

**ALIZA: SMART MIRROR AS AUTISTIC EDUCATION
ASSISTANT**

2020-079

Project Proposal Report

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B.Sc. (Hons) Degree in Information Technology

Department of Software Engineering

Sri Lanka Institute of Information Technology

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DECLARATION OF THE CANDIDATE & SUPERVISOR

We declare that this is our 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 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.

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The supervisor/s should certify the proposal report with the following declaration.

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

Signature of the supervisor:

Date:

ABSTRACT

Autism spectrum disorder (ASD) is globally a major cause of childhood disability. It is estimated that in Sri Lanka up to 1.07% of the children are affected with this disorder in 2019 [1]. Researches has shown that children with autism experience specific challenges regarding the learning process. Some autistic children struggle with language abilities, and it can be challenging to teach them tasks such as reading, writing and listening. Because it involves coordination, muscle strength, language skills, organization, and sensory issues. Since writing skills are so crucial to everyday life, it's important to help autistic children develop these abilities. One of the aim of this research is to develop a pre-writing system as Writing Mentor (Aliza) and approach that enables ASD children to successfully develop their pre-writing skills such as Lines, curves and shapes. Writing mentor system help to practice and improve pre-writing skills (lines, curves and shapes) through animation and pictures on smart mirror. Due to this, autistic children are encourage to do their own writing exercises. This study get information about randomly selected 100 ASD pre-children from 5 selected schools in Colombo and Jaffna district. Collect data from selected ASD children's day to day normal written work (lines, curve and shapes) and make use of this as data for creating evaluation models. They are constantly monitored and evaluated during their training by Deep Learning technology. This research expect that hopefully can produce pre-writing learning system in order to assist educating ASD children. Outcome of this research can be improve ASD children's pre-writing skills with the help of Writing Mentor system (Aliza).

Key words: ASD, Writing Mentor, Smart mirror, pre-writing skills

TABLE OF CONTENTS

DECLARATION OF THE CANDIDATE & SUPERVISOR.....	i
ABSTRACT	ii
TABLE OF CONTENTS.....	iii
LIST OF FIGURES	iv
LIST OF TABLES.....	v
1. Introduction	1
1.1 Background	1
1.2 Literature survey	3
1.3 Research Gap	5
1.4 Research Problem statement	7
2. Objectives.....	9
2.1 Main Objective.....	9
2.2 Specific Objectives.....	9
3. Methodology.....	10
4. High-level System Architecture	15
5. Description of Personal and Facilities	16
5.1 Work Breakdown Structure (WBS)	16
5.2 Self-evaluation Plan	17
6. Requirements.....	18
6.1 Functional Requirements.....	18
6.2 Non-Functional Requirements	18
7. Budget	19
8. Commercial Value	20
Reference	21

LIST OF FIGURES

Figure 1.1: The autism statistics prevalence of children	7
Figure 3.1: System Overview	10
Figure 3.2: Sample primary data	11
Figure 3.3: Dot tracing game.....	12
Figure 3.4: Seven-layered CNN	13
Figure 4.1: High-level System Architecture	15
Figure 5.1: Work Breakdown Structure.....	16
Figure 5.2: Self-evaluation plan	17

LIST OF TABLES

Table 1.1: Comparison of former researches	5
Table 1.2: Comparison of related work	6
Table 3.1: Pre-writing activity games levels	12
Table 7.1: Research budget	19

1. Introduction

1.1 Background

ASD children with learning disabilities are as smart as or smarter than their peers. But they may have difficulty in reading, writing, listening, spelling, reasoning, recalling and/or organizing information if left to figure things out by them or if taught in conventional ways [2]. With the right support and intervention, however, ASD children with learning disabilities can succeed in school and go on to successful, often distinguished careers later in life. Parents can help children with learning disabilities to achieve such success by encouraging their strengths, knowing their weaknesses, understanding the educational system, working with professionals and learning about strategies for dealing with specific difficulties.

Writing skill used for self-expression, communication, and recording of thoughts and experiences. Informal reports suggest a high level of writing impairment among children with autistic spectrum disorder (ASD), it's important to help autistic children develop these abilities.

According to the National Center on Educational Statistics approximately 90% of children ages five through seven use computers [4]. In contrast, children with disabilities are significantly less likely to use computers than their typical peers. Today's children with disabilities also need to be trained in the use of technology in order to become successful workers in the future. The use of technology to teach children with ASD is not a new concept. In fact, technology has been used to teach children with ASD for over 35 years [3].

In this research we introduce a writing mentor system with the help of smart mirror (Aliza). It's like an advanced self-teaching software. When they are initially starting writing mentor system (Aliza), system will pre-evaluate ASD children with the help of deep learning technics through that system find their writing skill level. Based on this evaluation system will provide some pre-writing skill activities (such as drawing

lines, curve and shapes) to ASD children. For example, in one activity, Connect line, curve and shapes dots [5] with digital drawing guide and in another activity is imitate lines, curves and shapes using appropriate drawing utensils [5] with the help digital drawing guide.

The system continuously evaluate those children when they are practicing with the help of Deep learning technics. Pre-writing task will be leveled up through every evaluation report. For example, after 1st level of activity completion, the system will give a task to a user based on 1st level activities. If the evaluation report show the progress level above 80%, then the activity level is up, if not the progress level is below 80%, then the 1st level activities will continue until the user got progress level above 80%.

Based on Aliza-Writing Mentor system, we predict that the students would increase the overall quality and knowledge of the ASD children's pre-writing skills after using the Aliza-Writing Mentor system. We also expected few peer interactions, but given that socialization was not the primary purpose of this system.

1.2 Literature survey

A search of the literature revealed a little has been written on this subject. Only three studies which were identified empirically examined this issue. Colby conducted one of the first studies examining the use of computers to teach students with ASD in 1973. Colby used a computer program consisting of various computer games organized at various levels of complexity with 17 students with ASD. For example, in one game, the child pressed a letter on the computer and simultaneously heard the computer say the letter. The purpose of the study is to increase students understanding of how letters and sounds form words, and how words can form expressions. Results claim that 13 of the 17 children showed an increase in understanding the letters and sounds [8].

One of the literature study is a mobile platform called “Picaa” based on iPad and iPod touch devices. It may also encourage children with ASD to be more active participants in their writing skills. Alvaro Fernandez-Lopez, Maria Jose Rodríguez-Fortiz, Maria Luisa Rodriguez-Almendros and Maria Jose Martinez-Segura examined about the use of Picaa by 39 students with special education needs from Spain. Picaa's one of the activity is writing activities. The purpose of the Picaa was developing of learning basic skills such as language, math, environmental awareness, autonomy and social for children who have special educational needs. Results claim that language skills (writing skill) were up 5.76% on average [9].

Frank Jamet, Olivier Masson, Baptiste Jacquet, Jean-Louis Stilgenbauer, and Jean Baratgin conducted a research on AI robot help to teach writing skills based on the concept of learning by teaching to ASD children. This study concentrates on ASD children 6 to 8 years old. One of this study's goal is to teach how to draw letters using a humanoid robot (NAO) to ASD children. In its design, the experimental setup allow the child to drawing many times and to be motivating in order for it to be efficient. Results show the children progress in various areas of learning such as reading, writing, language and reasoning [10].

Also, there are some mobile application available for teaching writing skills to ASD children. Writing Wizard [11] is the one of the apps to help ASD children learn how

to write the letters of the alphabet, numbers and words through a fun system and it's allow to check learning progress with reports. Autism Read & Write App [12] also one of the apps to help ASD children to learn the basic of reading and writing. Autism Read & Write App also one of the apps to help ASD children to learn the basic of reading and writing skills using images. Another mobile application for teaching ASD children is called "Otsimo". Otsimo App [13] aims as to teach fundamental education about core skills such as words, alphabet, numbers, emotions, colors, animals and vehicles through assistive matching, drawing, choosing, ordering and sound games.

As per the above-mentioned studies, there are researchers prevailing in the in the area of teaching writing skills with the help of modern technology smart device for ASD children, but there are no researches prevalent regarding the evaluation based teaching pre-writing skills with the help of the modern technology smart device.

1.3 Research Gap

Review of literature suggests that a number of studies have been carried out to study improve ASD children's writing skills with the help of modern technologies. Moreover, most of these studies have mainly considered the teaching words to ASD children. According to the available related works, there are several mobile applications also developed for improving ASD children's writing skills (Table 1.1). Many mobile applications are mainly concerned with teaching shape drawing prewriting activities for ASD children (Table 1.2).

Research A [8] has concerned about identifying alphabets and words through various levels based game playing activities to ASD children (Table 1.1) and the research B [9] has concerned only writing words activities (Table 1.1). Finally, research C [10] has concerned about encouraging to drawing lines, curve and shapes (pre-writing skills) and finding words by learning by teaching approach. (Table 1.1). There is no research that would provide a progress report based on ASD children's writing activity evaluation.

	pre-writing activities (Line, Curve, shape)	Alphabets Activities	Words Activities	Game Based Activities	Leveling Up tasks	Evaluation
Research A	✗	✓	✓	✓	✓	✗
Research B	✗	✗	✓	✗	✗	✗
Research C	✓	✗	✓	✗	✗	✗

Table 1.1: Comparison of former researches

Writing Wizard – Handwriting App [11] and Otsimo App [13] provides pre-writing activities, but it is not have leveling up activity based on evaluation (Table 1.2). Autism Read & Write App [12] provides only shape drawing activity and also, provides evaluation's reports for those activities (Table 1.2). There are no products that would provide suggestions to leveling up activity based on evaluations.

	Line Drawing pre- writing activities	Curve Drawing pre- writing activities	Shape Drawing pre- writing activities	Leveling Up tasks	Evalu ation	Type	Cost
Aliza	✓	✓	✓	✓	✓	Based on smart mirror	mode rate
Writing Wizard – Handwritin g App	✓	✓	✓	✗	✗	Mobile App	cheap
Autism Read & Write App	✗	✗	✓	✗	✓	Mobile App	cheap
Otsimo App	✓	✓	✓	✗	✗	Mobile App	cheap

Table 1.2: Comparison of related work

The Aliza: Writing Mentor system which is proposed, is designed with many more functionalities than other researches which are currently prevailing. By the proposed solution the Aliza: Writing Mentor would suggest probable solutions to the teaching ASD children problems.

The proposed system is creating an Aliza: smart mirror as autistic education assistant to teach pre-writing activities such as lines, curves and shapes for ASD children. Proposed system continuously evaluates ASD children when they are practicing Alize: Writing Mentor system. The pre - writing task will be leveled up through every evaluation report.

1.4 Research Problem statement

Statistics show an annual increase of the disease about 1 child of 59 in 2018 has with autism in world in comparison of 1 child of 1000 in 1970 [6] [Figure 1.1]. This increase in the number of people infected with ASD should have a corresponding increase in the methods of handling and treat the patients. Besides, teaching writing skills is not a trivial task. Autistic kids spend a huge amount of time learning pre-writing skills [7]. Therefore, we have to find modern ways of using information technology to help teach children with autism.

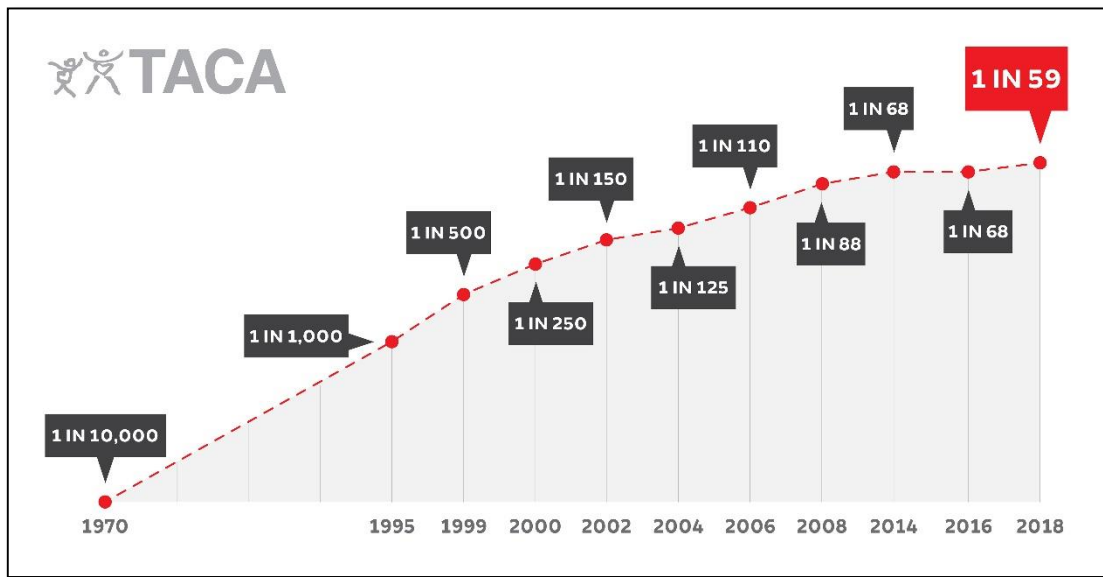


Figure 1.1: The autism statistics prevalence of children
(<https://tacanow.org/autism-statistics/>)

The new development of technologies is now extending its functions to assist the children suffering from Autism Spectrum Disorders (ASD) in areas of socialization, communication, and playful behavior through AI application-based intervention. Therefore, this research studied and analyzed of previous studies of existing system for using different types of modern technologies based systems in autistics children. Even though research and computer-based interventions for pre-writing skills doesn't have level up based activities or task and progress. Computer-based interventions and robots based tutor systems are very expensive.

We used these previous researches and existing system results as a key for our research to choose the suitable type of system and methods to enhance educate pre-writing skills for children with Autism. The results helped to design and implement an Aliza writing mentor system for teaching children with ASD based on smart mirror.

2. Objectives

2.1 Main Objective

Developing a writing mentor system based on smart mirror to improve ASD children pre-writing skills such as drawing lines, curve and shapes in each level activity within the activity level.

2.2 Specific Objectives

- 1) Increasing the overall quality and knowledge of the ASD children's pre-writing skills through using Aliza-Writing Mentor system.
- 2) Improving few peer socialization among the ASD children' after using the Aliza-Writing Mentor system.
- 3) Accustoming modern technology learning system among the ASD children.

3. Methodology

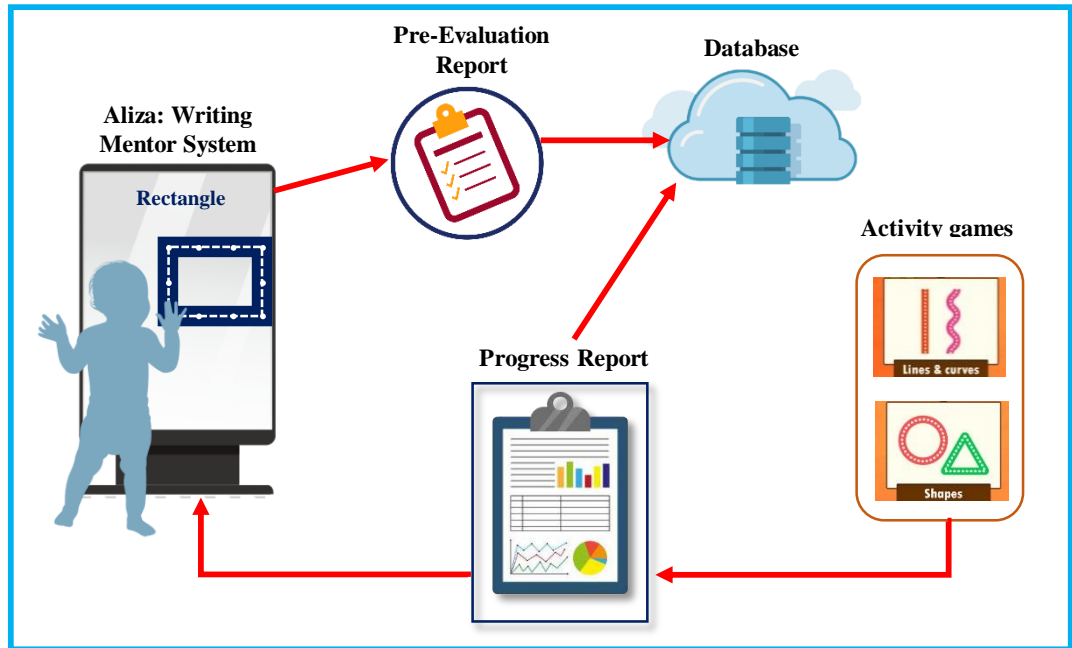


Figure 3.1: System Overview

To conduct this research we have divided our methodology as below sections:

- Data Collection
- Activities and levels
- Modeling CNN to classify drawn lines, curves and shapes
- Evaluation

Data Collection

This study is going to get primary data about randomly selected 100 ASD children between the age of 5 to 12 from 5 selected schools in Colombo and Jaffna districts. The data will be collected by document data collection method from selected ASD children's day to day normal written works such as line, curve and shape drawing works.

The data retrieved from the ASD children will be analyzed, and will be converted into images. Then the images will be fitted into a 28x28 pixel images. Original black and white images are converted to gray scale by anti-aliasing technique during the

normalization process. This data that is needed in order to use as inputs of algorithms will be stored in the database. Figure 3.2 provides the sample data which we decided to collect from the ASD children.

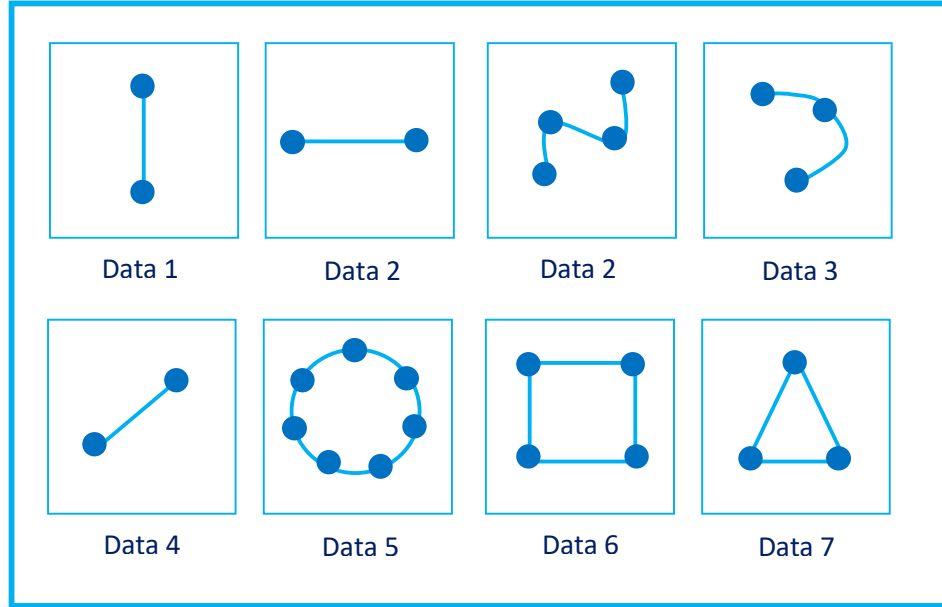


Figure 3.2: Sample primary data

Activities and levels

Learning pre-writing skills through game, can further enhance the sense of presence, engaging even more deeply the ASD child with the game and, consequently, further foster motivating them to learn [14], Because of this we teach pre-writing skills through AI games to ASD children. The pre-writing activity games are based on tracing and connecting dots strategy [Figure 3.3]. Through this strategy ASD children can easily able to develop their pre-writing skills [15]. To conduct this research we have divided our pre-writing activity games to 3 levels as below [Table 3.1]:

Levels	Activity	Stage	Stage Details
Level 1	Drawing Lines	Stage 1	if pre-evaluation progress below 20%
		Stage 2	if pre-evaluation progress below 40%
		Stage 3	if pre-evaluation progress below 60%
		Stage 4	if pre-evaluation progress below 80%
Level 2	Drawing curve	Stage 1	if pre-evaluation progress below 20%
		Stage 2	if pre-evaluation progress below 40%
		Stage 3	if pre-evaluation progress below 60%
		Stage 4	if pre-evaluation progress below 80%
Level 3	Drawing shapes	Stage 1	if pre-evaluation progress below 20%
		Stage 2	if pre-evaluation progress below 40%
		Stage 3	if pre-evaluation progress below 60%
		Stage 4	if pre-evaluation progress below 80%

Table 3.1: Pre-writing activity games levels

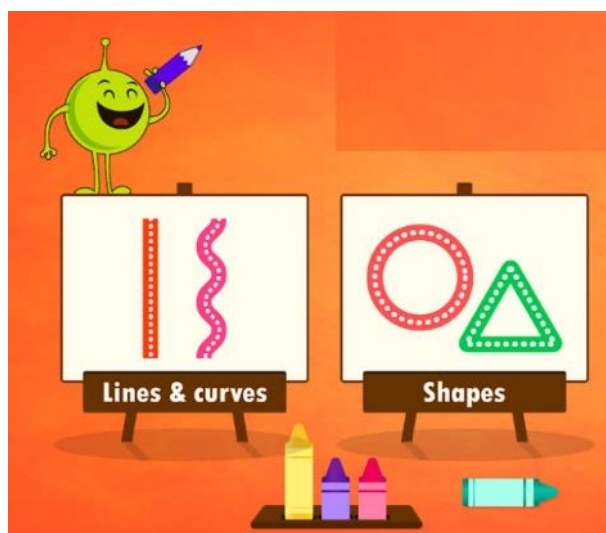


Figure 3.3: Dot tracing game

Modeling CNN to classify drawn lines, curves and shapes

To recognize the lines, curve and shape drawing, we are going to use a seven-layered CNN strategy. A seven-layered convolutional neural network with one input layer followed by five hidden layers and one output layer is designed and illustrated in Figure 1.2.

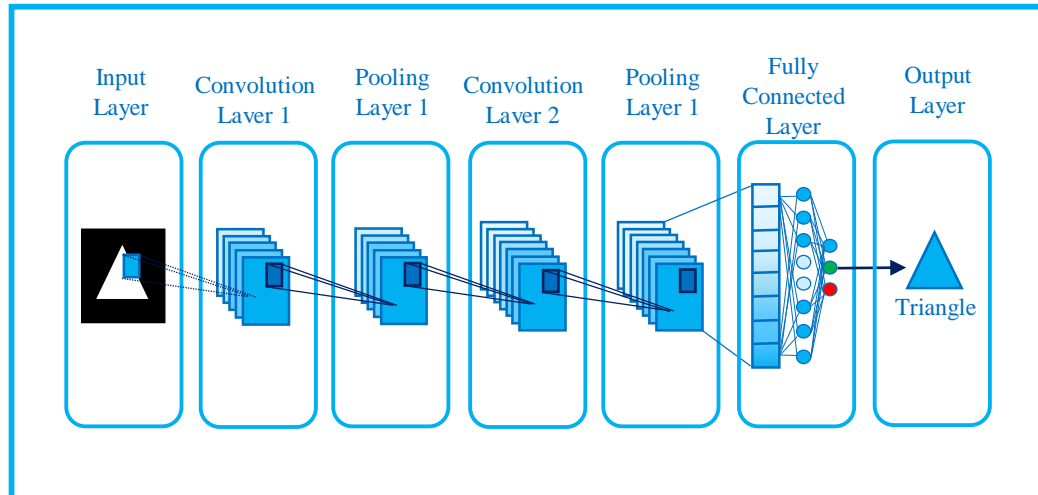


Figure 3.4: Seven-layered CNN

The input layer will consist of 28 by 28 pixel images which mean that the network contains 784 neurons as input data. The input pixels are grayscale with a value 0 for a white pixel and 1 for a black pixel.

Here, this model of CNN has five hidden layers. The first hidden layer is the convolution layer 1 which is responsible for feature extraction from an input data. The next hidden layer is the pooling layer 1. It reduces the output information from the convolution layer and reduces the number of parameters and computational complexity of the model. Convolution layer 2 and pooling layer 2 which has the same function as convolution layer 1 and pooling layer 1 and operates in the same way except for their feature maps and kernel size varies. A fully connected layer is another hidden layer also known as the dense layer. It is similar to the hidden layer of Artificial Neural Networks (ANNs) but here it is fully connected and connects every neuron from the previous layer to the next layer. In order to reduce over fitting, dropout regularization method is used at fully connected layer. The output layer of the network

classifies the output as the lines, curve, and shapes types. Through this seven-layer CNN strategy can identify the input image, as well as we can get the output of percentage which is consistent with ideal image.

Evaluation

To conduct this research we have divided our evaluation into two levels as bellow:

1. Pre-evaluation
2. Level Evaluation.

Pre-evaluation is done when the ASD children initially starting Aliza with the help of CNN technique. The pre-evaluation writing-mentor system will be find out the pre-writing skill knowledge of children with autism. Then the system will be create a report based on this pre- evaluation. This pre-evaluation data that is needed in order to use as inputs to progress analyzing process will be stored in the database. At the same time system will be analyzed the pre-evaluation report to find the ASD children's game stage [Table 3.1]. Then the system will be assigned game activities based ASD children's game stage.

Level evaluation is done when the ASD children are practicing with the help of Aliza. End of the each level writing mentor system will be given an evaluation test activity. Through this can find out the pre-writing skill's knowledge of children with autism. The system will be analyzed in the evaluation test report with pre-evaluation report to find the ASD children's progress. When the progress report agrees with the leveled up conditions, then the ASD children's pre-writing game activity is leveled up to the next level [Table 3.1].

4. High-level System Architecture

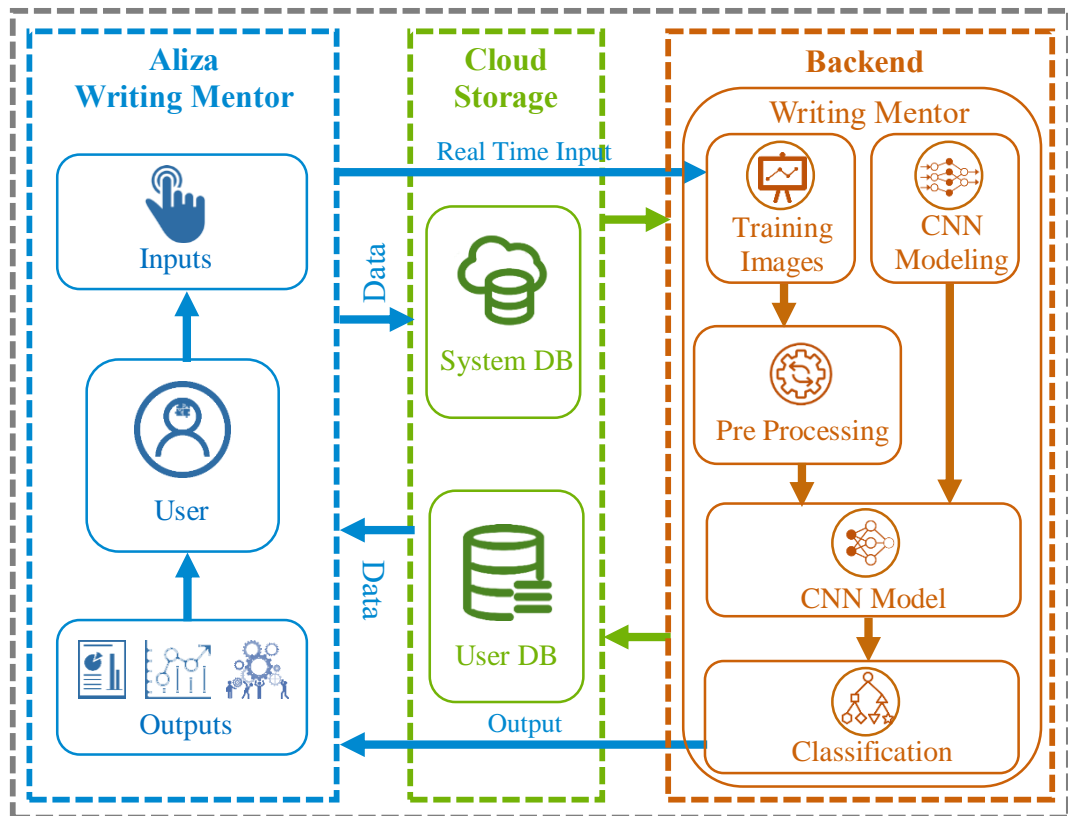


Figure 4.1: High-level System Architecture

5. Description of Personal and Facilities

Aliza: Writing Mentor Tasks:

- Building the smart mirror.
- Collecting data from selected ASD children's day to day normal written work (lines, curve and shapes)
- Creating evaluation models and train those models.
- Creating pre-writing activity's animations and pictures.
- Create pre-writing activities and levels.
- Evaluating ASD children pre-writing skill levels in each activity.
- Leveling up activity levels through the evaluation.
- Integrating Writing Mentor system with the Aliza main system.

5.1 Work Breakdown Structure (WBS)

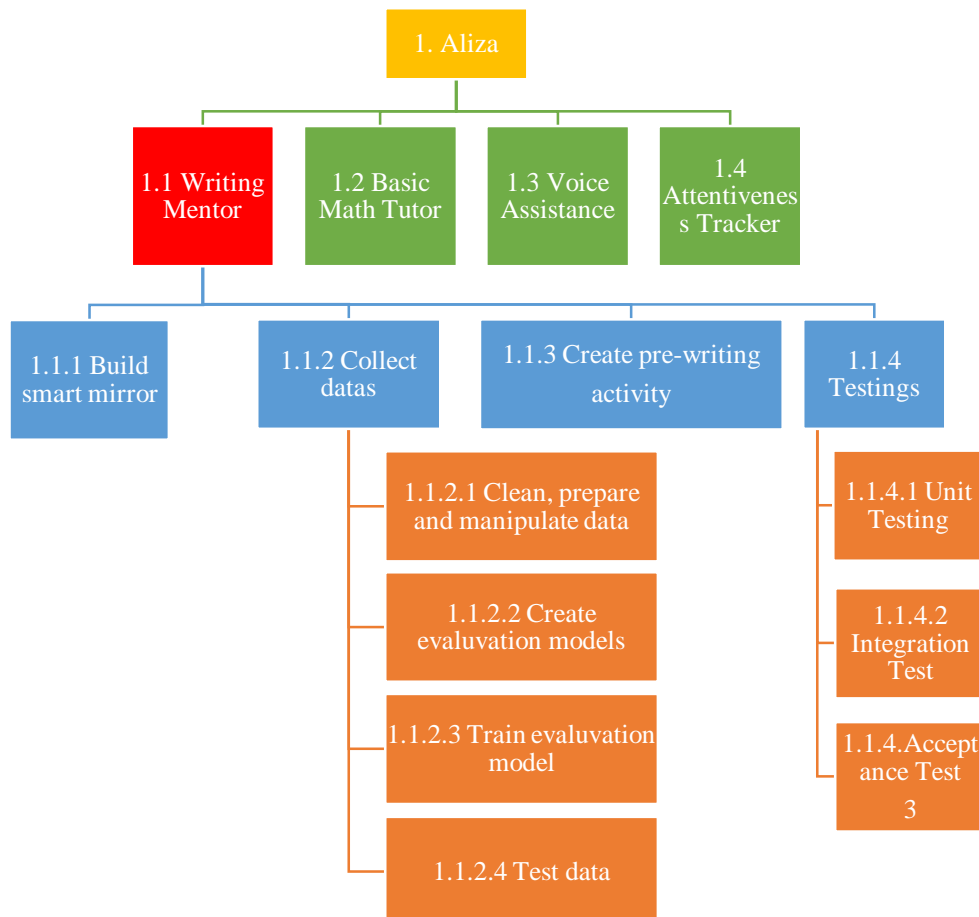


Figure 5.1: Work Breakdown Structure

5.2 Self-evaluation Plan

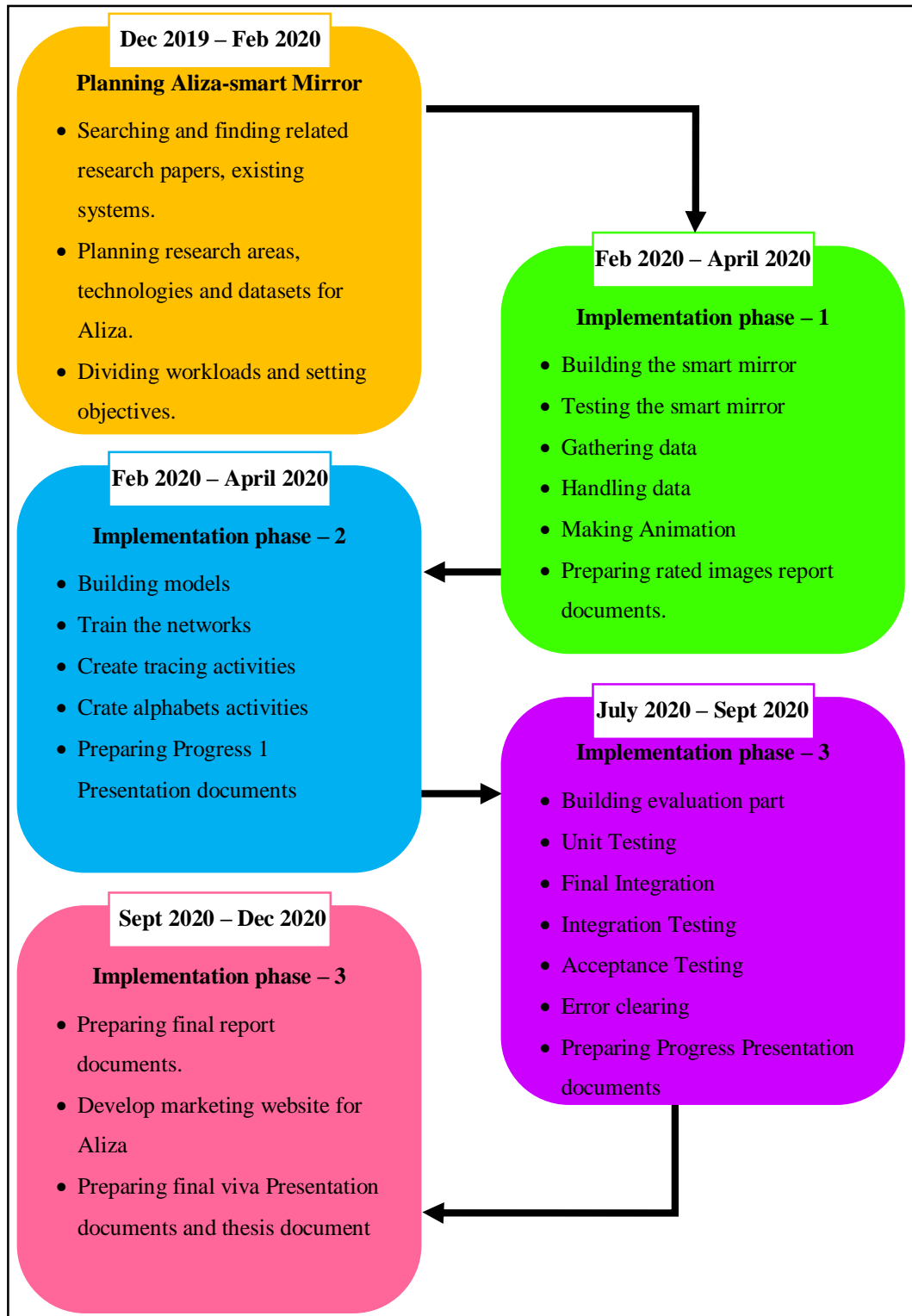


Figure 5.2: Self-evaluation plan

6. Requirements

6.1 Functional Requirements

- 1) The user should be pre evaluated their pre-writing skills before a task.
- 2) The system allows user to practice pre-writing activities on smart mirror.
- 3) The user will be able to generate a report of the progress of writing skills.
- 4) The Writing mentor system should be integrated with the Aliza main system.
- 5) The user can swap through activities. (Based on their facial reactions).

6.2 Non-Functional Requirements

- 1) Usability

Simple use of language and basic instructions provide for a user friendly system.

- 2) Affordability

The system is at an affordable price that can be used for household as well as in schools. Moreover the system facilitates many user accounts through one mirror.

- 3) Security

The images of the individuals will only be processed and stored as a result. No individual data will be exposed.

7. Budget

Project period: February – December

Expenditure Description	Budget Requested (\$)	Justification for Expenditures
Wood Frame and Two-way mirror	5000	Purchasing this items for smart mirror creation.
Raspberry pi	8000	
IR panel	20,000	
LCD monitor	12,000	
Power Supply unit	500	
Travelling	3000	Travelling cost of for pre-data collection to ADD children's schools
Others	2000	Printing, photocopy, Internet, Telecommunication
Total	50,500	

Table 7.1: Research budget

8. Commercial Value

The commercial value of the proposed solution is increased through below mentioned information:

- The system accommodates many users through one mirror which can be used in schools and homes as well.
- The system provides parents with the facility to easier way to track their child's progress.
- Since the system is wall smart mirror therefore easy to use and attracts many users.
- The system provides the facility to swap game activities by user as per their convenience.
- Especially this smart mirror has a user friendly voice assistant.

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