Project ID:

24-25J-228

1. Topic (12 words max)

EnlightenDS:- Developing a detection System for Down Syndrome

2. Research group the project belongs to

Centre of Excellence for AI (CEAI)

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.

Down syndrome is a genetic condition caused by the presence of an extra chromosome 21, resulting in a total of 47 chromosomes instead of the usual 46. This additional genetic material profoundly impacts various aspects of individuals' cognitive, physical, and developmental abilities.

Physically, individuals with Down syndrome typically exhibit distinct features such as almond-shaped eyes, a flat facial profile, and a smaller stature. While these physical characteristics are recognizable, it is the cognitive and developmental aspects that present significant challenges. Many individuals with Down syndrome experience intellectual disabilities of varying degrees, which can range from mild to moderate or severe. This intellectual disability affects their learning abilities, problem-solving skills, and overall cognitive function.

Children with Down syndrome (DS) often struggle more with learning numbers compared to reading. This difficulty stems from their slower pace of learning and cognitive differences associated with DS, necessitating customized learning approaches. Unfortunately, there is limited theoretical guidance specifically designed to help DS children learn and master mathematics.

Educational methods have evolved over time, progressing from traditional paper and pen methods to computer applications such as courseware, and now to the latest technologies like mobile applications on smartphones and tablets. Despite these advancements, there is currently a lack of personalized mathematics learning mobile applications tailored specifically for DS children. (Ahmad, 2014)

Another significant challenge for individuals with Down syndrome is speech development. Anatomical differences such as smaller oral cavities and differences in muscle tone contribute to delays and difficulties in speech production. This leads to unclear speech, articulation challenges, and reduced intelligibility. (Chapman, 1997)

Coupled with cognitive challenges such as impaired phonological awareness and language processing, individuals with Down syndrome may find it challenging to communicate effectively. Clear speech is essential for social interactions, academic achievement, and accessing employment opportunities. (Buckley, 1993)

Furthermore, late identification of Down syndrome deprives individuals of crucial early intervention services essential for their cognitive, speech, motor and social-emotional development. Without timely detection, individuals may struggle to achieve developmental milestones, face limited access to specialized educational opportunities and encounter challenges in social integration.

Delayed diagnosis also hinders early management of associated health conditions, impacting long-term health outcomes. (M. Crombie, 2024) Early identification is therefore vital to ensuring individuals with Down syndrome receive timely support tailored to their needs, optimizing their overall development and quality of life. (Ganuwala, 2023)

Another significant challenge faced by children with Down syndrome is the unrecognized potential and talents they possess in various areas. (10 famous and successful people with Down's syndrome, 2022) Despite their capabilities, these talents are often overlooked or misunderstood by parents and caregivers who may not fully appreciate their child's strengths. However, when these talents are identified and nurtured with appropriate guidance and support, children with Down syndrome can excel and achieve remarkable accomplishments.

Unfortunately, the underestimation of their potential can lead to missed opportunities for these children to explore and develop their talents fully. This lack of recognition may result in limited access to appropriate educational and extracurricular programs that could further nurture their skills and interests. (Momaya, 2024)

Our research study aims to address the challenges outlined above by developing innovative solutions that enhance learning outcomes for children with Down syndrome and our goal is to provide comprehensive support that enables children with Down syndrome to thrive academically, socially and personally, fostering a more inclusive and supportive environment for their overall well-being.

References

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

Children with Down syndrome (DS) often face significant challenges in their education, primarily due to delays in speech, early detecting and cognitive development. The system proposed in this research project addresses these barriers by providing comprehensive solutions that enhance detection, speech and cognitive skills in DS children.
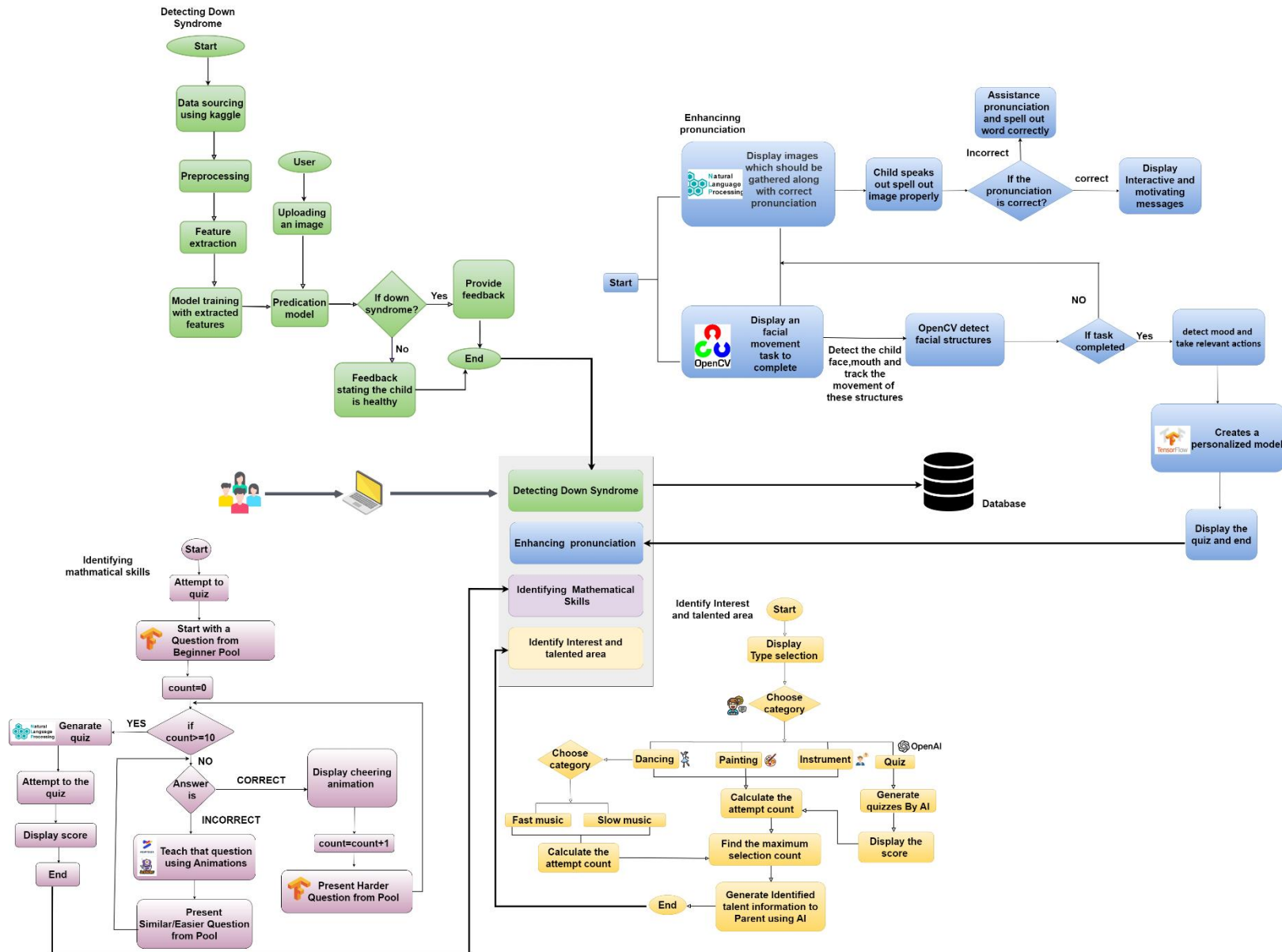
1. Detecting Down Syndrome Using Image Processing: Leveraging machine learning and image processing, we analyze facial features to detect Down Syndrome. Technologies include convolutional neural networks (CNNs) for feature extraction and classification. This requires high-quality, annotated images of children with and without Down Syndrome, covering a range of ages and ethnicities, will be crucial. These images can be sourced from public datasets like those available on Kaggle.

2. Enhancing Mathematical Skills Using Personalized Mathematical Quizzes: We utilize reinforcement learning algorithms to create personalized quizzes that adapt to the learning pace and style of everyone. Technologies involve Python libraries such as TensorFlow and Keras for building and training models. Data requirements include user performance data on various mathematical tasks and a diverse set of mathematical problems.

3. Speech and Language Processing for Enhancing Communication Skills: Natural Language Processing (NLP) and machine learning and image processing are applied to develop tools that aid speech, language and Detecting Motion and Analyzing Actions To enhance pronunciation training through motion detection and action analysis, development. Technologies include OpenCV An open-source computer vision library for real-time image processing for speech recognition and language understanding. Required data comprises speech recordings and language usage patterns of individuals with Down Syndrome.

4. In the proposed research to identify and enhance the talents of children with Down Syndrome, various technologies are employed to create an engaging learning environment. Artificial Intelligence (AI)is used for activity tracking and interest recognition to analyze engagement. JavaScript underpins the interactive functionalities, while React.js or Next.js frameworks are used to develop a responsive interface for multimedia activities. Databases store and update activity records, helping identify each child's interests and talents. This data-driven approach allows for tailored learning experiences, enabling parents and educators to nurture and develop the children's unique abilities.

Link of the diagram = https://bit.ly/4czMWtI

Detecting Down Syndrome

Start → Data sourcing using kaggle → Preprocessing → Feature extraction → Model training with extracted features → Predication model

User → Uploading an image → Predication model

Predication model → If down syndrome? → Yes → Provide feedback → End

If down syndrome? → No → Feedback stating the child is healthy → End

Enhancinng pronunciation

Start → Natural Language Processing: Display images which should be gathered along with correct pronunciation → Child speaks out spell out image properly → If the pronunciation is correct? → Incorrect → Assistance pronunciation and spell out word correctly

If the pronunciation is correct? → correct → Display Interactive and motivating messages

OpenCV: Display an facial movement task to complete → Detect the child face,mouth and track the movement of these structures → OpenCV detect facial structures → If task completed → NO → (loop back)

If task completed → Yes → detect mood and take relevant actions → TensorFlow: Creates a personalized model → Display the quiz and end

Users → Laptop → Detecting Down Syndrome → Database

- Detecting Down Syndrome
- Enhancing pronunciation
- Identifying Mathematical Skills
- Identify Interest and talented area

Identifying mathmatical skills

Start → Attempt to quiz → Start with a Question from Beginner Pool → count=0 → if count>=10 → YES → Natural Language Processing: Genarate quiz → Attempt to the quiz → Display score → End

if count>=10 → NO → Answer is → CORRECT → Display cheering animation → count=count+1 → Present Harder Question from Pool

Answer is → INCORRECT → Teach that question using Animations → Present Similar/Easier Question from Pool

Identify Interest and talented area

Start → Display Type selection → Choose category

Choose category → Dancing → Choose category → Fast music / Slow music → Calculate the attempt count → Find the maximum selection count

Painting → Calculate the attempt count → Find the maximum selection count

Instrument → Calculate the attempt count

Quiz (OpenAI) → Generate quizzes By AI → Display the score → Find the maximum selection count

Find the maximum selection count → Generate Identified talent information to Parent using AI → End

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

In this project, we are collaborating with medical professionals, particularly a Dr. Kamalini Wanigasighe who specializes in Down syndrome. Her extensive knowledge and experience with children affected by Down syndrome have been instrumental in providing a comprehensive understanding of their unique characteristics and needs. Kamalini Wanigasighe, who has over 20 years of experience working with disabled children, including those with Down syndrome, brings invaluable expertise to our team. This expertise has guided our approach in identifying symptoms, understanding the developmental challenges these children face and recognizing their potential talents. Additionally, the insights from the doctor help in refining our data collection strategies and ensuring that our methods are both ethical and effective in addressing the needs of these children.

Data Requirements:- Our data collection will involve a combination of primary and secondary data sources. For primary data, we plan to conduct focus groups and collect information from a specialized school for students with disabilities. This will provide us with direct insights and detailed, real-world data on children with Down syndrome. On the secondary data front, we will utilize datasets from sources like Kaggle, which contain relevant information that can support our analysis. This combination of primary and secondary data will ensure a robust and comprehensive dataset that reflects a wide range of experiences and scenarios.

Knowledge:- The research areas involved in this project span several advanced domains, including image processing, natural language processing (NLP), and machine learning. Image processing techniques will be used to analyze facial features and identify distinguishing characteristics of children with Down syndrome. NLP will help in analyzing speech patterns to detect specific markers of Down syndrome, supporting early diagnosis and intervention. Machine learning models will be developed to identify patterns in the collected data, enabling us to tailor educational and developmental interventions that leverage the unique strengths of each child. This multidisciplinary approach will ensure that our project not only identifies children with Down syndrome but also helps in enhancing their learning and development.

8. Objectives and Novelty

Main Objective

employ advanced technologies such as image processing and machine learning to detect key challenges faced by children with Down syndrome (DS)

Member Name	Sub Objective	Tasks	Novelty
Kumarasinghe D.P	Detecting Down syndrome using image processing so that we can cater to their requirements early and provide necessary countermeasures to enhance their performance	Initially, we are sourcing data from established repositories such as Kaggle. This dataset includes facial images of children diagnosed with Down syndrome as well as a control group of typically developing children. It encompasses both normal children and those with Down syndrome. We are utilizing this dataset to train a machine learning model capable of distinguishing between facial features associated with Down	The novelty in this approach lies in its integration of advanced image processing techniques with machine learning for the detection of Down syndrome and identification of specific facial symptoms. Unlike traditional methods that focus solely on diagnosis, this system allows users to upload images of children, where the model not only determines the presence of Down syndrome but also provides detailed feedback

		syndrome and those of typically developing children. Alongside this, our novel approach incorporates image processing capabilities where users can upload images of children, and the model determines if the child has Down syndrome based on facial characteristics. This system not only identifies the presence of Down syndrome but also provides detailed feedback on specific symptoms present in the uploaded images. For instance, if a picture with a short neck indicative of Down syndrome is uploaded, the model will analyze and identify such symptoms. To achieve this, we will implement algorithms to automatically detect and extract key facial features relevant to Down syndrome, such as eye shape, nose structure, ear size, mouth	on observable symptoms like facial features and physical attributes such as neck length.

		shape and additional physical attributes like neck length. This data will train our classification model, utilizing techniques like Support Vector Machines (SVM), Logistic Regression or simple neural networks for their straightforward implementation and interpretability. The model will then provide informative outputs upon image upload, aiding in diagnosis and support for individuals with Down syndrome.	
Jayasuriya S.H	Enhancing communication skills in children with Down Syndrome (DS) through the integration of speech and image processing technologies	Technologies: Natural Language Processing (NLP) for Speech Recognition, Image Processing for Motion Detection, Sentiment Analysis and Machine Learning (ML) for Difficulty Levels and No-SQL Database Store images along with correct pronunciations. To enhance communication skills in	To introduce novelty in pronunciation training for children with Down Syndrome (DS), advanced motion detection and action analysis will be implemented. This approach will utilize OpenCV, an open-source computer vision library for real-time image

children with Down Syndrome (DS) through advanced technology, a comprehensive approach involving multiple detailed tasks will be employed. Initially, a set of images accompanied by their correct pronunciations will be gathered and stored in a No-SQL database. This database serves as the foundation for interactive speech tasks.

1) In the first sub-task, Using Natural Language Processing (NLP) for Speech Recognition, the child will be prompted to speak out the image correctly, and their response will be assessed for accuracy, pronunciation, and punctuation. Based on their performance, motivating messages or emojis will be displayed to encourage engagement.

2) The second sub-task requires the child to spell out the word, with similar

processing, and MediaPipe, a Google framework for detecting facial landmarks, hand movements, and pose estimation. The process begins by capturing video of the child's face and movements while they speak These features will then be compared with typical pronunciation patterns to provide tailored feedback and guidance, enhancing the child's pronunciation skills through precise and interactive motion analysis

		interactive feedback provided for their spelling accuracy. NLP Assistance will be available to help correct spelling mistakes, fostering a supportive learning environment. 3)additionally, Image Processing for Motion Detection, emotion-based engagement will be integrated using image processing techniques to detect the child's mood. Depending on the detected mood, funny tasks, messages, or music will be displayed to provide emotional encouragement. 4 To ensure continuous learning and adaptation, a quiz will be conducted after each task to review the child's knowledge. Machine learning algorithms will then adjust the difficulty level based on the child's previous answers.	
Semini B.V.S	Detecting mathematical skills of children with Down Syndrome (DS) by developing	Data Collection and Analysis:	Personalization Using Reinforcement Learning:

| a personalized quiz system that adapts to their learning pace and style using reinforcement learning algorithms | Gather user performance data on various mathematical tasks. Compile a diverse set of mathematical problems covering addition, subtraction, multiplication, and division.

Model Development:

Use Python libraries such as TensorFlow and Keras to build and train reinforcement learning models. Implement algorithms that adapt quizzes based on the user's learning pace and performance.

Initial Question Pool Creation:

Create three initial question pools categorized by difficulty: Beginner, Intermediate, and Advanced. Ensure each pool covers fundamental arithmetic concepts such as addition, subtraction, multiplication, and division. | The use of reinforcement learning algorithms to create quizzes that adapt to the individual learning pace and style is a novel approach in educational technology for children with Down Syndrome.

NLP for Question Generation:
Utilizing NLP techniques to generate or adapt mathematical problems, ensuring a diverse and appropriate set of questions for each difficulty level.

Integration of Animations:
Using animation tools to create educational content that helps explain concepts and provides feedback in an engaging and understandable manner. |

		Initial Question Selection:	
		Start with a question from the Beginner pool (e.g., simple addition like 1+1). Ensure questions are basic and understandable for initial assessment.	
		Adaptive Question Logic:	
		Present slightly harder questions if the answer is correct. Provide another question of similar or slightly easier difficulty if the answer is incorrect. Implement a simple rule-based system to determine when to move to the next difficulty level (e.g., if correct answers > 5).	
		Quiz Creation at Each Level:	
		After completing a set number of questions (e.g., 10 questions) at a difficulty level, present a quiz. Create quizzes	

		from random or slightly adjusted questions from the same pool. Use NLP techniques to generate or adapt questions based on existing problem sets. Scoring and Feedback: Calculate the score based on the number of correct answers out of the total questions in the quiz. Provide feedback and animation-based explanations for incorrect answers. Move to the next difficulty level if the score is above a certain threshold (e.g., 70%) Educational Animations: Use tools like Animaker or Powtoon to create animations that explain concepts and provide step-by-step solutions for incorrect answers. Integrate animations into the learning	

		process to make explanations engaging and comprehensible.	
Methsahani K.K.S.P	Identify the interests and talents of a child with Down syndrome and sharpen up their talents.	Down syndrome children are different than the normal children. Because normal children are talented in multiple areas. Normal children can be talented with multiple areas like learning dancing, singing and many more but down syndrome children cannot do everything in different areas. They are mostly talented for one area. In this case parents should identify their talented and interested area. After that, parents need to improve their talents. Through this research we try to identify the interested area of down syndrome children. If we identify the talented are of the down syndrome children, we can Sharpe up their talents. As an example, to do that we can use couple of	Using this system, we can identify the interest and talented area of a down syndrome child. Through the selection of their choice, the system will identify the interested area of the child and helps to sharpen up their talent through quizzes and activities. Quiz generation kind of stuff is generated using AI approaches. Also, every time new quizzes and new activates are getting generate. These stuff we can mention as novel of this component.

		dancing video clips, play instrument activities and random quiz selection kind of stuff using AI technologies java script and next.js or react.js. According to the number of times those children attend the activities the record will be updated to the database. Through that we can identify their most interesting and talented areas. once we identify their interested areas, we can help to Sharpen up down syndrome children's talents.	

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9. 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:

   Recommended.

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Prof.	Samantha	Thelijjagoda	
Co-Supervisor	Dr	Junius	Anjana	20/June/2024
External Supervisor	Dr.	W.M.K	Wanigasinghe	-23/06/2024
Summary of external supervisor's (if any) experience and expertise				
Work experience in disabled child clinical exposer 20 yrs.				

This part is to be filled by the Topic Screening Panel members.

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.