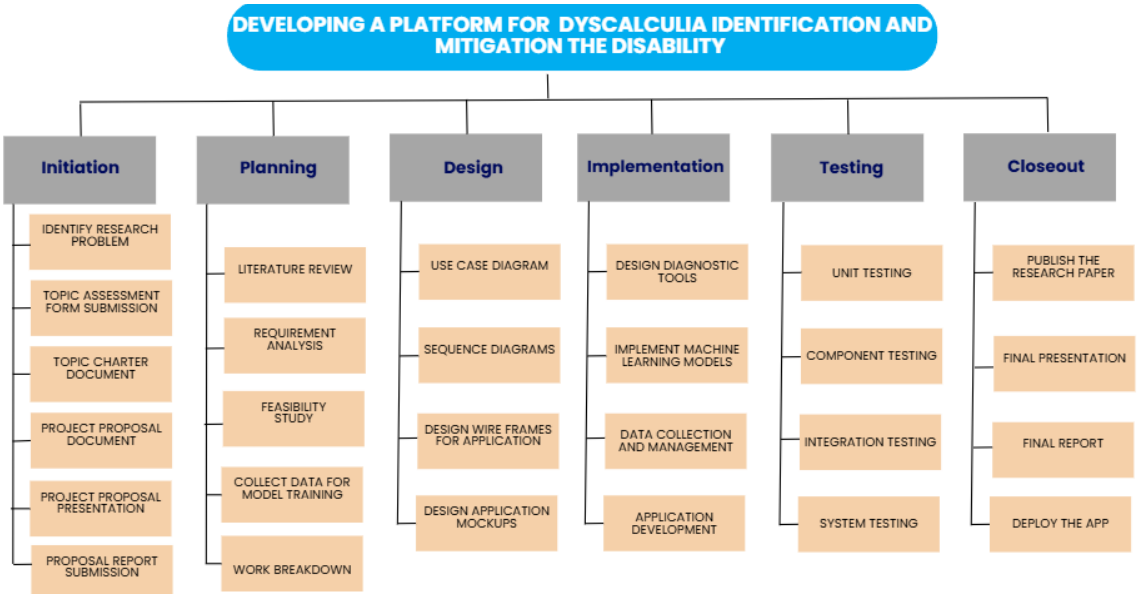

Figure 4 Work Breakdown chart

6.0 Budget and budget justification

The below table depicts the overall budget of the entire proposed system

Description	Amount (LKR)
Field visiting	6000.00
Cost of Deployment	7000.00
Commercialization	8000.00
Hosting cost	5000.00
Others	5000.00
Total	31,000.00

Table 2 Budget

7.0 Commercialization Plan

We hope to market our product directly to the end-users through E-commerce platforms or app We will monetize our mobile application via major app stores, such as Google Play Store, Apple App Store, and Amazon Appstore, employing a strategy of direct distribution to the end-user. The application gets maximum reach, and the users find it very convenient to download and use the application easily on their devices.

It will be a Software as a Service, subscription-based model with tiered plans: basic, premium, and institutional packages. A SaaS model is cost-effective as it eliminates users' expenditures in setting up vast infrastructure; this approach also provides for simple scalability depending on the user base. With this approach, we will also ensure regular updating and maintenance, hence making improvements both in user experience and security.

Our marketing strategy will use target-specific online advertising, strategic partnerships with educational institutions, and content marketing to drive brand visibility and adoption. Across the media of social platforms and educational blogs, we will finally be able to reach a huge number of stakeholders—be it educators, parents, or schools—by collaborating with influencers.

This full commercialization plan will help us get to our target market in an efficient manner, with user attraction and drive of sustainable growth and revenue.

8.0 References list

[1] K. Mukherjee, R. Kumar, S. Vasishat, N. Bhargava, S. Upadhyay and S. Muhuri, "Unraveling Dyscalculia: Identifying Mathematical Learning Difficulties in Early Education," *2024 International Conference on Innovations and Challenges in Emerging Technologies (ICICET)*, Nagpur, India, 2024, pp. 1-6, doi: 10.1109/ICICET59348.2024.10616352. Available at: https://vpn.sliit.lk/proxy/7396ef13/https/ieeexplore.ieee.org/document/10616352 (Accessed: 23 August 2024).

[2] N. Giri *et al*., "Detection of Dyscalculia Using Machine Learning," *2020 5th International Conference on Communication and Electronics Systems (ICCES)*, Coimbatore, India, 2020, pp. 1-6, doi: 10.1109/ICCES48766.2020.9137871. Available at: https://vpn.sliit.lk/proxy/7396ef13/https/ieeexplore.ieee.org/stamp/stamp.jsp?tp= (Accessed: 23 August 2024).

[3] H. Dehghani, "The effectiveness of a mobile application “Kalcal” on the learning of mathematics in students with dyscalculia," *2019 International Serious Games Symposium (ISGS)*, Tehran, Iran, 2019, pp. 1-6, doi: 10.1109/ISGS49501.2019.9047035. Available at: https://vpn.sliit.lk/proxy/7396ef13/https/ieeexplore.ieee.org/document/9047035 (Accessed: 23 August 2024).

[4] U. A.N., J. J.A.D.I.S, F. R.R.M., T. G.W.D.N.R., S. Rajapaksha and T. Thilakarathna, "Ganitha Piyasa: Effective Lesson Delivery Method for Graphical Dyscalculia Students," *2023 5th International Conference on Advancements in Computing (ICAC)*, Colombo, Sri Lanka, 2023, pp. 263-267, doi: 10.1109/ICAC60630.2023.10417645. Available at: https://vpn.sliit.lk/proxy/177b3523/https/ieeexplore.ieee.org/document/10417645 (Accessed: 23 August 2024).

SMART EDUCATIONAL TOOL FOR IDENTIFICATION, REDUCING THE IMPACT OF DYSLEXIA AND SKILL ENHANCEMENT IN PRIMARY SCHOOL STUDENTS

Group id -24-25J-325

Project Proposal Report

Gamlathge G.G.A.U. – IT21173868

Supervisor: Ms. Wishalya Tissera

Co-Supervisor: Dr. Dharshana Kasthurirathna

B.Sc. (Hons) Degree in Information Technology
Specialized in Information Technology

Department of Information Technology
Sri Lanka Institute of Information Technology
Sri Lanka

August 2024

DECLARATION

We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted or a degree or diploma in any other university or institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
Gamlathge G.G.A.U.	IT21173868	

Signature of the Supervisor

.....

Ms. Wishalya Tissera

Date

08/23/2024

ABSTRACT

The increasing prevalence of learning disabilities among children is one of the biggest concerns in the sphere of education affecting the children's results and psychological state. A few examples of such disorders are dyslexia, which is a learning disorder that impairs a child's ability to read and write, and which must be diagnosed in its early stage. The purpose of this research is to design a smart mobile application that will address the difficulties experienced by children with dyslexia and other learning disabilities in relation to writing. The proposed solution involves OCR and NLP to analyze handwriting and typed text and offer feedback with timely learning for the child. Using machine learning models the application will identify signs of dyslexia, dysgraphia, and other related disorders, so that a proper support can be provided. This will also apply to the mobile application of the software, where the components such as real time writing, performance analysis, and the interactive learning tools will be made available to both educators and parents. It also seeks to improve the delivery of education to children with dyslexia as well as the general provision of education that caters for all the children's needs. The findings of this research will help in the improvement of knowledge concerning learning disabilities and aid in the formulation of early identification and intervention procedures.

Keywords – Dyslexia, Dysgraphia, Learning Disabilities, Machine Learning, Natural Language Processing, OCR, Real-Time Feedback.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation	**Description**
IP	Image Processing
ML	Machine Learning
NLP	Natural Language Processing
OCR	optical character recognition

1. INTRODUCTION

Dyslexia is a learning disability that affects the reading and writing abilities of individuals, particularly in understanding and processing language. It is estimated that dyslexia impacts 5-10% of the global population, affecting students' ability to learn and perform academically. While a significant amount of research and technology has been devoted to understanding dyslexia's effects on reading, writing challenges remain a less explored area. Writing difficulties, also known as dysgraphia, often accompany dyslexia and can pose substantial challenges in academic and everyday settings, impacting students' confidence, academic success, and social integration.

Traditional approaches to diagnosing and supporting dyslexic students have primarily focused on reading disabilities, leaving a critical gap in addressing writing difficulties. Current technologies such as Optical Character Recognition (OCR) and Natural Language Processing (NLP) have been utilized to some extent in identifying dyslexia from printed and typed texts. However, these technologies often fall short in recognizing handwriting patterns typical of dyslexia and fail to provide real-time, interactive feedback that could help students improve their writing skills. Moreover, existing solutions are often static and do not adapt to individual users' needs, limiting their effectiveness in supporting personalized learning experiences.

To address these challenges, this project proposes the development of a mobile application that leverages advanced machine learning algorithms and NLP techniques to analyze and interpret handwritten text in real-time. The application aims to identify specific writing patterns associated with dyslexia and provide immediate feedback and corrective suggestions to users, helping them to improve their writing skills. By incorporating features such as voice-based feedback and a user-friendly interface, the system will offer an engaging and effective tool for students, teachers, and parents to support the learning and development of individuals with dyslexia.

This application has the potential to transform the way dyslexia and dysgraphia are managed, providing a comprehensive solution that not only identifies writing disabilities but also empowers users to overcome these challenges through interactive and adaptive learning methods. By bridging the gap between technology and education, the proposed solution aims to enhance the educational support provided to students with dyslexia, ultimately improving their academic outcomes and boosting their confidence.

1.1.Background & Literature survey

Dyslexia is a learning disorder which is manifested through difficulties in reading and writing whereby a person is likely to have problems in understanding written language, and also, to write coherently. Dyslexia writing difficulties are the main concern of this project, which aims to build a smart mobile application that comes with OCR and NLP.

A significant body of research has explored various approaches to assist individuals with dyslexia. Traditional methods often involve personalized tutoring, phonics-based instruction, and multisensory learning techniques. However, these methods require significant time, resources, and trained professionals, which are not always available, especially in under-resourced areas. Digital solutions, such as mobile applications and computer-based programs, have gained popularity in recent years due to their accessibility and scalability. These solutions leverage machine learning and NLP to offer personalized learning experiences tailored to the specific needs of the user.

The literature suggests that the integration of machine learning and NLP in educational tools can significantly enhance the learning experience for dyslexic individuals. For example, machine learning models can be trained to recognize dyslexic writing patterns and provide corrective feedback, helping users improve their writing skills over time. Similarly, NLP can be used to analyze text input, providing insights into common errors and suggesting appropriate corrections. These tools can also support multimodal learning by combining text, audio, and visual elements to cater to different learning styles, which is particularly beneficial for individuals with dyslexia.

Moreover, the use of handwriting recognition and analysis offers a unique advantage in identifying dyslexia. Handwriting samples provide a rich source of data that can be analyzed to detect signs of dyslexia, such as letter reversals, inconsistent letter sizes, and irregular spacing. OCR (Optical Character Recognition) technology, combined with machine learning, can be used to digitize and analyze handwriting, providing real-time feedback and support to users. This approach not only aids in identifying dyslexia but also helps in developing targeted interventions to improve writing skills.

While significant progress has been made in developing digital solutions for dyslexia, there remains a gap in integrating these technologies into a comprehensive, user-friendly platform that caters to diverse linguistic and cultural contexts. Most existing solutions are primarily designed for English-speaking users and may not be effective for individuals who speak other languages. There is a need for inclusive tools that support multiple languages and are adaptable to various educational systems and cultural nuances.

The proposed research aims to address this gap by developing a smart mobile application designed specifically to mitigate dyslexia. The application will utilize machine learning and NLP

to analyze both text and handwriting input, providing real-time assistance and feedback to users. By incorporating a user-friendly interface that allows for text input via keyboard and handwriting input through drawing interfaces, the application will cater to a wide range of user preferences and needs. The goal is to provide a comprehensive solution that not only assists in identifying dyslexia but also offers practical strategies to improve reading and writing skills, ultimately enhancing the learning experience for individuals with dyslexia.

1.2.Research Gap

Although there are technologies that can help diagnose dyslexia, there is still a lack of technology-based solutions for diagnosing and helping dyslexic learners in real-time using real-time feedback and multimedia incorporated into the English language instruction. Such systems are inadequate in addressing both reading and writing difficulties in students. Many current approaches are oriented primarily on the reading disorders, whereas the writing disorders, which are as important, are investigated less frequently. Most of today's systems use OCR and NLP to identify dyslexia signs in the printed and typed text. However, these systems do not have the capacity to offer real-time feedback that can assist users in recognizing their errors and promptly rectify them. Additionally, many systems do not incorporate multimodal learning methods, such as integrating auditory and visual aids, which are essential for creating an engaging and effective learning experience for users with dyslexia.

Furthermore, existing solutions are often designed as standalone applications that do not fully utilize the potential of machine learning for personalized, adaptive learning experiences. They lack the ability to dynamically adjust to the individual needs of users based on continuous performance monitoring and feedback.

For example, Study A [1] discusses a mobile application that addresses writing, reading, and speaking weaknesses in dyslexia using a static set of exercises without adaptive feedback. Study B [2] focuses on a learning ecosystem for overcoming reading weaknesses in Sinhala, but does not address writing disabilities or provide real-time assistance. Study C [3] presents a machine learning model for early identification of dyslexia but lacks integration with interactive and multimodal educational tools that could provide a comprehensive learning solution.

Furthermore, the proposed system can recognize and process handwritten text, typed text in multiple languages including Sinhala and it is more efficient than the other methods which often focus on more popular languages or lack effective handwriting recognition support. Using modern machine learning approaches, the system will not only recognize dyslexia markers in writing but also offer suggestions on how to overcome the issue.

These gaps prove the importance of the future research on the creation of the system that can accurately recognize writing disabilities in real-time using the English language-specific advanced OCR and NLP tools. The proposed system will leverage machine learning to provide adaptive, personalized feedback, integrate multimedia learning methods, and support both reading and writing abilities, addressing the identified gaps in current technologies.

Table 1.1 Comparison of previous Research

Application References	**Handwriting Analysis**	**Typed Text Analysis**	**Realtime Assistance Feedback**	**Multimodal Integration**
Research A	✓	✗	✓	✓
Research B	✗	✓	✗	✓
Research C	✗	✗	✓	✗
Proposed System	✓	✓	✓	✓
Accuracy	Positive results	Positive results	Positive results	High Accuracy expect

2. RESEARCH PROBLEM

The main problem this project is going to solve is the problem of recognizing and interpreting the handwritten text concerning dyslexia and the impact it has upon reading and writing skills. As a result, people with dyslexia find it difficult to write in ways that can be easily interpreted and scrutinized utilizing handwriting skills in educational and other aspects of people's lives.

Modern approaches to text recognition, especially in the case of handwritten text, do not work properly in a dyslexic handwriting style. Most OCR technologies and text processing tools used in traditional assistive technology solutions are unable to handle the nature of dyslexic handwriting and may misinterpret or provide inadequate support.

The proposed solution is a mobile application designed to scan and analyze handwritten text using advanced machine learning algorithms and Natural Language Processing (NLP). This application aims to provide a comprehensive tool for identifying and interpreting writing patterns associated with dyslexia. By offering real-time feedback and corrective suggestions, the system seeks to improve the readability of handwritten text and support users in overcoming writing challenges.

A key feature of the proposed application is its ability to recognize and analyze dyslexic handwriting with a high degree of accuracy, something that existing systems often struggle with. The application will also include interactive elements such as voice-based feedback to aid users in understanding and correcting their writing. Performance will be evaluated based on the accuracy of text recognition, user satisfaction, and the overall effectiveness of the application in improving writing skills.

The research problem centers on developing a solution that not only addresses the limitations of current text recognition technologies but also provides a practical and user-friendly tool for individuals with dyslexia. The potential impact of this system extends to enhancing educational support, improving writing abilities, and boosting the confidence of those affected by dyslexia.

3. OBJECTIVES

3.1. Main Objectives

The primary goal of this project is to develop a mobile application that effectively addresses writing disabilities associated with dyslexia. The application will utilize advanced machine learning algorithms and Natural Language Processing (NLP) techniques to analyze and interpret handwritten text. By integrating real-time feedback and corrective suggestions, the application aims to provide a practical and effective tool for individuals with dyslexia to improve their writing skills and overcome common writing challenges.

3.2. Specific Objectives

- **Develop Handwriting Recognition:** Implement advanced machine learning algorithms to recognize and digitize handwritten text, focusing on capturing the unique patterns associated with dyslexic handwriting.
- **Analyze and Interpret Text:** Utilize Natural Language Processing (NLP) to accurately interpret and analyze the digitized text, identifying specific dyslexia-related writing patterns and providing meaningful feedback.
- **Enhance User Interface:** Create an intuitive and user-friendly interface that displays analyzed text and correction suggestions clearly, making it easier for users to understand and apply the feedback.
- **Integrate Real-Time Assistance and Feedback:** Implement features that offer real-time analysis and assistance to correct grammar and writing errors, providing users with immediate guidance on improving their writing skills.
- **Incorporate Voice-Based Technology:** If beneficial, include voice-based feedback to read out suggestions and corrections, supporting users who may find auditory information more accessible.

4.METHODOLOGY

The effectiveness and user satisfaction of the proposed mobile application for mitigating dyslexia will be evaluated through a comprehensive mixed-methods approach. The study will be conducted in two main stages: development and testing.

4.1 Data Acquisition and Integration

- **Handwritten Data Collection**: Handwritten text samples are collected from individuals with dyslexia. These samples include various writing exercises designed to capture different aspects of writing disabilities, such as letter formation, spacing, and word structure.
- **Textual Data Analysis**: The collected handwritten text samples are digitized using Optical Character Recognition (OCR) technology. The OCR process converts the handwritten text into machine-readable text while preserving unique dyslexic handwriting patterns. This data is crucial for understanding the specific writing challenges faced by individuals with dyslexia.
- **NLP Data Processing**: Natural Language Processing (NLP) techniques are applied to analyze the digitized text. The NLP process focuses on identifying specific dyslexia-related writing patterns, such as letter reversals, misspellings, and inconsistent spacing. This analysis helps in extracting meaningful features that will be used for further machine learning modeling.

4.2 Preparation of AI/ML Models

- **Model Development**: Machine learning models are developed to analyze the extracted features from the digitized text. These models are designed to recognize patterns indicative of dyslexia, such as frequent spelling mistakes, inconsistent handwriting, and unusual letter spacing. Various algorithms, including neural networks, support vector machines (SVM), and decision trees, are trained to classify the text as dyslexic or non-dyslexic.
- **Model Training and Optimization**: The machine learning models undergo training using labeled data, where handwriting samples are annotated as dyslexic or non-dyslexic. Optimization techniques, such as feature selection, dimensionality reduction, and hyperparameter tuning, are employed to enhance the accuracy and robustness of the models.

4.3 User Interface and Real-Time Feedback

- **Interactive User Interface**: An intuitive and user-friendly interface is developed for the mobile application. The interface displays real-time analysis results and corrective

suggestions to users, allowing them to understand and improve their writing. The interface also includes voice-based feedback options to accommodate users who prefer auditory guidance.

- **Real-Time Assistance**: The application integrates real-time handwriting recognition and feedback mechanisms. As users write, the system provides immediate analysis and suggestions, highlighting errors and offering corrections to improve handwriting quality. This real-time assistance is critical for helping users develop better writing habits and skills.

4.4 Collaborative Development Environment

- **Version Control and Collaboration**: The development environment, including AI/ML model code, data processing scripts, and user interface components, is hosted on a version control platform like GitHub. This setup facilitates collaborative development, version control, and transparency among the research team, ensuring efficient and coordinated progress.

By integrating handwriting data collection, OCR and NLP analysis, and machine learning models, the proposed mobile application offers a comprehensive solution for recognizing and interpreting dyslexic handwriting. The inclusion of real-time feedback and a user-friendly interface aims to improve the writing skills of individuals with dyslexia, providing them with valuable support in overcoming their writing challenges.

4.1. System Architecture

For the proposed dyslexia mitigation application, a client-server architecture is considered the most suitable approach. This design divides the system into two main components: the client and the server. The client, which operates on the user's device, is responsible for capturing handwritten text samples and interacting with the user. It uses machine learning algorithms and Natural Language Processing (NLP) techniques to preprocess and recognize the text, and provides real-time feedback and corrective suggestions based on the analysis.

The other component is the server that is responsible for the complicated computational processes. It gets the text samples from the client, uses the best machine learning models and NLP algorithms to understand and analyze the handwriting and provides the required feedback. Further, the server is responsible for the storage and access of the user data; that is, the handwriting samples and the analysis results.

The client server model has the following advantages; scalability, reliability and security. Scalability is achieved as the architecture can support multiple users at the same time and does not slow down the system. This is important for handling different loads and an increasing

number of users. This is because different components of the client and server are independent of one another, and therefore problems in one do not directly affect the other; this makes the system more reliable and easier to debug. Another advantage is the security since the server can put in place mechanisms to enhance data security such as encryption and access control. Furthermore, the architecture promotes easy changes and updates since the changes can be done on the server side without affecting the client application, which makes it easy to improve and enhance the application.

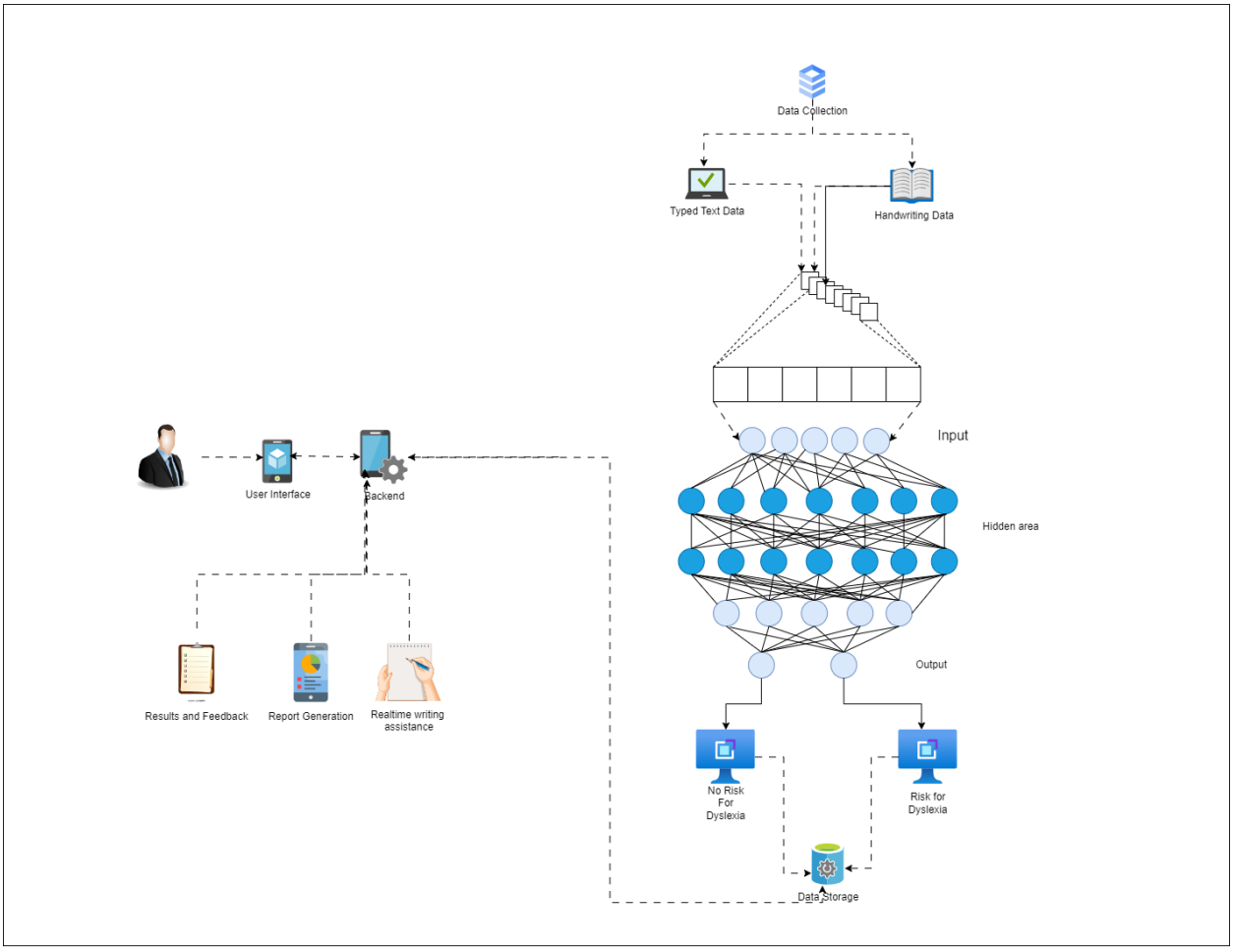

Figure 4.1 System Architectural Diagram for Dyslexia identification and mitigation Component

4.2. Software Solution

The proposed software solution for mitigating dyslexia is designed to offer an effective and accessible method for analyzing and improving handwritten text. This application will integrate several key components to address the challenges associated with dyslexic handwriting. At its core, the software will feature an advanced image processing algorithm capable of digitizing handwritten text. This algorithm will convert handwritten samples into a digital format that can be analyzed further.

Software Development Life Cycle (SDLC) is a crucial framework employed to develop a reliable and effective mobile application aimed at identifying dyslexia-related writing disabilities and supporting the development of writing skills. The SDLC is instrumental in ensuring that the final product aligns with the requirements of its primary users, which include students, educators, and parents. This structured approach is pivotal in delivering a high-quality, user-friendly, and efficient solution for identifying dyslexia and providing writing assistance.

The SDLC methodology provides a detailed roadmap for organizing, creating, and maintaining the mobile application tailored for dyslexia intervention. It encompasses various stages, each of which is critical to the overall success of the development process. These stages are interdependent, where the output of one phase forms the foundation for the next, fostering a smooth and continuous workflow throughout the project lifecycle.

The key stages of the SDLC model, as depicted in **Figure 3.2**, include:

1. **Requirement Analysis**: This initial stage involves gathering detailed requirements from stakeholders, such as educators, parents, and students. The aim is to understand the specific needs related to dyslexia identification and writing skill development, ensuring the application meets its intended purpose.
2. **System Design**: Based on the requirements gathered, the system design phase focuses on developing the architecture of the application. This includes designing the user interface, determining the data flow, and planning the integration of various machine learning models and NLP algorithms for handwriting analysis.
3. **Implementation**: In this phase, the actual coding and development of the application take place. The machine learning models and NLP algorithms are implemented, and the user interface is developed to provide a seamless user experience.

4. **Testing**: After implementation, rigorous testing is conducted to ensure the application functions as intended. Various types of testing, including unit testing, integration testing, and user acceptance testing, are performed to identify and rectify any bugs or issues.
5. **Deployment**: Once testing is successfully completed, the application is deployed to a production environment where it becomes accessible to the intended users. During this phase, initial feedback from users is gathered to identify any areas for improvement.
6. **Maintenance**: Post-deployment, ongoing maintenance is essential to ensure the application remains functional and up-to-date. This stage involves monitoring performance, fixing any emerging bugs, and implementing updates based on user feedback and technological advancements.

4.3.Commercialization

Target Audience

- **Primary Schools**:
  The primary audience for this system includes primary schools aiming to provide early detection of dysgraphia in students. Teachers and school administrators are key users who will benefit from the system's capabilities to identify students with dysgraphia and provide tailored support. The application is designed to assist educators in monitoring student progress and implementing personalized intervention strategies to improve writing skills and manage dysgraphia effectively.
- **Parents**:
  Parents of primary school students represent another crucial target audience. The system enables parents to monitor their child's writing progress and collaborate with teachers to support their child's learning journey. By providing real-time feedback and detailed insights into writing patterns, the system empowers parents to be actively involved in their child's educational development and address writing challenges early.
- **Educational Therapists**:
  Educational therapists and professionals specializing in learning disabilities will find the system valuable for diagnosing dysgraphia and developing effective intervention plans. The application provides these professionals with advanced tools to analyze handwriting samples, identify specific dysgraphia-related patterns, and recommend appropriate strategies to improve writing skills.

Market Space

- **Education Sector**:
  The primary marketplace for the system is the education sector, specifically targeting primary schools and special education centers. The application aims to make a significant impact by improving the early detection and intervention of dysgraphia, thereby enhancing student outcomes. By equipping educators with advanced tools for handwriting analysis and feedback, the system supports a proactive approach to learning disability management.
- **EdTech Industry**:
  Beyond traditional educational institutions, the system has potential in the broader EdTech market. It can be positioned as a specialized tool for learning disability detection and support, expanding its reach to a wider audience within the educational technology space. As a part of the growing EdTech industry, the application can cater to various educational programs and platforms, offering innovative solutions for writing skill development and dysgraphia management.

5.REQUIREMENTS

5.1. Functional requirements

- User Registration and Authentication
- I**mplement CNN Models**: Develop Convolutional Neural Network (CNN) models capable of analyzing handwriting features to identify writing disabilities, such as dysgraphia, in students. The models should accurately detect and classify dysgraphia-related patterns in handwriting.
- **Provide Real-Time Feedback**: The system must offer real-time feedback to students based on the analysis of their handwriting, allowing them to immediately understand and correct their writing errors.
- **Collaborative Platform Development**: Create a collaborative platform where students, teachers, and parents can share information, monitor progress, and communicate effectively. This platform should facilitate discussions, feedback, and continuous support.
- **User Interface Design**: Design an intuitive and user-friendly interface that is accessible to students, teachers, and parents, enabling them to interact seamlessly with the system and access relevant features.

- **Progress Visualization Tools**: Incorporate tools for visualizing student progress over time, highlighting areas for improvement and providing actionable insights for teachers and parents to help guide students' learning paths.

5.2. Non-Functional requirements

- L**ow Latency Feedback**: The system must deliver real-time feedback with minimal latency to ensure a responsive user experience.
- **Scalability**: The system should be scalable to handle an increasing number of users and handwriting samples without degradation in performance.
- **Reliability and Accuracy**: The system must maintain high reliability with minimal downtime and provide accurate analysis of handwriting samples to ensure trustworthy feedback.
- **Security and Privacy**: Implement robust security measures to protect student data and maintain user privacy, adhering to relevant data protection regulations and standards.
- **User Interface Usability**: The user interface should be intuitive and easy to use, requiring minimal training for effective utilization by all user groups.
- **Maintainability**: The system should be designed for easy maintenance, allowing for seamless updates, bug fixes, and enhancements to be deployed as needed.

5.3. System requirement

- **Compatibility**: Ensure the system is compatible with existing educational tools and infrastructure, enabling seamless integration into the current learning environment.
- **Integration with Technology**: The system should seamlessly integrate with image processing libraries, machine learning frameworks, and databases to support its functionalities.

5.4. Software requirement

- **Image Processing Libraries**: Utilize image processing libraries such as OpenCV for digitizing and analyzing handwriting samples, ensuring high-quality image handling and processing.
- **Machine Learning Frameworks**: Implement CNN models using machine learning frameworks like TensorFlow or PyTorch to provide robust handwriting analysis capabilities.
- **Database Management**: Employ a reliable database management system for efficient data storage, retrieval, and management, ensuring smooth operation and data integrity.

5.5. User requirement

- Basic knowledge about smartphones and apps.

6.GANTT CHART

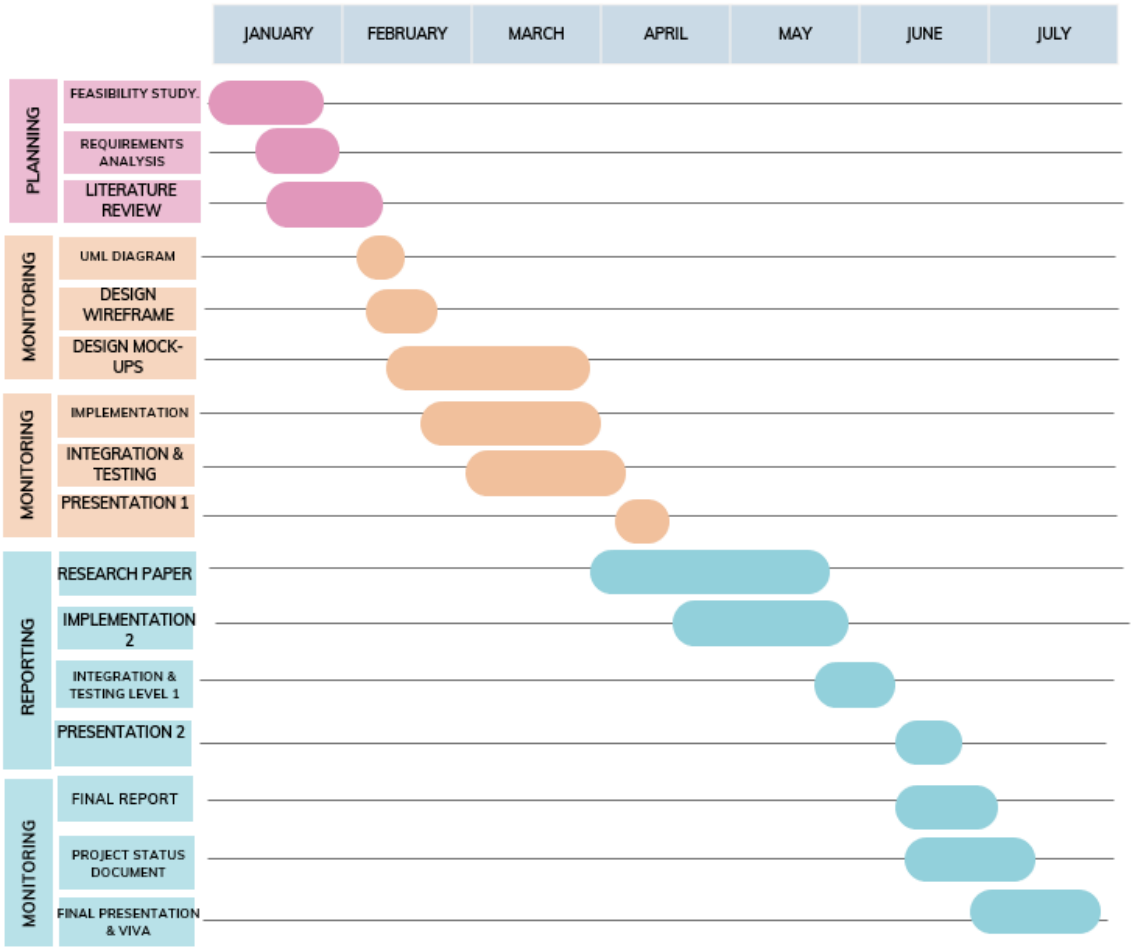

Figure 6.1 Gantt chart

7.WORK BREAKDOWN STRUCTURE (WBS)

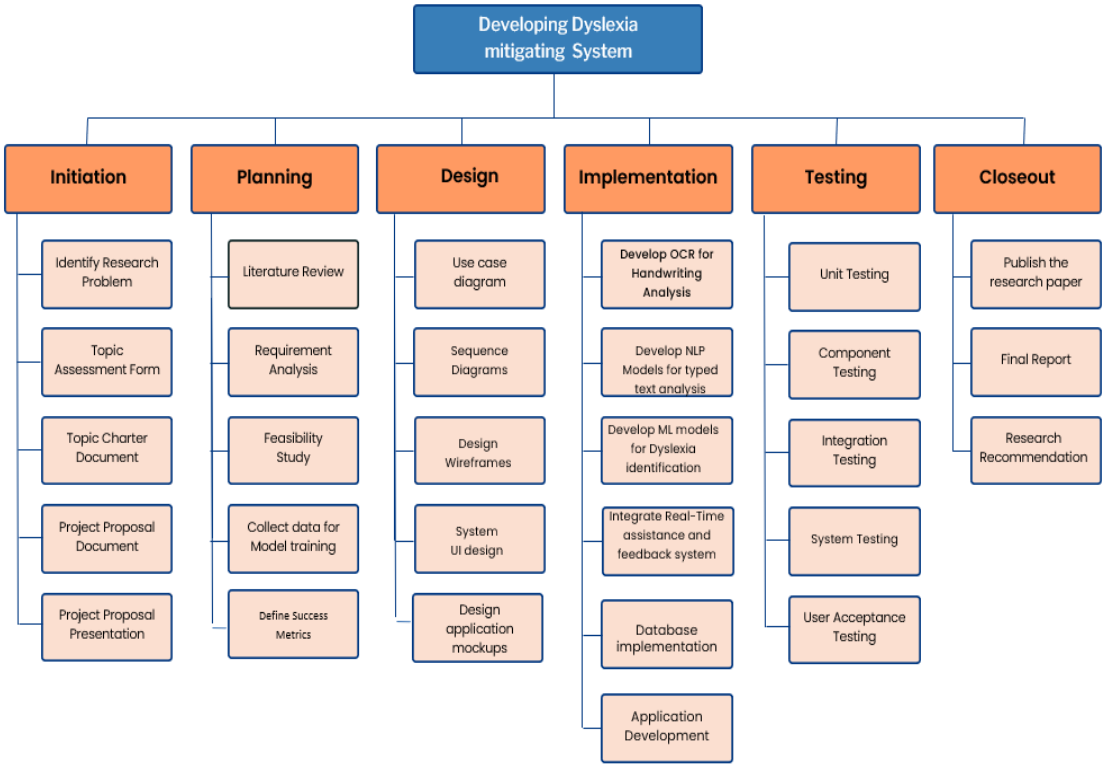

Figure 7.1 Work Breakdown Structure for Dyslexia identification and mitigating Component

8.BUDGET AND BUGET JUSTIFICATION

Expenses	
Requirement	**Cost (Rs.)**
Cost of Deployment	**15 000/-**
Testing and qa	**7 500/-**
Travelling cost	**10 000/-**
Commercialization	**20 000/-**
Hosting cost	**35 000/-(annual)**
Total Cost	**87 500/-**

1.2 The overall budget of the entire proposed system.

9.REFERENCES

[1] S. Thelijjagoda, M. Chandrasiri, D. Hewathudalla, P. Ranasinghe, and I. Wickramanayake, "The Hope: An Interactive Mobile Solution to Overcome the Writing, Reading and Speaking Weaknesses of Dyslexia," The 14th International Conference on Computer Science & Education (ICCSE 2019), pp. 150-155, Aug. 19-21, 2019, Toronto, Canada.

[2] L. Sandathara, S. Tissera, R. Sathsarani, H. Hapuarachchi, and S. Thelijjagoda, "Arunalu: Learning Ecosystem to Overcome Sinhala Reading Weakness due to Dyslexia," in 2020 2nd International Conference on Advancements in Computing (ICAC), 2020, DOI: 10.1109/ICAC51239.2020.9357268.

[3] S. Divakar and T. Mookkaiah, "Enhancing Dyslexia Awareness: A ML Model for Early Identification and Support," in 2024 International Conference on Communication, Computing and Internet of Things (IC3IoT), 2024, DOI: 10.1109/IC3IoT60841.2024.10550200