IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: **24 - 25J - 233**

1. Topic (12 words max)

AI-based Personalized Rehabilitation for Dyslexia and Dyscalculia Adolescents

2. Research group the project belongs to

Software Systems & Technologies (SST)

3. Research area the project belongs to

Bio-Medical and Health Informatics (HI)

4. If a continuation of a previous project:

Project ID	
Year	

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

Dyslexia is a learning disorder where individuals struggle with accurate word recognition, poor spelling, recognizing or identifying shapes, numbers, colors or speech sounds and learning how they relate to letters and words (decoding). (De Saram et al., 2023; Babu et al., 2022)

One focused area should be providing motivation as the most predictable experience for the age groups of children with dyslexia is the recognition of them as lazy and incompetent in their school days, which seems to be better now with the social awareness of learning disabilities. However, children with some risk level of dyslexia still have to face many difficulties in their education, hence resulting in lowering their self-esteem and frustration. (Alsobhi et al., 2014)

There are readily available Assistive Technologies that offer the potential to help students with learning difficulties such as dyslexia. However, the focus should not be correlating one technology to one disability. Instead of identifying different pedagogical needs, such as help with reading and writing. (Alsobhi et al., 2014)

Current educational games often lack real-time adaptability, leading to frustration and disengagement in learners. (Vural, 2024) The problem is the absence of adaptive systems that detect and respond to emotional and engagement cues through facial expressions and gestures.

(Manalu, 2024; Zhiqun, 2022) These systems can dynamically adjust difficulty, crucial for enhancing motivation and learning outcomes.

To enhance the accuracy and efficiency the utilization of proven efficient methods such as chromatic variation to ease the readability have to be incorporated when developing solutions (Pinna & Deiana, 2018) but should focus on the usability as vision-related symptoms are more frequent in children with dyslexia. (Raghuram et al., 2019) And, regarding the auditory support, features such as customizing speed, pitch, volume, and voice can be utilized. (Rajapakse et al., 2018)

Furthermore, the approach should be more personalized with many features which can be customized according to their disability, letting them engage with their surroundings effortlessly and more enthusiastically as the symptoms vary in the context of the severity of dyslexia. (Rajapakse et al., 2018).

On the other hand, Dyscalculia is a unique learning disability that affects a person's ability to comprehend and manipulate numbers. (Aydemir, 2015) It manifests in difficulties with basic arithmetic skills, understanding number concepts, performing calculations, and understanding spatial relationships involved in math problems (Rebecca Simon, 2004).

Traditional instruction methods have consistently proven inadequate in effectively teaching mathematics to students with special needs. This shortfall highlights a critical need for alternative approaches that cater to the unique learning requirements of these students. (Aydemir, 2015)

Among the various innovative strategies, multisensory teaching methods have gained prominence due to their potential to enhance learning outcomes by engaging multiple senses. By incorporating visual, tactile, and kinesthetic elements, TouchMath aims to provide a comprehensive learning experience that addresses the diverse needs of students with special needs. (Ahmet Yıkmış, 2022; Aydemir, 2015)

In summary, the future of assistive technologies for dyslexia and dyscalculia should focus on personalized multi-sensory teaching methods incorporating the findings in medical treatment and should be concerned about the emotions and capabilities of the individuals.

References

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6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

The proposed system will be a systematic approach to address the deficiencies in the existing systems and to be precise on the objective,

- Target group: The ones who teach dyslexia and dyscalculia children
- Target children's age limit: In between 8 to 12

The system will comprise four main features and some sub-functions as follows.

1. **Chromatic variation-based teaching to improve the reading skills.**
    a. Test the efficient color variations for each individual
    b. Test the best-suited chromatic variations from monochromatic, word, half-word, syllable and letter for each individual
    c. Generate personalized training tasks
2. **Personalization of voice characteristics to enhance both readability and speaking skills.**
    a. Detect the speech pace of each child by utilizing the Speech Pace Detection Mechanism (SPDM) which primarily relies on a combination of Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN)
    b. Adjust the audio and guided task descriptions according to the personalized speech pace
    c. Track the speech pace progress and adapt appropriately through continuing training tasks
3. **Touch Math methodology to teach basic mathematics to children with dyscalculia.**
    a. Reduce the complexity through touch points simplifying the abstract nature of numbers
    b. Generate basic mathematical concept teaching lessons through the concept
4. **Incorporating emotions to deliver a personalized stress-free teaching strategy.**
    a. Detect real-time emotions of children while they engage in tasks
    b. Provide emotion-based output to other components to further personalize the task durations and complexity by examining the emotions

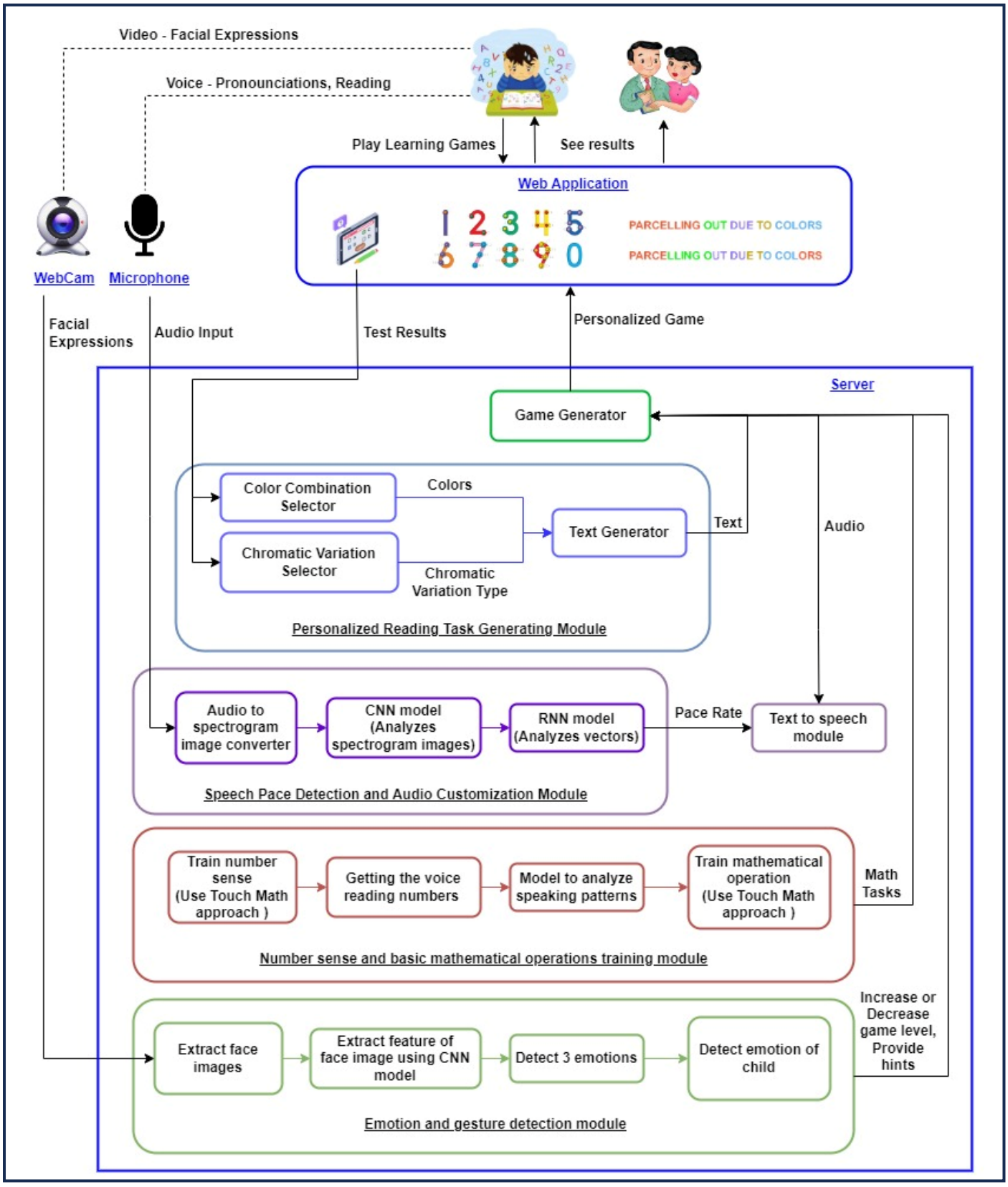

Figure 1 - Conceptual Diagram

7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

Domain Expertise

The proposed system focuses on a sensitive age category(children between the ages of 8 and 12) and a learning disability. So, the expertise knowledge from a specialist is required, and we have started contacting domain experts.

- Special education teachers specialized in dyslexia and dyscalculia teaching methods.
- Doctors specialized in treating children with dyslexia and dyscalculia.

Data Requirements

At the time of deployment, the system has to be tested and validated to find the efficiency and the accuracy. So, children with dyslexia and dyscalculia have to be found and we have started contacting;

- The Ayati Centre to request permission to engage with the children.

In the first phase of model training for speech pace recognition, and emotion detection some data sets have been found in Kaggle and we are continuing the process of finding the required data sets.

- Non-Native Children English Speech (NNCES) Corpus (https://www.kaggle.com/datasets/kodaliradha20phd7093/nonnative-children-english-speech-nnces-corpus)

Knowledge

For the development of the system we have identified knowledge of the following areas are required and we are in the process of learning them.

- Speech Pace Detection Mechanism (SPDM)
- Convolutional Neural Networks (CNN)
- Recurrent Neural Networks (RNN)
- Emotion Detection Algorithms

- Natural language processing (NLP)
- Sentence Segmentation
- Machine Learning
- Model Training
- Decision Tree Algorithm
- Scientific teaching strategies
- Web Development
- User Interface Design and User Experience Engineering
- Test Driven Development
- Project Management

8. Objectives and Novelty

Main Objective

The ultimate objective of the proposed innovative system is to deliver a personalized assistive learning platform for children with dyslexia and dyscalculia to overcome their educational obstacles by incorporating with the emerged Information Technological findings with already proven teaching strategies used in physical environment.

Member Name	Sub Objective	Tasks	Novelty
Silva T.U.D	Enhancing reading skills by utilizing chromatic variations ensuring personalized delivering of tasks, individuals satisfaction and usability.	1. Create a sample test to identify the efficient color combinations for the child. 2. Create a sample test to identify the most efficient chromatic variation type for the child. 3. Create a test to check the reading skills of the child to customize the complexity levels of the tasks. 4. Create personalized reading task plans for each child.	Usage of variations in colors to separate parts of a sentence in order to ease the understanding of a sentence and to organize and plan the order of a sentence has been proven to be efficient way in improving reading skills in previous researches. Not only that but also it has been proved some color combinations are preferred or discouraged by the ones with dyslexia. Existing teaching methods has a static approach where all the children will get the same task to practice on which lacks the personalization as dyslexia symptoms and disability levels varying from each other. Hence, identifying suitable color combinations and chromatic variation type at the first attempt

			as to ensure the efficiency of the teaching approach and then providing personalized effective reading practicing tasks will fill the previous research gaps and will enhance the efficiency of the proposed approach.
Thalangama T.P.	Implementing a personalized voice/audio output to enhance relatability and stress-free environment.	1. Implementing a speech pace detection AI model that outputs the pace as a numerical value. 2. Implementing a pace incorporating text to speech (TTS) model.	Dyslexia children struggles with pronouncing, speaking, reading and also with understanding others in a conversation as their speech pace varies from others. Previous researches has proved that controlling audio characteristics such as loudness, pace ease the processing of contents with audio for children with dyslexia and hence have added the features to providing tasks in detecting the disabilities. However, with the continued learning the speaking, reading skills will be improved thus there is a requirement to provide personalized audio with these changes which have not been taken into consideration. Therefore, speech pace detecting and output generating AI solution will provide a personalized

			and adaptive learning environment for the children with dyslexia.
Dissanayake M.G.T.W.	Improving mathematics skills through AI-powered multisensory solution and TouchMath approach	1. Implement Touchpoints on numerals for tactile learning 2. Providing a memorizing approach to improve mathematical skills. 3. Integrates visual, tactile, auditory, and kinesthetic elements.	Previous researches have been focused on teaching basic mathematical functions to dyscalculia students through different approaches where most of methods covers only a one sensor focused teaching approach. And also, in previous researches has been proved methods like TouchMath which focuses on muti sensory education has increased level of effectiveness comparing with other approaches. But it is hard to find a web application or a mobile application where the TouchMath method has been used except in physical teaching environments. Hence, usage of TouchMath approach to overcome mathematical learning problems and improve memorizing skills through a gamified approach will reveal a new path and will enhance the capabilities of teaching approaches.

Madusanka G.K.I	Dynamic changing of difficulty levels in tasks and providing supportive guides on performing tasks where necessary to avoid frustration and stress by detecting real time emotions of dyslexia and dyscalculia children.	1. Emotion Recognition Algorithm Development 2. Real-Time Adaptive Feedback Loop 3. Personalized Emotional Baseline Establishment 4. Integration of Emotion Regulation Strategies and provide feedback to educators and parents	Dyslexia and dyscalculia children can be suffer from levels of anxiety or frustration with the lower esteemed nature with their learning disabilities. Previous researches have been proven that emotion is a serious fact in all aspects. Emotions have been considered in teaching approaches for normal children, but it is hard to find a usage on teaching children with learning disabilities. If found the emotions have not been taken into consideration to adapt the teaching approaches in a way that providing guidance or support, degrading the difficulty levels of he tasks to avoid stressful learning environments. Therefore, the proposed solution will provide real-time adaptive feedback by integrating emotion and gesture recognition, dynamically adjusting game difficulty based on personalized emotional baselines. It will incorporate emotion-driven narrative

			adjustments, and gamified emotion regulation strategies, providing comprehensive feedback to educators and parents.

IT4010 – Research Project - 2024

Topic Assessment Form

1. Supervisor checklist

   a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes		No	

   b) Does the proposed topic exhibit novelty?

Yes		No	

   c) Do you believe they have the capability to successfully execute the proposed project?

Yes		No	

   d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes		No	

   e) Supervisor's Evaluation and Recommendation for the Research topic:

2. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor				
Co-Supervisor	Dr	Janina	Ahjana	20/June/2024
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

IT4010 – Research Project - 2024

Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.