

ELLIE'S ADVENTURES

A GAMIFIED APP TO IMPROVE COMMUNICATION,
EMOTIONAL, COGNITIVE AND MOTOR SKILLS IN
CHILDREN WITH AUTISM.

Proposal Presentation

RP-24-25J-114



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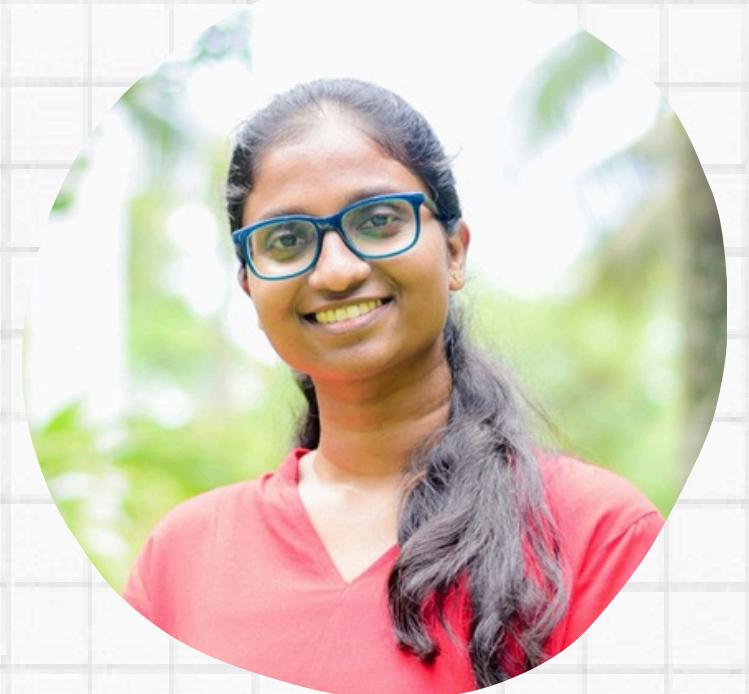
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BACKGROUND



Autism spectrum disorder, also referred to as **ASD**—constitutes a diverse group of conditions related to development of the brain



some people with autism **can live independently**, others have **severe disabilities and require life-long care** and support



Evidence-based psychosocial interventions **can improve communication and social skills**, with a positive impact on the well-being and quality of life of both autistic people and their caregivers.

INTRODUCTION

- ★ A Gamified Mobile App
- ★ Customizable 3D avatar “Ellie”
- ★ Comprises serious-game exercises addressing several focus areas
- ★ Aims to engage the child to improve in these areas

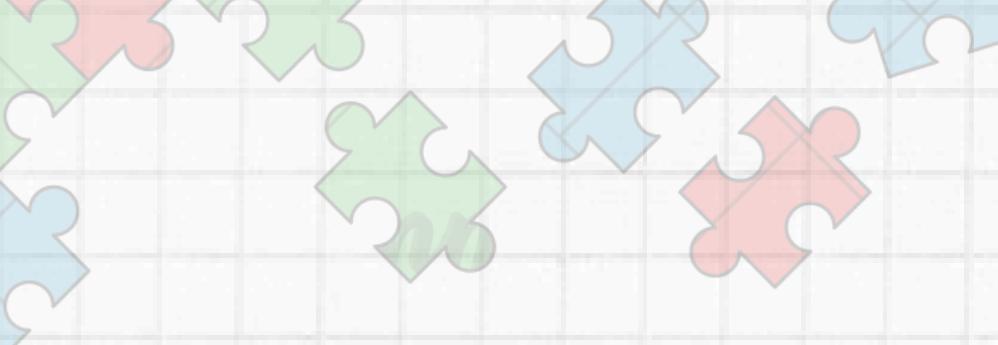


RESEARCH CONDITIONS

Autism is a spectrum of disorders, this research will be conducted for a selected community of the spectrum

1. Children between the age of 3 to 12
2. Activities to be done under parental supervision
3. Children who can speak but not comprehensively





RESEARCH PROBLEMS

- ★ Difficulty in communication such as speaking and understanding a language.
- ★ Difficulty in interacting with other people or with surrounding objects and connecting events.
- ★ Playing with toys or other objects unnaturally
- ★ Difficulty to understand their own emotions and other people's emotions





EVERY 1 IN 100



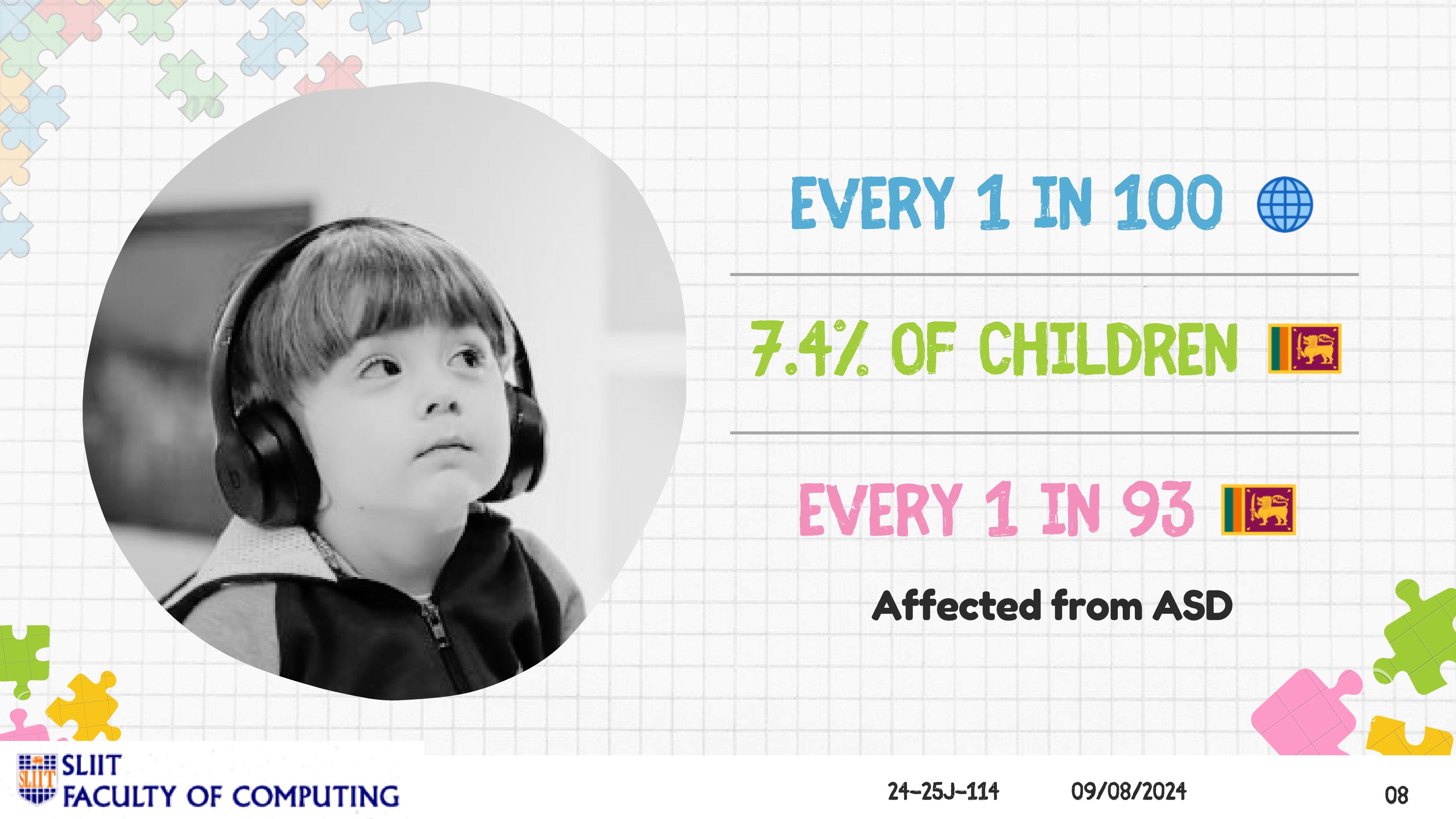
7.4% OF CHILDREN



EVERY 1 IN 93



Affected from ASD



RESEARCH PROBLEM – STATISTICAL ANALYSIS

80 %.

SPEECH DEVELOPMENT

40.9 %.

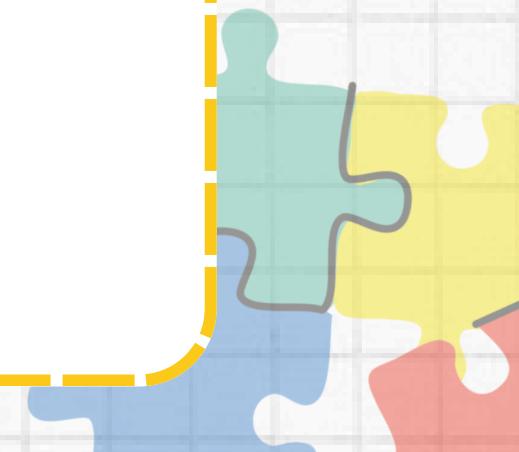
LANGUAGE COMPREHENSION

42 - 50 %.

MENTAL RETARDATION

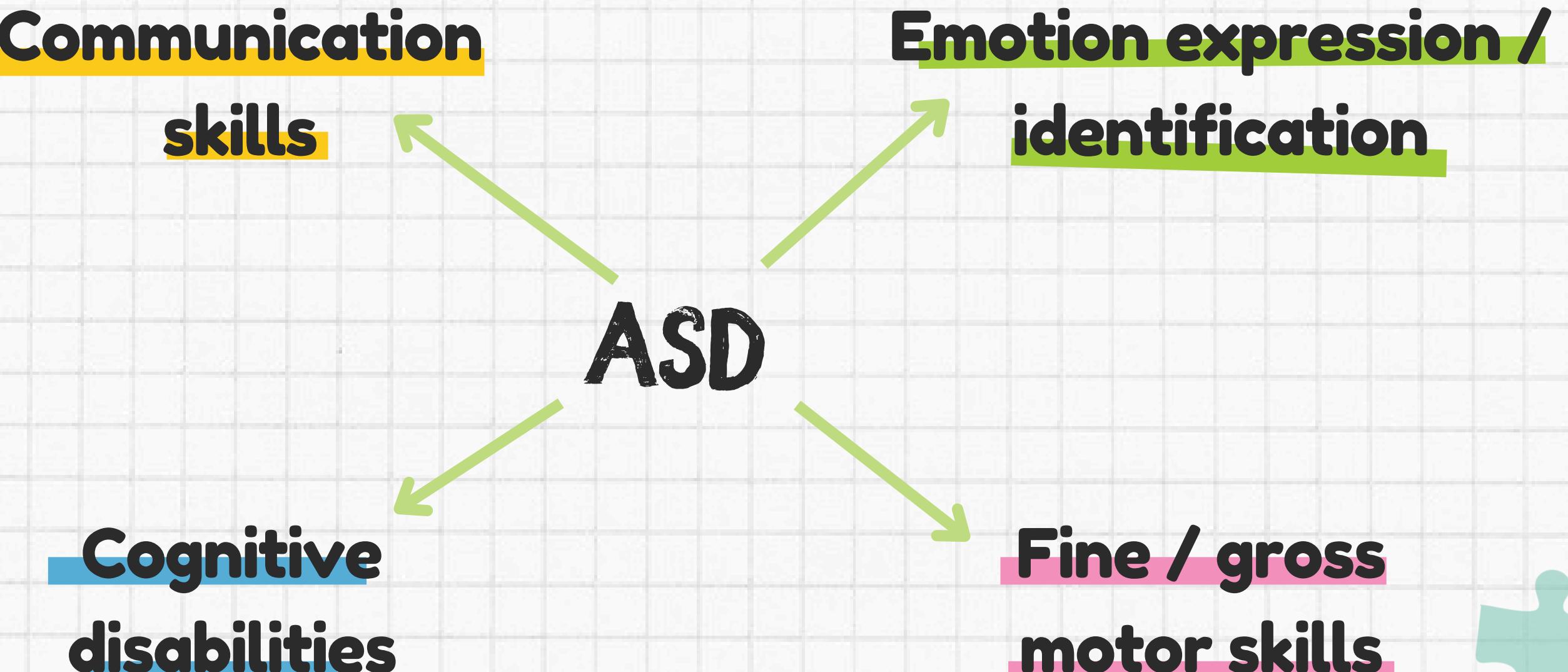
87 %.

MOTOR SKILLS





EFFECTS OF ASD ADDRESSED BY THE RESEARCH



RESEARCH OBJECTIVES

MAIN OBJECTIVE

To develop and evaluate communication and interactive skills for children with autism spectrum disorder, which aims to bridge the gap between home and therapeutic settings by providing accessible, engaging, and customizable exercises and activities that can adapt to the unique needs of each child using an avatar as the main communication agent.



Improvement of speech and language development



Improving Cognitive and Verbal Communication skills

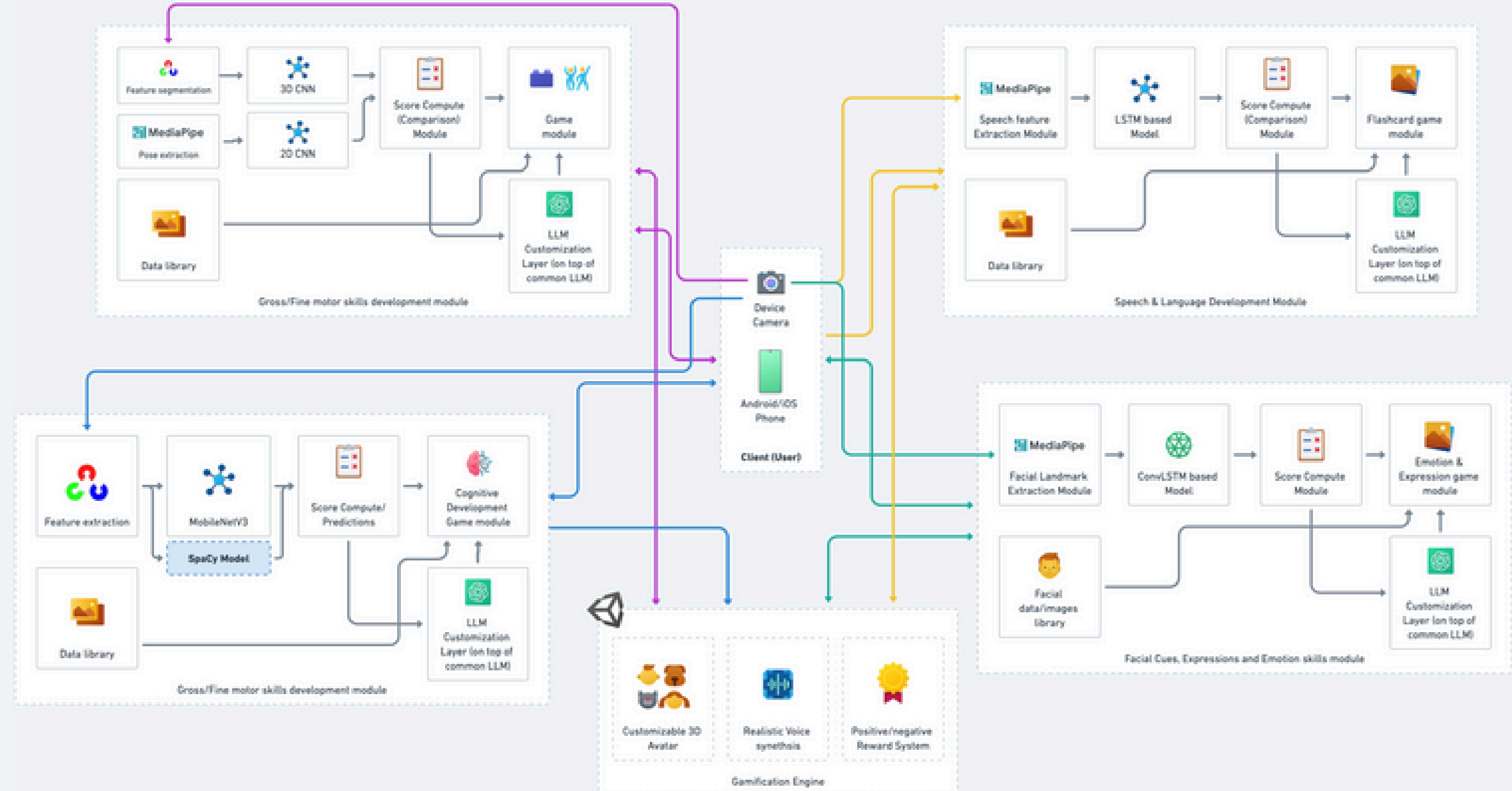


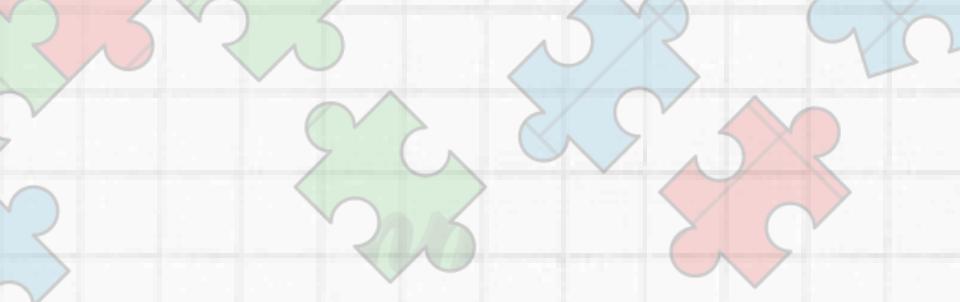
Facial Cues and Expressions (FCEs) Recognition Improvement



Improving fine and gross motor skills

OVERALL SYSTEM OVERVIEW DIAGRAM





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IMPROVING FACIAL EXPRESSIONS & EMOTIONAL SKILLS



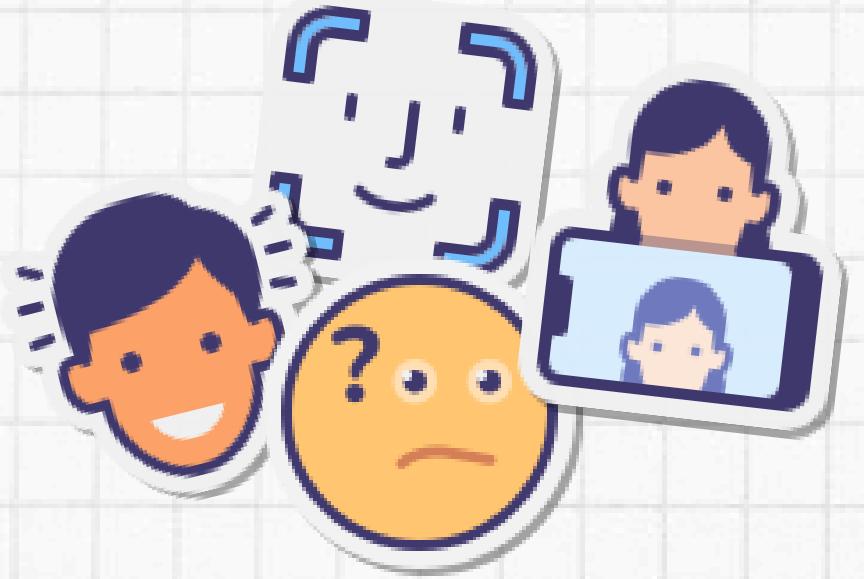
IMPROVEMENT OF FACIAL CUES & EXPRESSION SKILLS

INTRODUCTION AND BACKGROUND

- ★ Children with ASD have trouble expressing their emotions as facial expressions.
- ★ They have trouble recreating different facial cues
- ★ Most of them have trouble recognizing the emotions and expressions of someone in front of them.
- ★ With this they face various difficulties in communication.
- ★ Evenmore, their parents often get frustrated all the time.
- ★ This leads them to avoid social interaction making it unfavourable at social settings



RESEARCH QUESTION & GAPS



**How to Improve
facial expression
& emotion skills?**

RESEARCH GAPS

RESEARCH A

An interactive game that teaches facial expressions to children with ASD

RESEARCH B

A serious game that uses animations with emotions to screen children with ASD

RESEARCH C

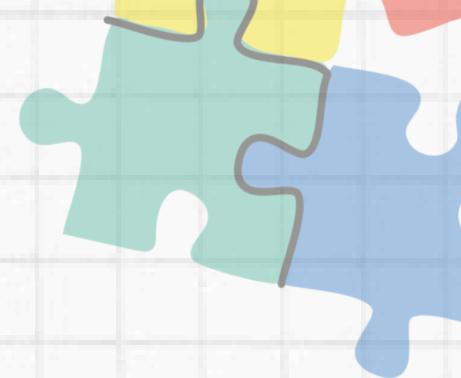
A facial expression training platform using device camera for children with ASD

RESEARCH GAP ANALYSIS

SYSTEM	An avatar mirroring expressions (MES)	Use facial landmark analysis	Realtime Interaction with the child	Serious-game features with rewards	Constructive feedback with GenAI
RESEARCH A	✓	✓	✓	✗	✗
RESEARCH B	✗	✗	✓	✓	✗
RESEARCH C	✗	✓	✗	✗	✗
PROPOSED SYSTEM	✓	✓	✓	✓	✓



SUB OBJECTIVES



SPECIFIC OBJECTIVE

- • •
- Improving the ability of children with ASD to identify, understand, and express facial cues and emotions.

APPLIED BEHAVIOURAL THERAPY

-  A game to determine the child's initial competencies in identifying & expressing FCEs
-  A model that detects child's FCEs and predicts the accuracy with data from camera
-  3D avatar that mirrors exact facial cues and blendshapes real-time from camera
-  Interactive game that enhances identification skills of FCEs for the child
-  Realtime attention tracking and constructive feedback

REQUIREMENT ANALYSIS – PT I

Functional requirements

- ⭐ Detect facial expressions with device camera
- ⭐ Predict accuracy of those expressions
- ⭐ Mimic the expressions on the 3D avatar realtime
- ⭐ Give realtime supportive audio feedback
- ⭐ Gamified experience based on competency

Non-Functional requirements

- ⭐ Distraction free, child-friendly, sensory experience + UI
- ⭐ Ensure data privacy and security with various techniques
- ⭐ The realtime detection/mirroring should be fast
- ⭐ System should be scalable to suit multiple users
- ⭐ 3D components should be rendered smoothly

REQUIREMENT ANALYSIS – PT II

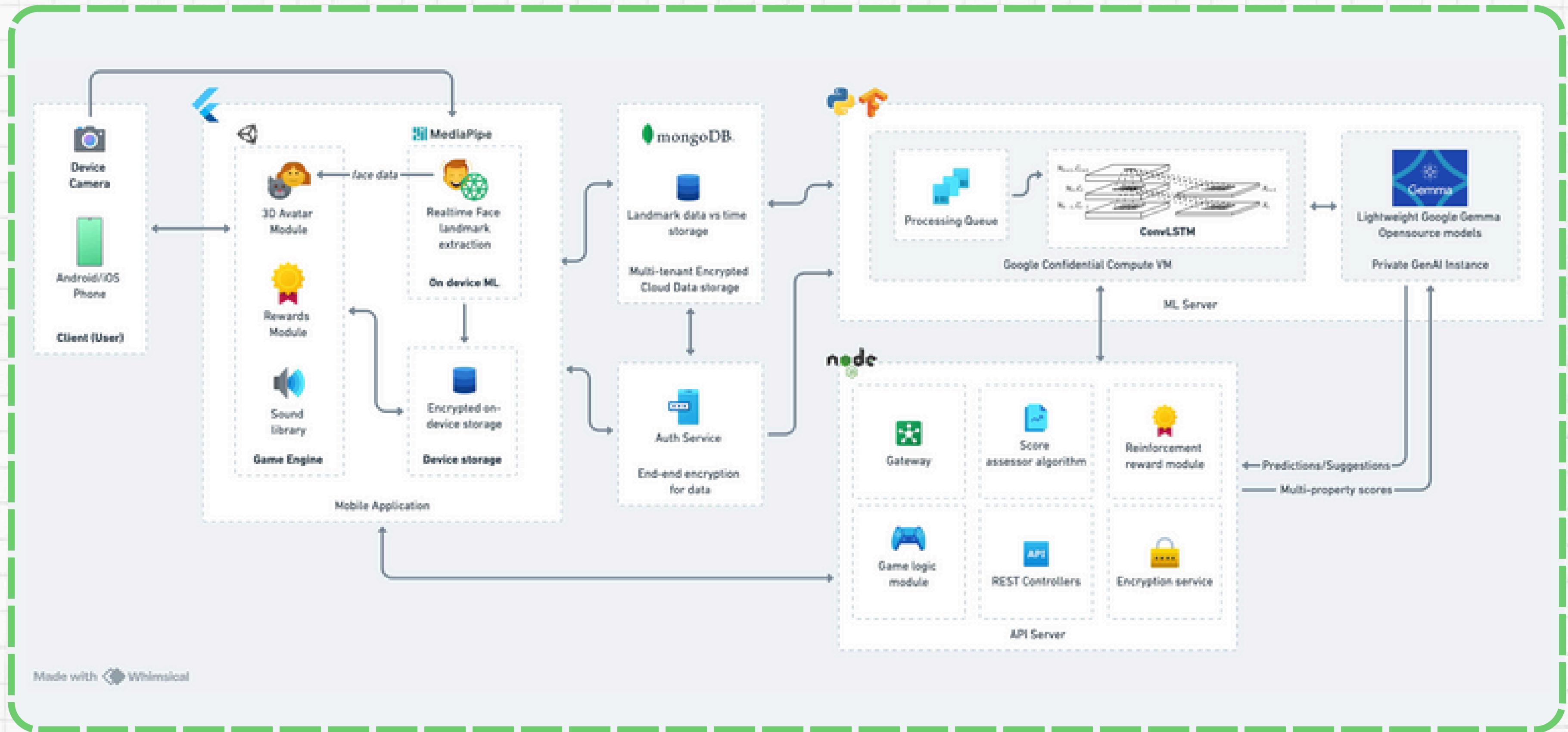
System requirements

- ⭐ Device should have at least a HD front & rear camera
- ⭐ The processor should handle on device lightweight ML models
- ⭐ Internet connectivity with constant connection
- ⭐ Should be Android or iOS compatible device
- ⭐ System should perform in moderate lighting conditions

Personnel requirements

- ⭐ Children with ASD
- ⭐ Parents of children with ASD
- ⭐ Dr. Asiri Hewamalage (@ FHB)
- ⭐ Therapists associated with the therapy center we chose

HIGH LEVEL SYSTEM OVERVIEW DIAGRAM



TECHNIQUES, TECHNOLOGIES AND ALGORITHMS

TECHNOLOGIES </>

Flutter
Python
Firestore
Media Pipe
TensorFlow
Confidential Cloud
VS code

TECHNIQUES



Face Landmark detection
Facial blendshapes
Data Pre processing
MES (mirroring emotion system)

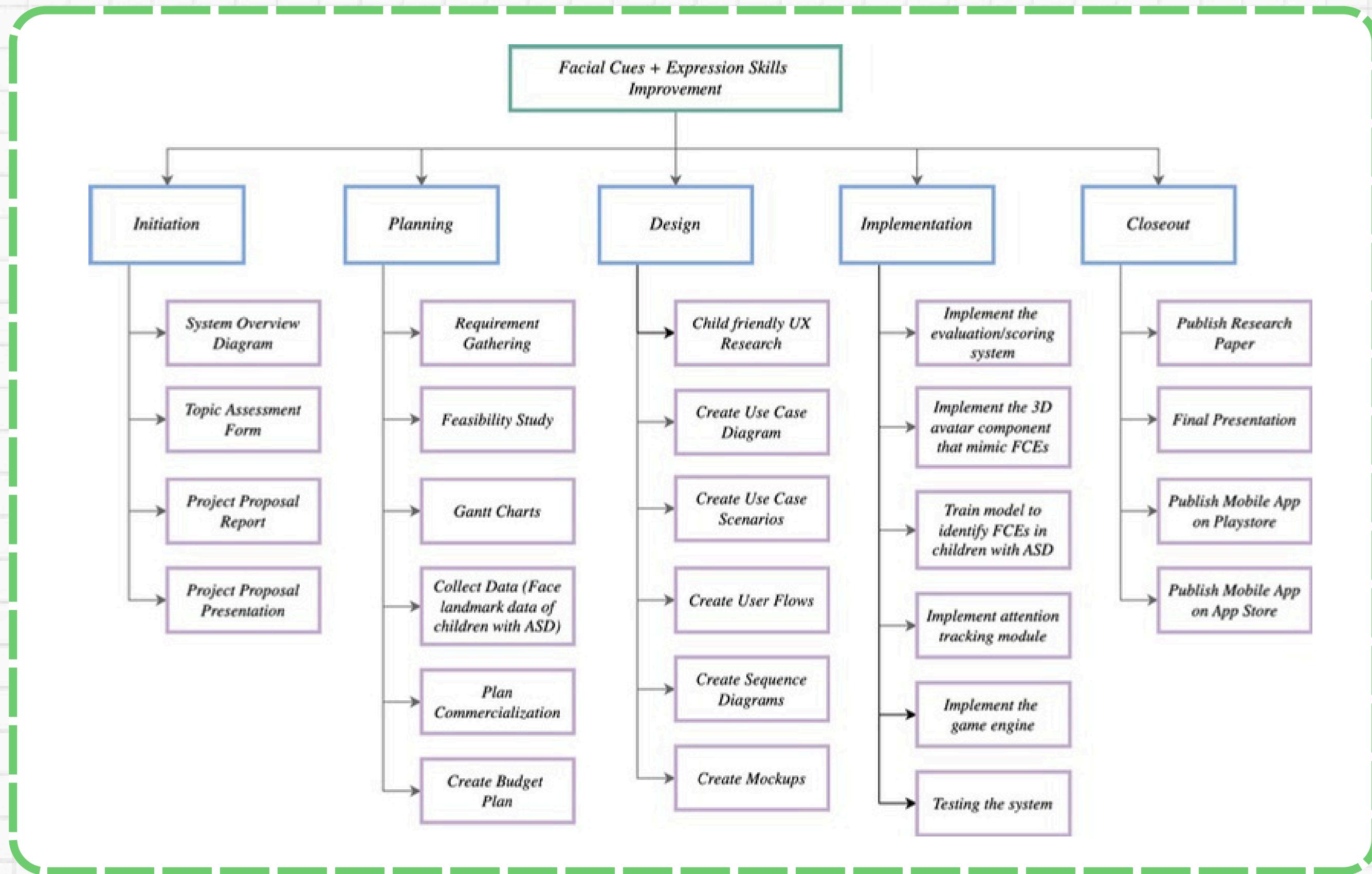
ALGORITHMS



ConvLSTM

- A type of recurrent neural network for spatio-temporal prediction
- Used for [Video predictions](#)

WORK BREAKDOWN STRUCTURE



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IMPROVING SPEECH AND LANGUAGE DEVELOPMENT



IMPROVEMENT OF SPEECH AND LANGUAGE DEVELOPMENT

INTRODUCTION AND BACKGROUND

Parents suffer from high levels of anxiety due to fear of child being isolated and unable to communicate.

Almost all children with autism retain difficulty in speaking and language.

In Sri Lanka over 80 % of children with autism presents with speech related problems..

some may have limited or no speech, while others might struggle with understanding and using language appropriately.



RESEARCH QUESTION & GAPS

How to Improve speech and language skills in children with autism?



RESEARCH GAPS

RESEARCH A

A research based on computer game to learn and enhance speech problems for children with autism.

RESEARCH B

A research based on picture exchange communication intervention for caregivers and children with autism.

RESEARCH C

A research on developing a mobile application using speech therapy to monitor autism conditions.



- RESEARCH GAP ANALYSIS -

SYSTEM	Voice recognition for image identification	Gamified approach to improve speech	Lip pattern analysis for evaluation	Usage of generative AI to predict more words
RESEARCH A	✓	✓	✗	✗
RESEARCH B	✓	✗	✗	✗
RESEARCH C	✓	✗	✗	✗
PROPOSED SYSTEM	✓	✓	✓	✓



SPECIFIC OBJECTIVE

Improvement of speech and language development through a series of games and exercises.

SUB OBJECTIVES



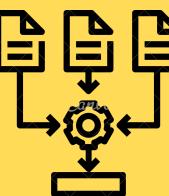
Identifying and evaluating the child's current level of speech and language.



Lip pattern Identification of the child while pronouncing a word.



Developing an interactive flash card game with flash cards with words in different categories.



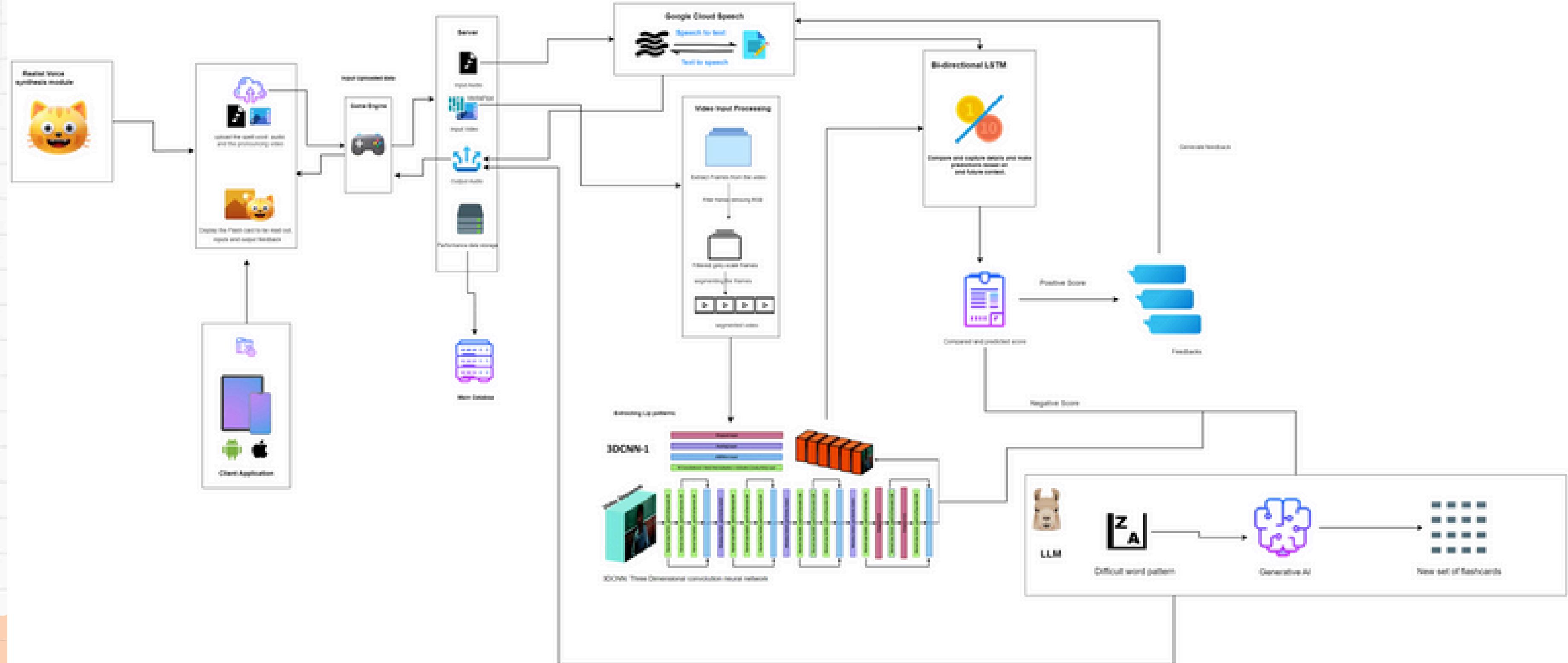
Training an LLM to identify areas where the child is finding difficult to pronounce.



Training the LLM to suggest new words using gen AI for the identified difficulty areas.



SYSTEM OVERVIEW DIAGRAM



TECHNIQUES, TECHNOLOGIES AND ALGORITHMS

TECHNOLOGIES </>

Flutter
Python
Firebase Database
Media Pipe
TensorFlow
Google Cloud Speech
VS code

TECHNIQUES



Text to Speech
Speech to Text
Feature extraction and segmentation
Data Augmentation
Data Pre processing

ALGORITHMS



3DCNN

- an extension of 2D CNNs
- effectively capture the **spatio-temporal features** of video data
- Is important for the tasks like lip reading

LSTM

- model the temporal dependencies between the frames and generate predictions



REQUIREMENT ANALYSIS - 1

Functional requirements

-  should be able to recognize speech accurately
-  should accurately capture lip movements while pronouncing.
-  should capture the words the child is finding difficult to pronounce
-  should predict new words according to the identified difficult sections.
-  The games should be short and limited to certain time to avoid screen addiction.

Non-Functional requirements

-  User-friendly Interfaces
-  Quick processing speech recognition system.
-  Reliability by accurate speech capturing
-  Secure, ensuring the privacy of user data.
-  Availability with high functionality and minimum downtime.



REQUIREMENT ANALYSIS – 2

System requirements

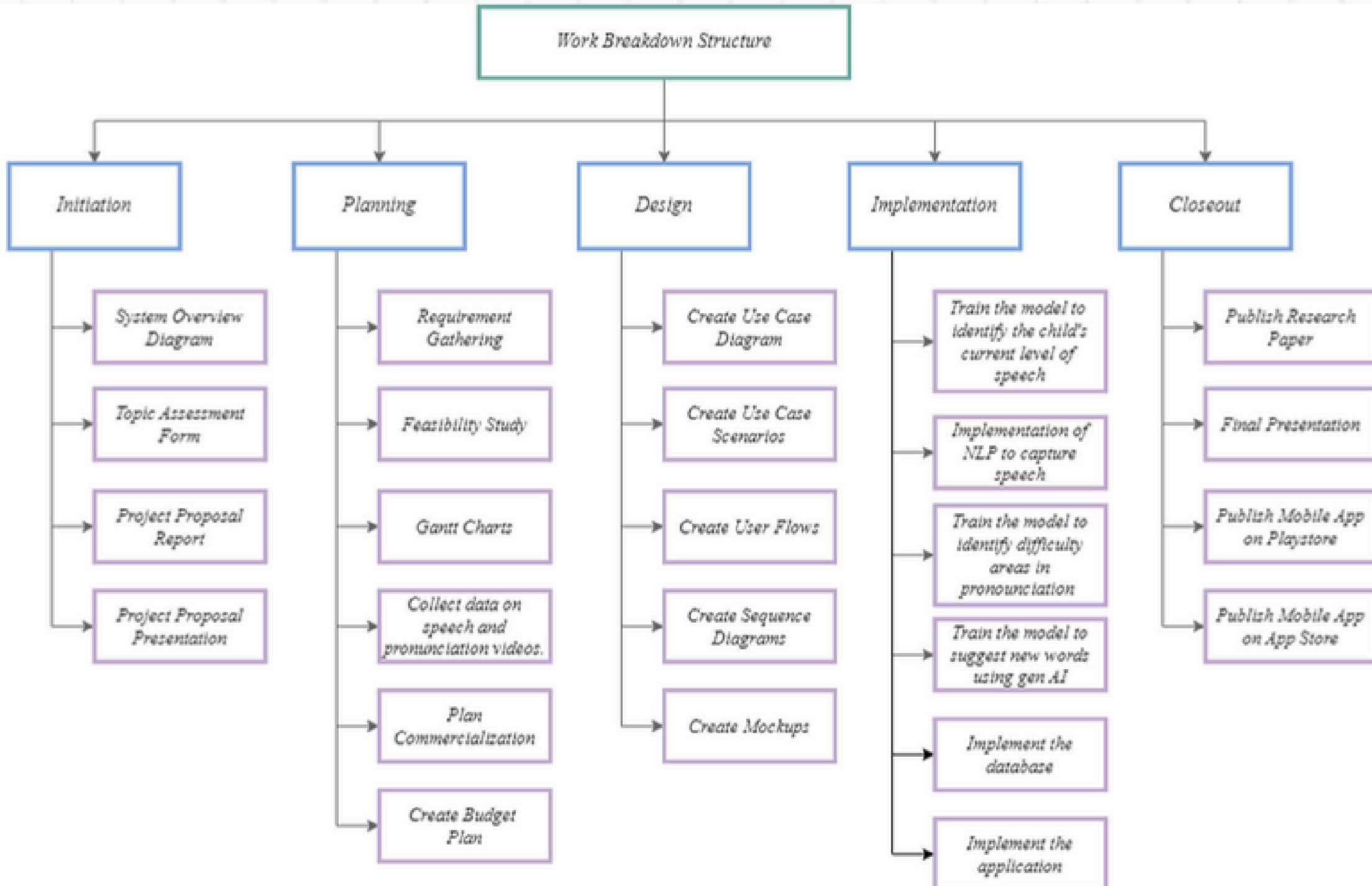
-  A device with a camera and microphone
-  Adequate storage and memory to support the application
-  The system should be compatible with major operating systems
-  Dependencies - relevant ML libraries and game development tools.
-  A strong network connection to set up and update.

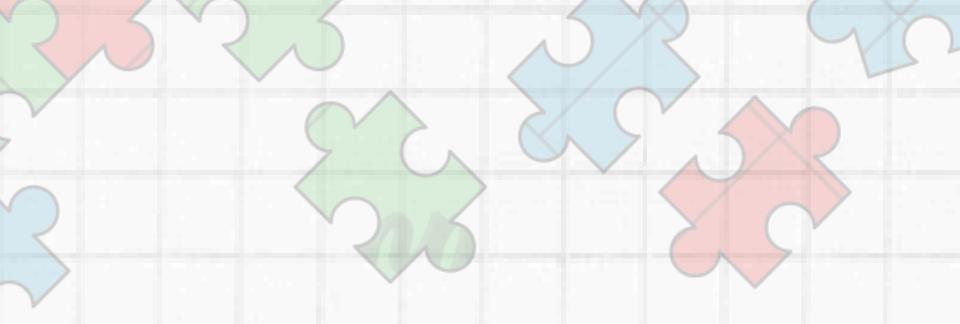
Personnel requirements

-  Children with autism who has speech difficulties.
-  Parents and caregivers of children.
-  Dr. Asiri Hewamalage



WORK BREAKDOWN STRUCTURE





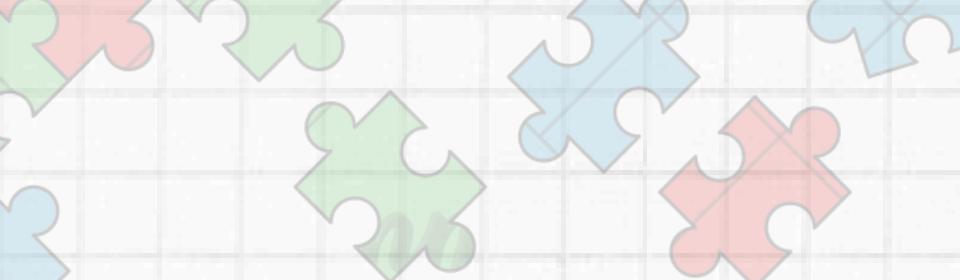
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IMPROVING COGNITIVE & VERBAL COMMUNICATION SKILLS



IMPROVING COGNITIVE & VERBAL COMMUNICATION SKILLS

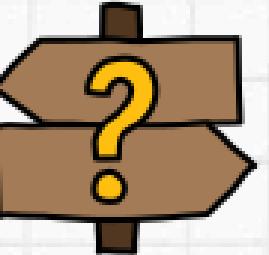
INTRODUCTION AND BACKGROUND

- ★ Children with ASD have difficulties with communication, leading to isolation and frustration.
- ★ These challenges impact daily interactions and overall well-being.
- ★ Enhancing these skills is crucial for better social interactions and quality of life.
- ★ Approaches to improvement often include targeted educational strategies and cognitive exercises.



RESEARCH QUESTION & GAPS

How to Improve cognitive & verbal communication skills in children with autism?



RESEARCH GAPS

RESEARCH A

A research based on Multi-sensory learning approach to create a Sentence learning platform Students with Autism Spectrum Disorder

RESEARCH B

A research based on developing a Computer Game-Based Social Skill Intervention for Children with Autism Spectrum Disorder

RESEARCH C

A research based on developing a Computer-Based Story Builder for Children with Autism



- RESEARCH GAP ANALYSIS -

SYSTEM	Writing and sentence structure exercise	Identify the accuracy of written letters	Usage of generative AI to predict more words	Gamified approach to improve verbal communications	Track hours & pain points to monitor progress
RESEARCH A	✓	✗	✗	✓	✗
RESEARCH B	✗	✗	✗	✓	✓
RESEARCH C	✗	✓	✗	✓	✗
PROPOSED SYSTEM	✓	✓	✓	✓	✓

SUB OBJECTIVES

SPECIFIC OBJECTIVE

Improvement of cognitive & verbal communication skills through a series of games and exercises.



Identify the child's current cognitive and verbal communication skills.



Collect written letters and sentence structures from children to identify the current context.



Developing a game to practice writing exercises, Sentence structure.



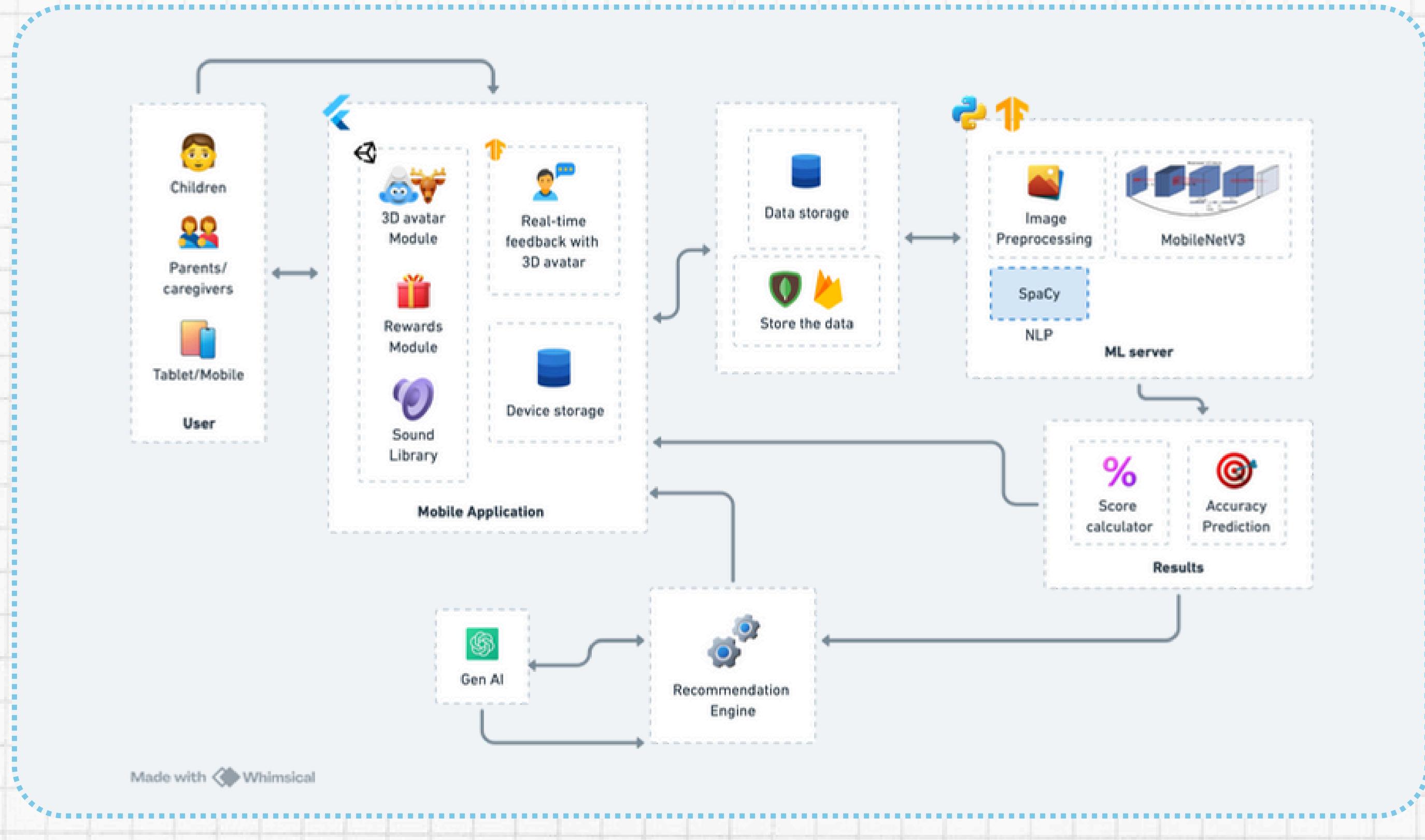
Developing a game to building shapes from blocks to enhance cognitive skills.



Employ DL models and rule-based systems for word prediction, grammar correction, accuracy of the letter and provide feedback.



SYSTEM DIAGRAM



TECHNOLOGIES, TECHNIQUES AND ALGORITHMS

TECHNOLOGIES </>

Flutter
Python
Firebase Database
TensorFlow
VS code
Figma

TECHNIQUES

Image to text
Data Preprocessing
Pattern Recognition for Handwriting Analysis
Grammar Correction and Suggestions

ALGORITHMS

SpaCy library (NLP)
MobileNetV3 (CNN)

- **Real-time** image processing tasks
- Analyzing **handwritten** **text**
- **Object detection** or **Image classification**
- **Lightweight**

OpenAI's GPT-3/GPT-4



REQUIREMENT ANALYSIS - 1

Functional requirements

-  Assess written letters accurately using trained models.
-  DL model and rule-based system for word prediction and grammar correction.
-  Choose predefined or custom exercises for writing and sentence structure.
-  Predict new words according to the identified difficult sections.
-  Track hours and identify difficulty areas.

Non-Functional requirements

-  User-friendly Interfaces
-  Quick processing speech recognition system.
-  Reliability by accurate speech capturing
-  Secure, ensuring the privacy of user data.
-  Availability with high functionality and minimum downtime.



REQUIREMENT ANALYSIS – 2

System requirements

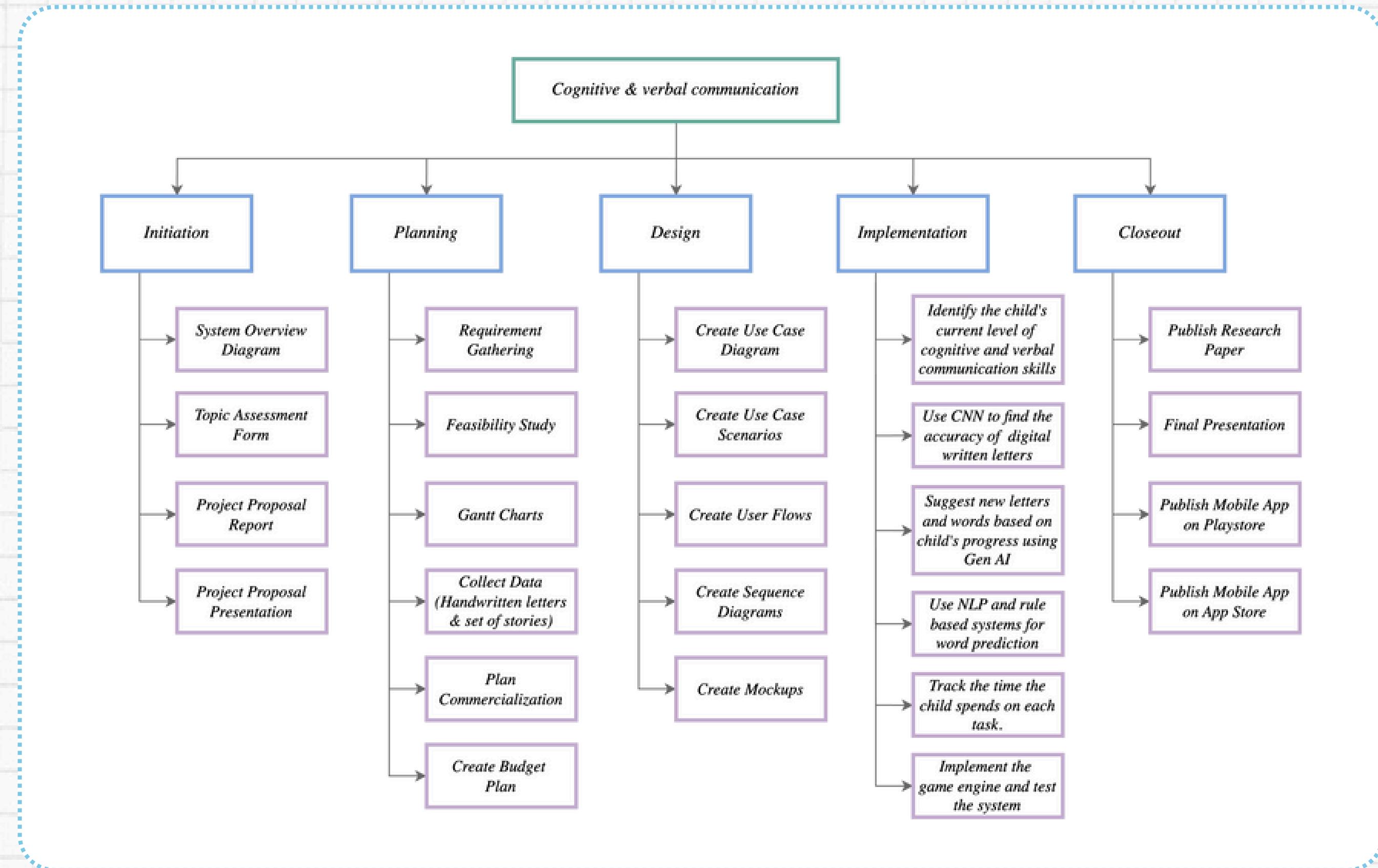
-  Compatibility varying screen sizes and performance capabilities.
-  Adequate storage and memory to support the application
-  The system should be compatible with major operating systems
-  Dependencies - relevant ML libraries and game development tools.
-  The system should be lightweight to run smoothly.

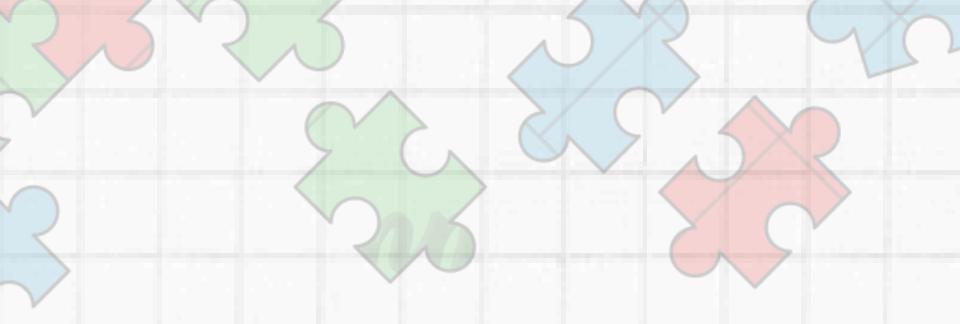
Personnel requirements

-  Children with ASD
-  Parents of children with ASD
-  Dr. Asiri Hewamalage (@ FHB)
-  Therapists associated with the therapy center we chose



WORK BREAKDOWN STRUCTURE





REFERENCES

- S. L. De Silva and N. Dissanayaka, "Multisensory Learning Approach to Create a Sentence Learning Platformfor Students with Autism Spectrum Disorder," 2018 3rd International Conference for Convergence in Technology (I2CT), Pune, India, 2018, pp. 1-5, doi: 10.1109/I2CT.2018.8529560. keywords: {Three-dimensional displays;Visualization;Autism;Databases;Object recognition;Sensors;Education;Autism Spectrum disorder;Multisensory learning approach;Sentence learning platform},
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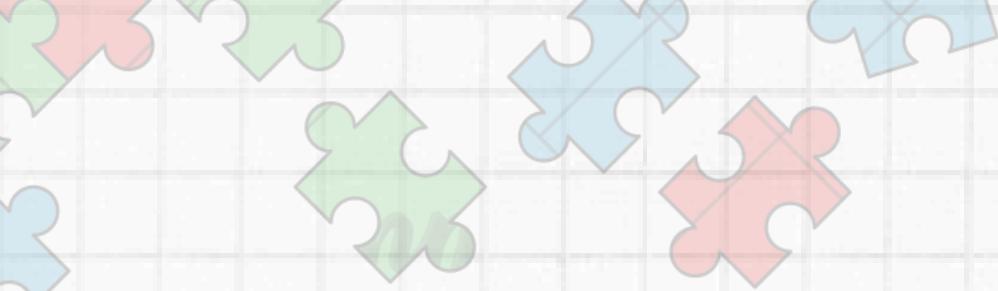
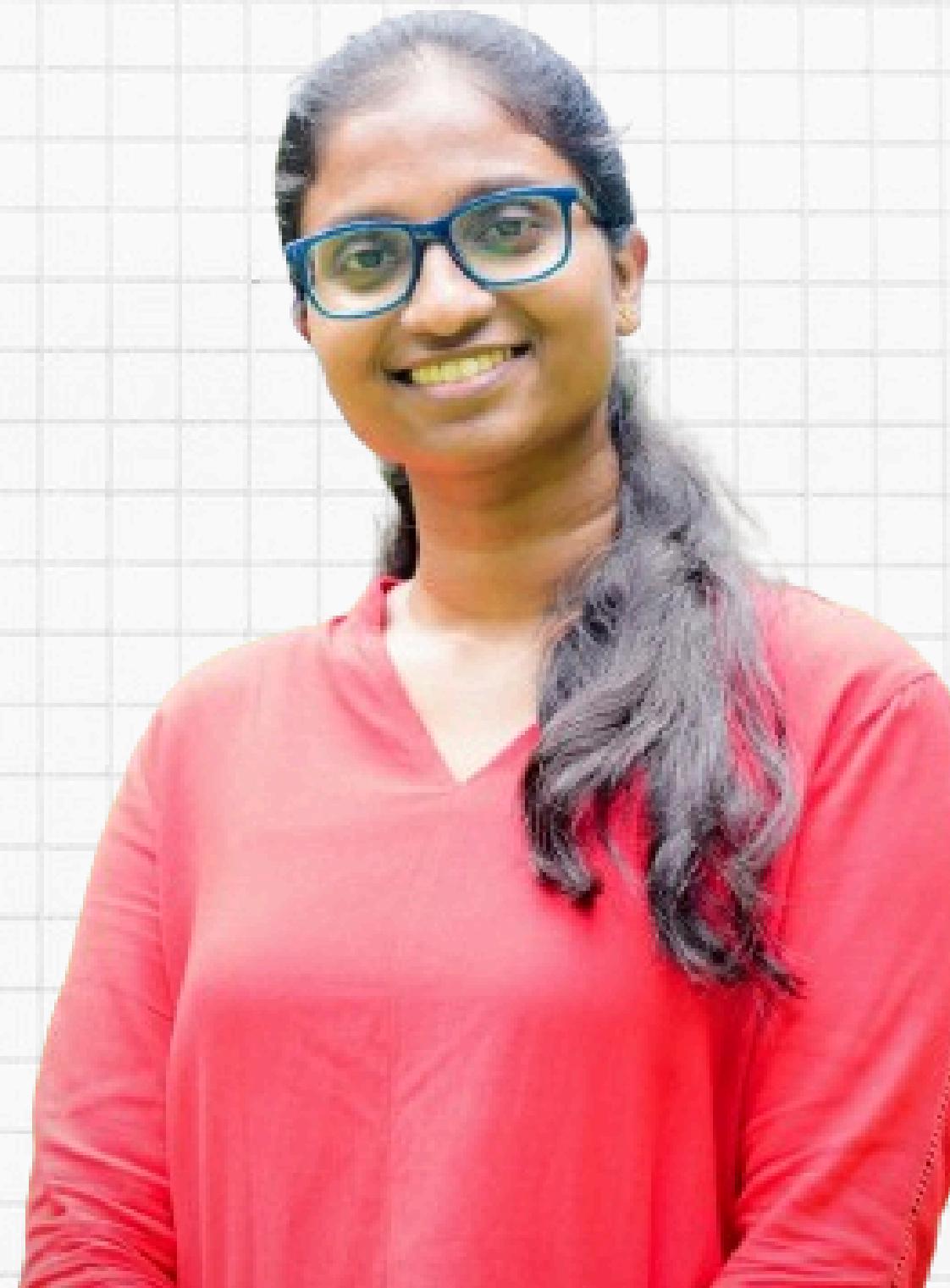
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SP: SOFTWARE ENGINEERING

IMPROVEMENT OF MOTOR SKILLS



IMPROVEMENT OF MOTOR SKILLS

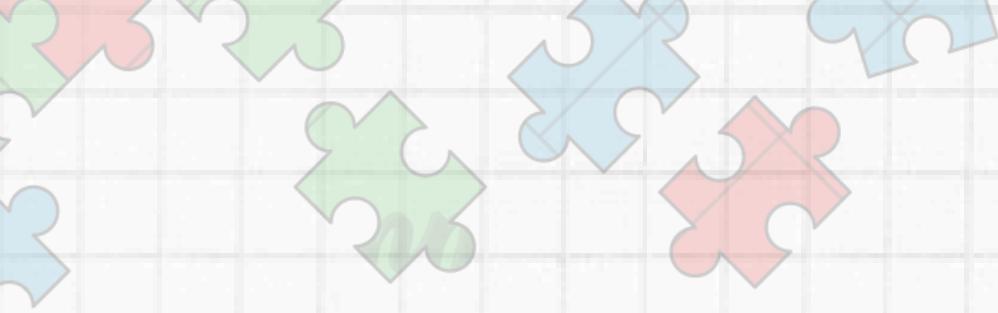
INTRODUCTION AND BACKGROUND

Children with ASD often experience delays in motor skills development, affecting their daily activities and overall growth.

87% of autistic people face some sort of motor difficulty.

Motor skill activities can stimulate cognitive development and improve attention, planning, and problem-solving abilities.

Interactive exercises and games can promote social engagement and communication skills.



- RESEARCH QUESTION & GAPS -



How to Improve motor skills of children with autism?

RESEARCH GAPS

RESEARCH A

A research based on developing a mobile application platform to enhance speech, fine motor, gross motor, cognitive and oral motor skills [1]

RESEARCH B

A research based on developing a learning platform as a comprehensive mobile application for children with ASD [2]

RESEARCH C

A research based on developing a mobile learning application aimed at enhancing the Mathematics knowledge of autistic children [3]



- RESEARCH GAP ANALYSIS -

SYSTEM	Various exercises available	Real-time feedback available	Enhancement of pattern recognition skills	Gamified approach
RESEARCH A	X	X	X	✓
RESEARCH B	X	X	✓	✓
RESEARCH C	X	X	X	✓
PROPOSED SYSTEM	✓	✓	✓	✓



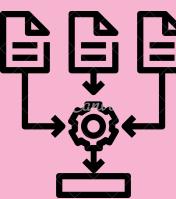
MAIN OBJECTIVE

Improving motor skills and pattern recognition through a series of games and exercises.

SUB OBJECTIVES



Identifying and evaluating the child's ability to mimic the given exercises correctly.



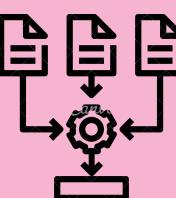
Train the model to identify the various actions performed by the child.



Provide real-time feedback and encouragement based on the performance.



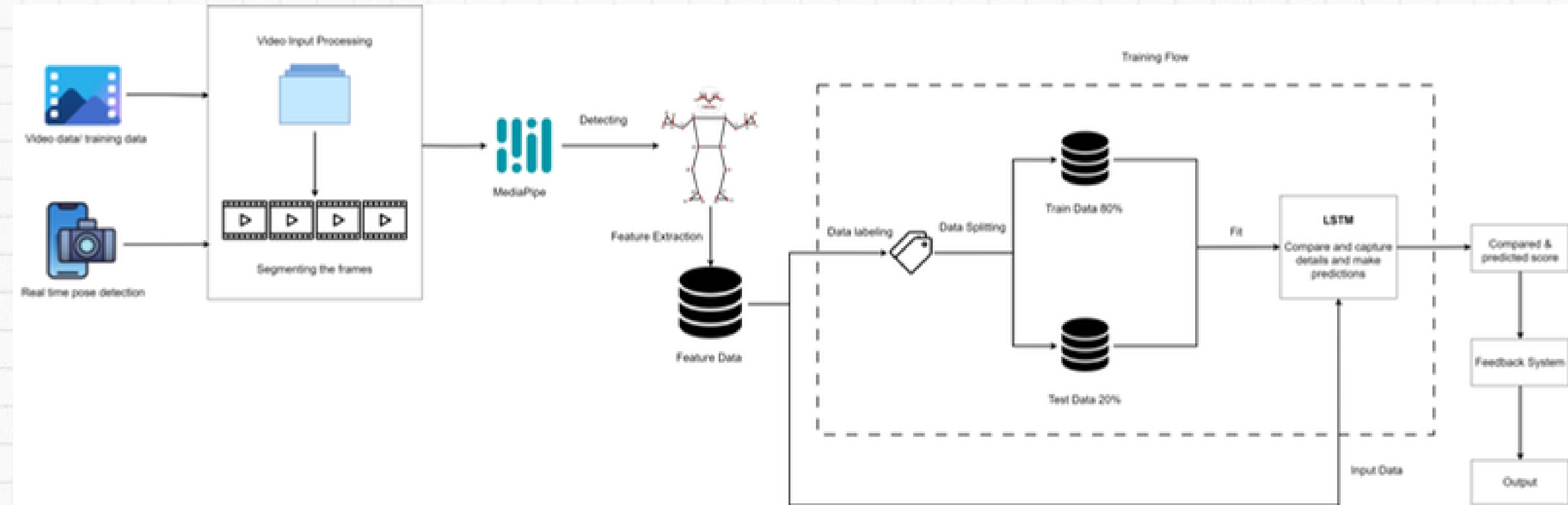
Identifying the child's ability to create a given color patterns with a set of objects (Lego blocks)



Training the CNN model to identify colour segmentations and object patterns



SYSTEM DIAGRAM – GROSS MOTOR SKILLS ANALYSIS



TOOLS, TECHNOLOGIES AND ALGORITHMS

TOOLS

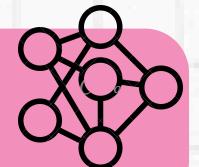


Flutter Open CV
Python Tensorflow
MediaPipe
Firebase Database
VS Code

TECHNOLOGIES </>

Computer Vision
Machine Learning
Object Detection
Convolutional Neural Network (CNN)

ALGORITHMS



LSTM

- (Long Short Term Memory)
Processes the sequences of extracted angles to identify and classify exercises based on the temporal progression of movements.



REQUIREMENT ANALYSIS - 1

Functional requirements

-  The system should identify if the child performed the relevant exercises correctly.
-  The system should provide real-time feedback based on the accuracy of the child's actions.
-  The system should use the trained model to identify if the child created the given object and color pattern correctly.
-  The games should be implemented with minimal distractions to keep the child engaged.

Non-Functional requirements

-  The interfaces must be user-friendly and simple adapting to the child's needs.
-  The action recognition system must process quickly.
-  The system should be reliable ensuring accuracy in exercise identification and object pattern identification.
-  The interfaces must be user-friendly and simple adapting to the child's needs.



REQUIREMENT ANALYSIS – 2

Sytem requirements

-  A device with a camera
-  Adequate storage and memory to support the application
-  The system should be compatible with major operating systems
-  Dependencies - relevant ML libraries and game development tools.
-  A strong network connection to set up and update.

Personnel requirements

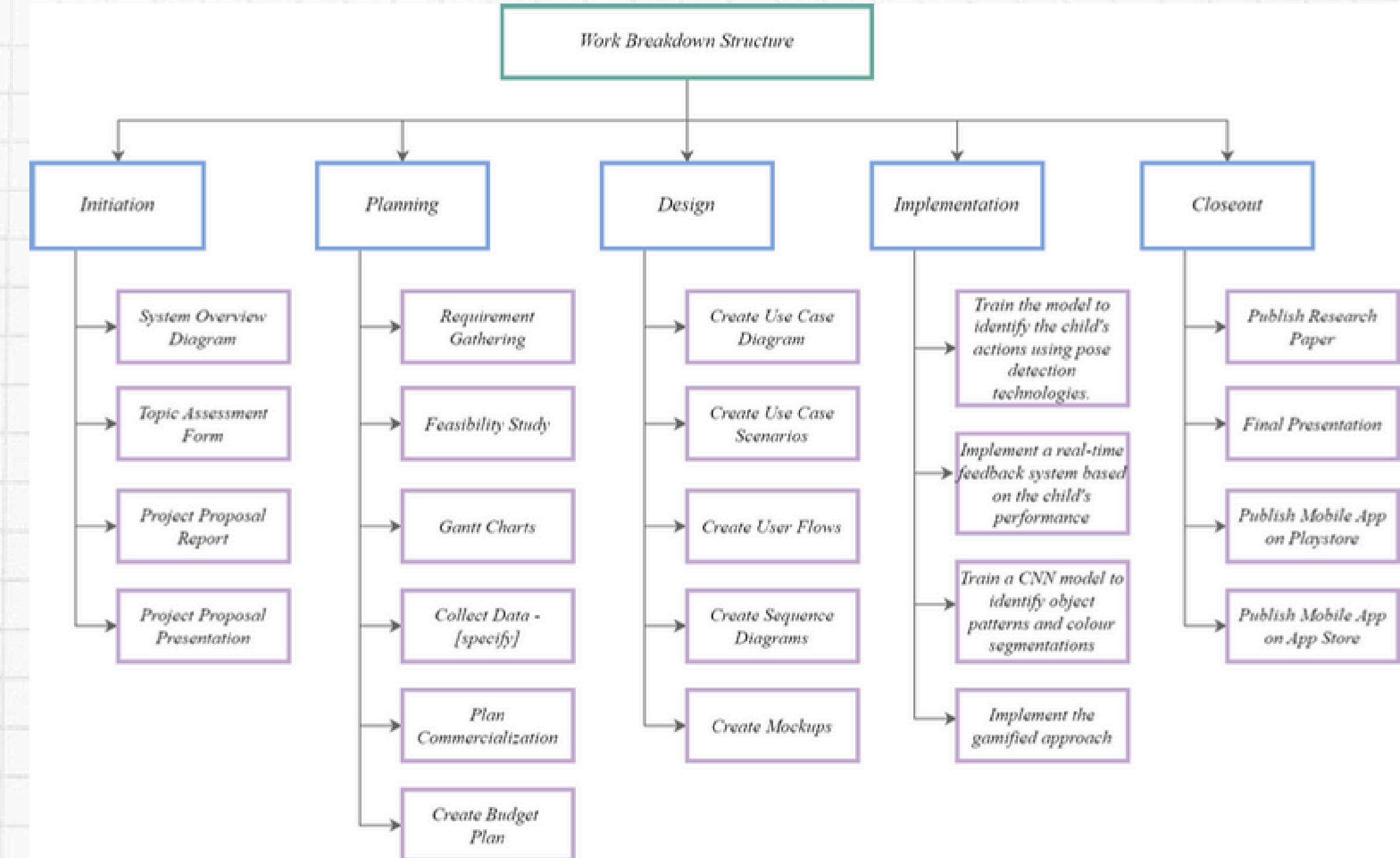
-  Children with autism (ASD)

-  Parents and caregivers of children.

-  External supervisors



WORK BREAKDOWN STRUCTURE



REFERENCES

- [1] S. Silva, A. Jayasinghe, R. Dilshan, C. Dissanayake, S. Vidhanaarachchi and D. De Silva, "Effectiveness of Deep Learning Technologies to Assist Educational Inclusion for Children with Down Syndrome," 2023 5th International Conference on Advancements in Computing (ICAC), Colombo, Sri Lanka, 2023, pp. 448-453, doi: 10.1109/ICAC60630.2023.10417312. keywords: {Deep learning;Image processing;Medical treatment;Speech enhancement;Mobile applications;Convolutional neural networks;Proposals;Down Syndrome;Inclusion;CNN;LSTM;YOLOV8;MediaPipe},
- [2] K. G. Ranaweera, J. Praneetha, W. P. S. De Silva, K. R. B. N. Kempitiya, I. Gamage and T. Thilakarthna, "Personalized and Interactive Learning Platform for Students with Autism Spectrum Disorder," 2023 5th International Conference on Advancements in Computing (ICAC), Colombo, Sri Lanka, 2023, pp. 828-833, doi: 10.1109/ICAC60630.2023.10417404. keywords: {Autism;Visualization;Games;Variable speed drives;Motor coordination;Behavioral sciences;Planning;Autism Spectrum Disorder (ASD);Augmented Reality (AR)},
- [3] Hassan, Muslihah. (2020). Designing an Interactive Mobile Learning Game for Children with Autism Spectrum Disorder (ASD).

SOFTWARE FEATURES

Customization and Personalized UI/UX

Sensory-Friendly Design

Multi-tenant encrypted storage

Google confidential computing

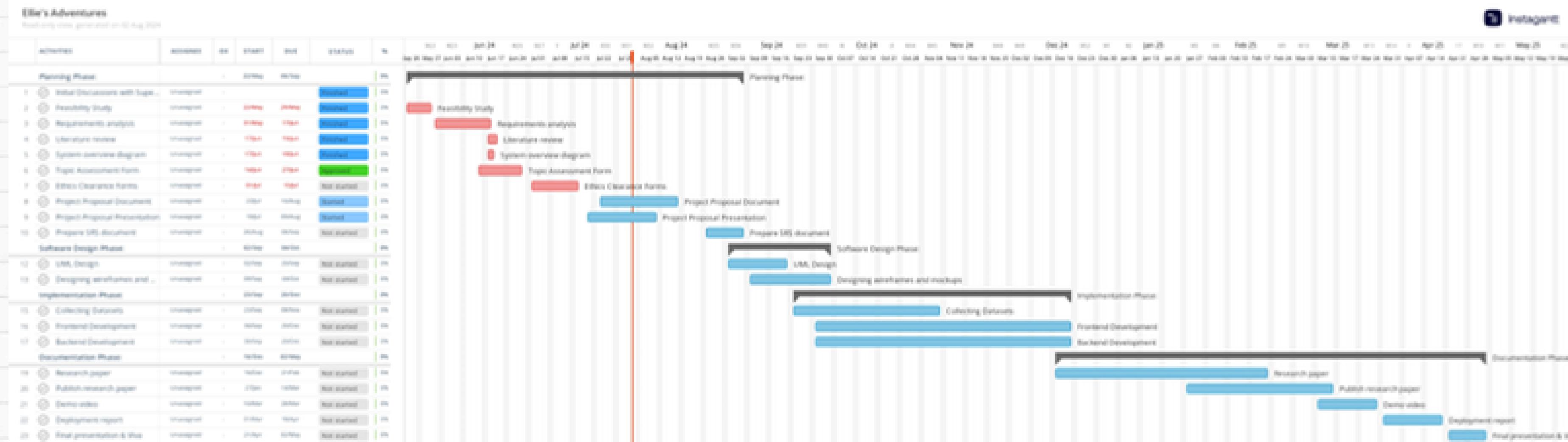
Layered client-server architecture

Deploy as a distributed system

Linting code using tools such as [Dart Linting](#) for Flutter and [PyLint](#) for Python

Unit testing for Flutter using flutter_test

COMMON GANTT CHART



COMMERCIALIZATION

Subscription plans



FREE
LKR 0

FEATURES

- Limited real-time feedback
- Limited GenAI features

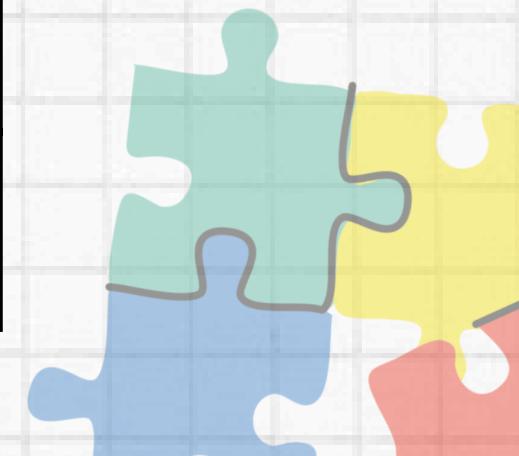
PREMIUM
LKR 4000

FEATURES

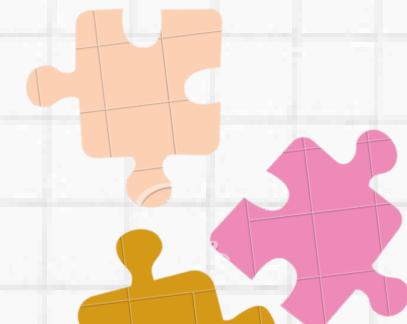
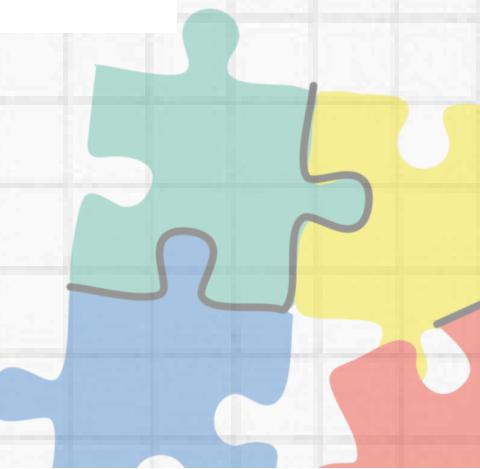
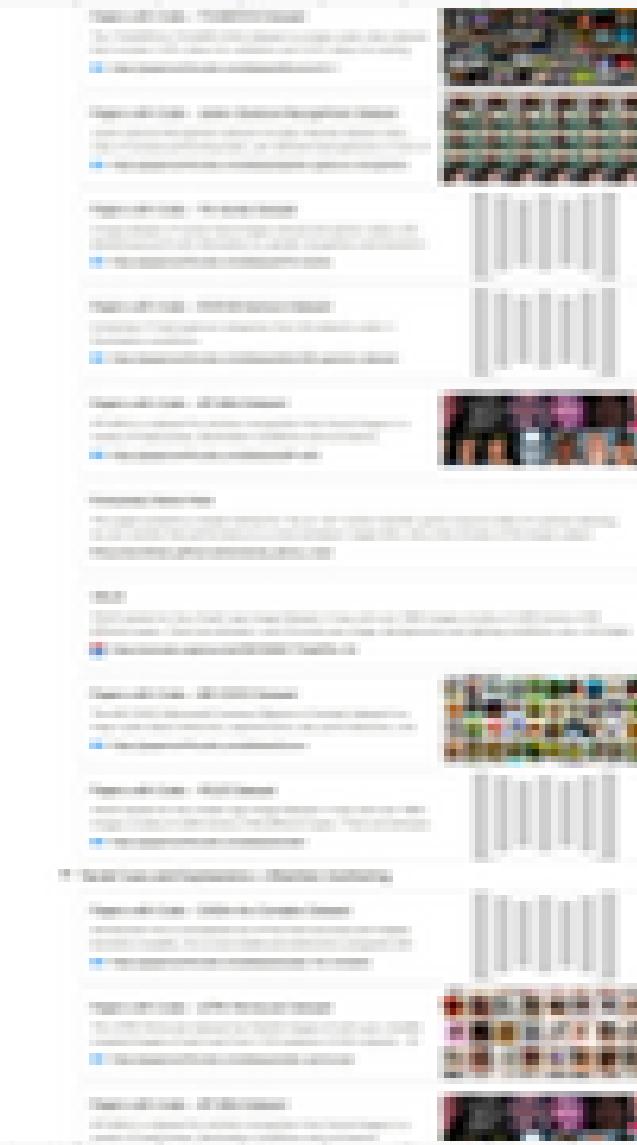
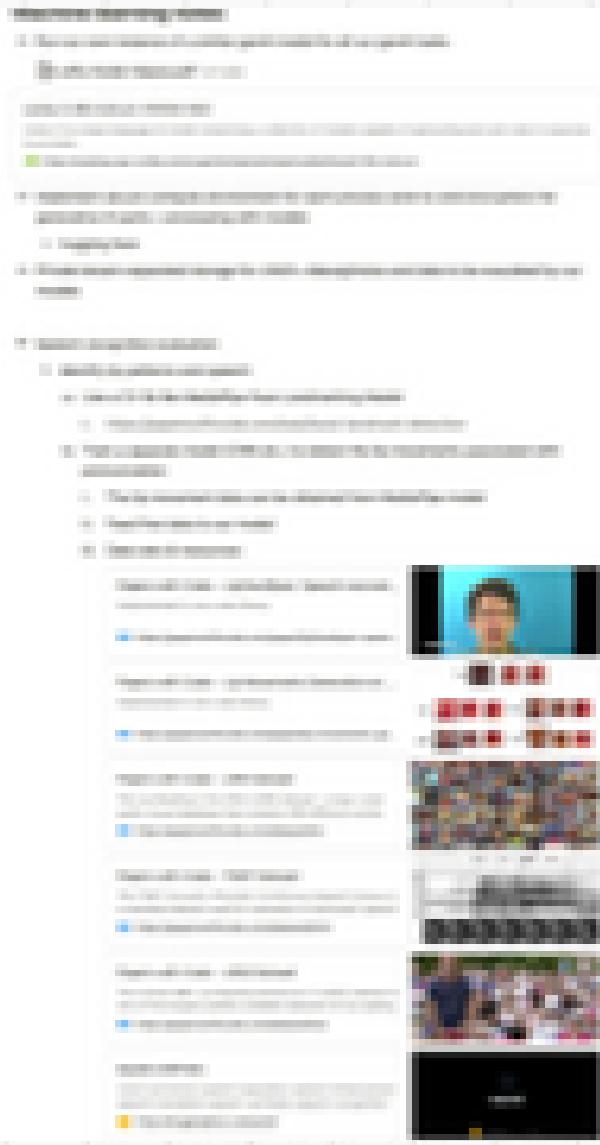
- Unlimited access to the application
- More personalized feedbacks

PROPOSED BUDGET

INITIATIVE	AMOUNT (LKR)
Travelling cost for data collection	30 000
Cost of deployment to cloud	25 000
Cost of storage and database	7 000
ML model training and deployment	35 000
Cost of hosting in play store	8 000
cost of hosting in app store	33 000 / year



DATA



THANK YOU!

