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

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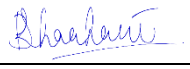
R.S.Najeeb	IT17137560	

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

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ABSTRACT

Education is the most important factor in human life. Thus, children are educated from a very small age. Unlike adults, children aged 5 have approximately only 15 minutes of concentration time [1]. Therefore, teachers and parent s are advised to change activity, involve in motor skill activities or to have a power nap.

When considering Autism spectrum disorder (ASD) affected children they are way more sensitive to the background environment thus reacts to even small vibrations, noise, etc. They tend to get more distracted than non-autistic children [2]. Experts say that children with ASD quite often are diagnosed with attention deficit hyperactivity disorder (ADHD) [3]. Many teaching techniques and therapies are given to children to make them stay more focused and develop linguistic skills. These children need positive reinforcement to encourage them in activities. Additionally, they need to be directed with simple instructions and actions in order to perform a task. Also, to educate them, their behavior patterns and emotions are observed and learning activities and fun activities are given. This is a great challenge to their mentors and parent. Considering all above as a result this study innovates the learning method of ASD students and introduces a smart mirror named “Aliza. This facilitates any ASD child within the age of 4-15 learn shapes, numeric, alphabets based on their facial emotion state.

KEY WORDS: Autism spectrum disorder (ASD), Attention deficit hyperactivity disorder (ADSD), smart mirror

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1. Introduction

1.1 Background

"Emotions are biological states associated with the nervous system [4] brought on by neurophysiological changes variously associated with thoughts, feelings, behavioral responses, and a degree of pleasure or displeasure. There is currently no scientific consensus on a definition. Emotion is often intertwined with mood, temperament, personality, disposition, creativity and motivation" [5]. Most studies classify 7 basic emotions. Such as happiness, anger, sadness, surprise, fear, disgust, contempt. The table 1.1 shows how an emotion the 7 basic expression characteristics [6].

Emotion	**characteristics**
Happiness	Raised lip corners, wrinkle around the eyes, cheeks raised
Sad	Loose eyelids, lips pull down
Anger	Pull down eyebrows, tightened lips
Surprise	Slight mouth open, chin drop, raised eyebrows, out exposed eyes
Fear	Stretched mouth, wrinkled forehead
Disgust	Pull down eyebrows, nose wrinkles, pulled-up upper lip
Contempt	Neutral eyes, neutral face

Table 1.1.Facial expression description

When considering ASD individuals they lack verbal communication. World health organization defines that "Autism spectrum disorder (ASD) refers to a range of conditions characterized by some degree of impaired social behavior, communication and language, and a narrow range of interests and activities that are both unique to the individual" [7]. Thus, lack of communication in learning creates a tough situation to their tutors. However, ASD children are very sensitive to the surrounding environment that they tent to react quickly and get distracted easily. In order to overcome such

impediment experts, guide them to teach ASD students based on their reaction which is a concept of Sensory Integration Therapy (SIT) [8]. Figure 1.1 depicts the key elements that affects facial expression of an individual.

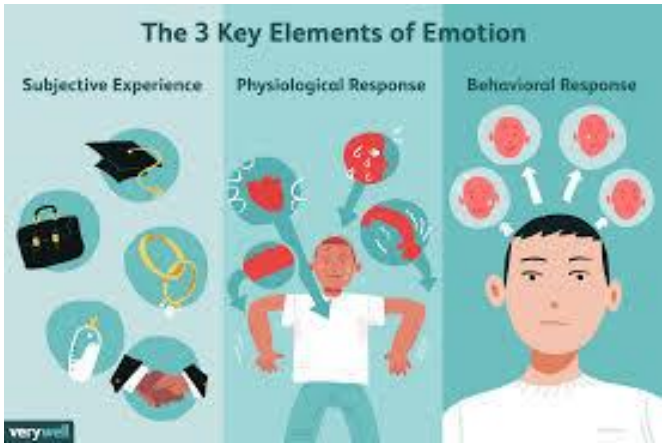

Figure 1.1.Key elements of emotions

(https://www.verywellmind.com/what-are-emotions-2795178)

Sensory Integration therapists mainly lets children play with household objects, playdough, swings etc. and measures the reaction of the adolescents and improve activities overtime. Surprisingly they were more engaging with mirrors, spent more time gazing at their own reflection and treating it like a real person [9]. Even children with ASD level 3 [10] gradually started to talk looking at their own reflection.

This study reflects upon all the key pillars when educating ASD adolescents and introduces an Aliza: smart mirror as an autistic education assistant, not only that provides activities for basic education but reacts upon once facial reaction and acts accordingly. Furthermore, upcoming topics in detailly describes the concepts of this smart mirror. Motor skill activities are also provided to enhance their concentration with fun activities.

1.2 Literature survey

Vast variety of studies discuss the importance of emotion recognition for ASD individuals. The study "Basic and complex emotion recognition in children with autism: cross-cultural findings" clearly states that children with ASD are unable to recognize emotions [11]. As these studies gives a major importance to emotion recognition, to this point no learning application monitors the child reaction instead a manual assistant incorporates with the child while using the system. They assist them in their activities in a planned routine.

Meanwhile the authors Suzan Anwar and Mariofanna milanova in their research "Real Time Face Expression Recognition of Children with Autism" [12] have come up with a real-time facial emotion recognition system where a web cam records the ASD children's while playing and recognize the emotions of the children. Success rate of 80.76% [12] percentage was achieved in the study. This is a major achievement because autistic kids' emotions expressions slightly differ from a normal kid. But a solo application which monitors students in a concentrated environment like this would not be helpful in any mean for a learning ASD student.

Also "The rationale for computer-based treatment of language difficulties in nonspeaking autistic children" [13] research by Kenneth Mark Colby in 1973 described computer-based methods for level 3 ASD children [10]. "13 out of 17 nonspeaking autistic children have shown linguistic improvement" [13]. This is an ideal example that brings up how technological advancement can affect on ASD child and improve their communication skills.

1.3 Research Gap

Even though there are many hands-on applications it only contains few of the aspects of ASD. Even considering emotions many systems are there to teach emotions through activities. Popular example is the “Milo” humanized robot [14] engages with students as their peer and assist them in education. It teaches about emotions but doesn’t evaluate the student or doesn’t take users emotions as an input into the system. Motor skill development is a missed-out element in this study.

Similarly, a mobile application named “Otsimo” [15] was developed to facilitate ASD children with fun activities. A leveling up process is done after a successful completion of activities. All users are given the same basic level to start and gradually progress. Otsimo app neither tracks the user’s emotions nor have motor skill activities. However, contains activities for pre-writing skills, numeric, colors, alphabets.

Application	**Type**	**Emotion tracking**	**Swapping activities**	**Motor skill activities**	**cost**
Aliza	Smart mirror	yes	Yes (based on emotion)	yes	moderate
Milo	Humanized robot	no	Yes (only by exiting the current activity)	no	expensive
Otsimo	Mobile application	no	Yes (only by exiting the current activity)	no	moderate

Table 1.2.Comparison of existing apps

Above Table 1.2 depicts how other existing mobile app and humanized robot vary from the proposed system Aliza. Aliza recognizes the users, recognizes their emotions and proposes decisions based on their facial reactions and continue the activity process. Aliza also provides motor skill activity “catch the dot” which makes users interact with the mirror physically moving their hands, bending and jumping to complete the focus exercise.

1.4 Research Problem statement

ASD is a common cause in the current time and it is primarily affecting children in their beginning of childhood and continues when they grow. These children have a tendency to depend on an assistant since they have lack of verbal and nonverbal communication towards people. They find challenging to follow regular methods of learning in fact visual way of learning is most ideal solution.

Does existing apps and technologies serve their needs is a major question so far. Because these systems don't consider their level and provides every user from a basic level. Even though they are unable to express themselves in a linguistic they express it through their emotions. Emotions determine what states, thoughts or feeling they are in. Neither these apps provide motor skill actives nor recognizes user's facial expression as an input of the system

A novel solution is proposed by the study to overcome these needs. Introducing a smart mirror "Aliza" is considers facial emotions as an input and make decisions and provide motor skills to improve attentiveness. A smart companion to the individuals in need.

2. Objectives

2.1 Main Objectives

The main objective is to implement a smart mirror that helps to improvise the education of ASD individuals based on their behavior and emotions and improving their focus and concentration by providing motor skills.

2.2 Specific Objectives

- Monitoring users' facial reactions to determine activities.
- Providing motor skills activity to improve users' focus.
- Train users to do activities without a manual assistant.
- Adapting users for smart IOT devices.

3. Methodology

Data Collection

The data collection is done by collecting data from public data archives. Which are confidential and requires permission. The two archives that was selected to be used are: 1. Child Affective Facial Expression (CAFE) set [16] and 2. Autistic Spectrum Disorder Screening Data for Children Data Set [17]. These are photographs of 2 to 8-year-old children with 7 different expressions listed in the Table 1.1 mix of Asian and American children approximately total of 160 students. These data will be kept confidential and secure.

Hardware and system requirements

The main requirement is the camera to capture the facial expressions. The camera would need a regular mini surveillance camera that with resolution of 1080p, and high-quality recording, support Linux system or windows 7 or above with USB pin. Power supply of domestic voltage of 220v-240v. smart mirror integrated with raspberry pi. 40” inches display of two-way mirror. Speakers attached for the feedback and activity sounds. Thick wood frame and wall mounted for stability. IR panel for touch activities.

Activities

Activities provided for this component are attentiveness enhancement activities. The activity requires physical movements of the individual. Stretching, moving, bending poses are required. This is to engage users with the device for a long period of time without any hassle. Retaining focus of ASD students is the objective of this activity.

Process

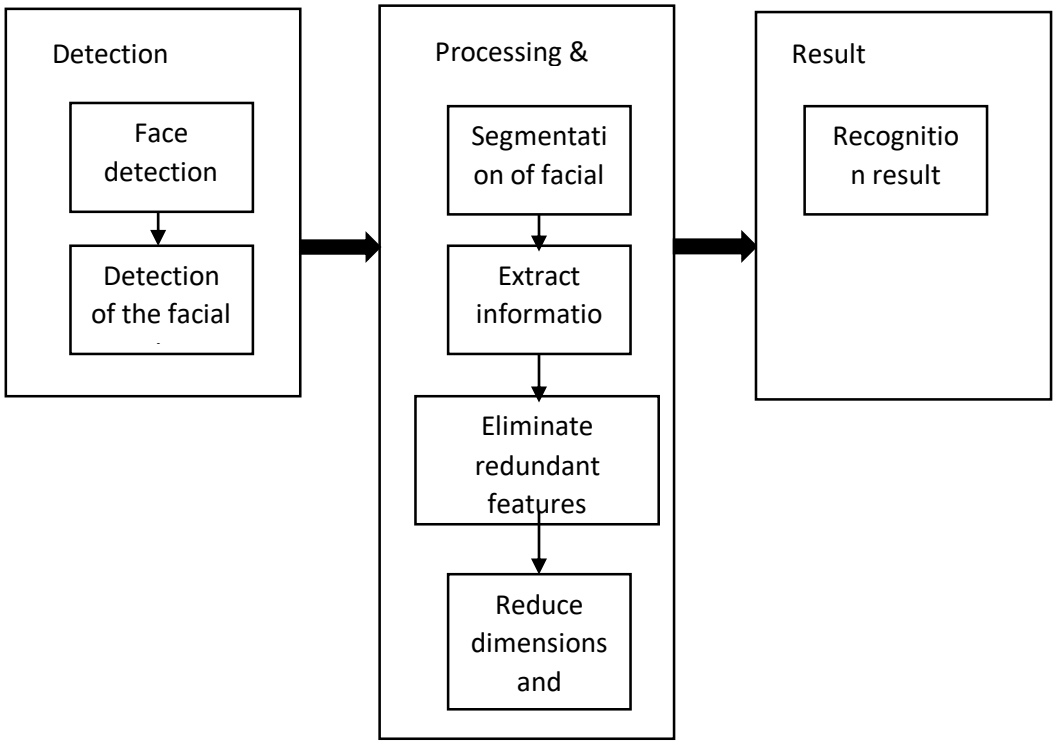

Figure 3.1.Block diagram of emotion extraction

Collected data set will be processed to detect the face with Viola-Jones algorithm. Figure 3.2 shows the facial detection frame. It detects the face on gray-scale mode then find the actual location in the colored image [18]. Then normalization process is done to decrease the n-dimensional data. Active shape model is the most ideal technique for detection and tracking of triangulation points [19] in the face. Table 1.1 points out the types of emotions and the variations of the face using these changes in the face facial points are fixed in the eyebrows, lips, chin, eyes and nose. Figure 3.3 shows a regular face with the facial points for the points detected the location of the image is identified by the gradient of image texture. This extracts the facial emotions of the user. Figure 3.1 illustrated the block diagram of the process.

Figure 3.2.Face detect in a frame

https://www.pyimagesearch.com/2018/06/25/raspberry-pi-face-recognition/

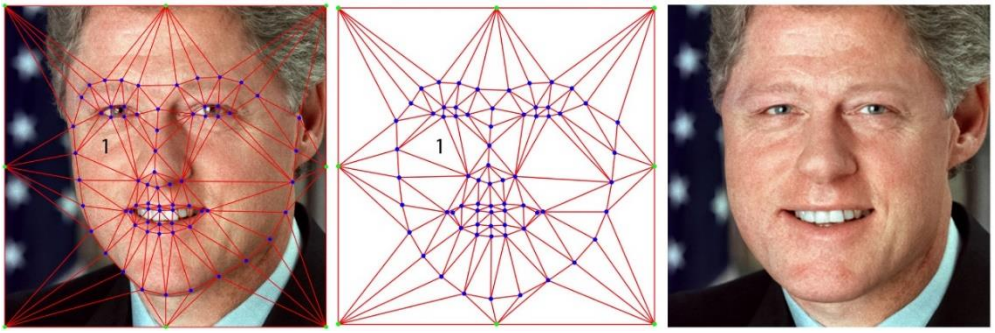

Figure 3.3.Regular face with triangulation points

https://www.learnopencv.com/average-face-opencv-c-python-tutorial/

The motor skills activity is based on dot to dot strategy. The activity starts with a dot and when the user correctly touches the dot then it leads to the next dot in the screen. The evaluation for this activity is based on their response time. To make them more physically moving the dots are appeared all over the mirror to place the dots. This is generally done by optimization. The longest response time taken to the dots will be generated in a pattern using reinforcement learning [20].

Verification

A group of students in the autism school located in Borella are taken to verifiers of the system. A group of randomly selected 20 students of both genders approximately the age of 5-10 are given to use the Smart mirror “ALIZA” and seen the progress of them, and how the mirror caters them.

4. High-level System Architecture

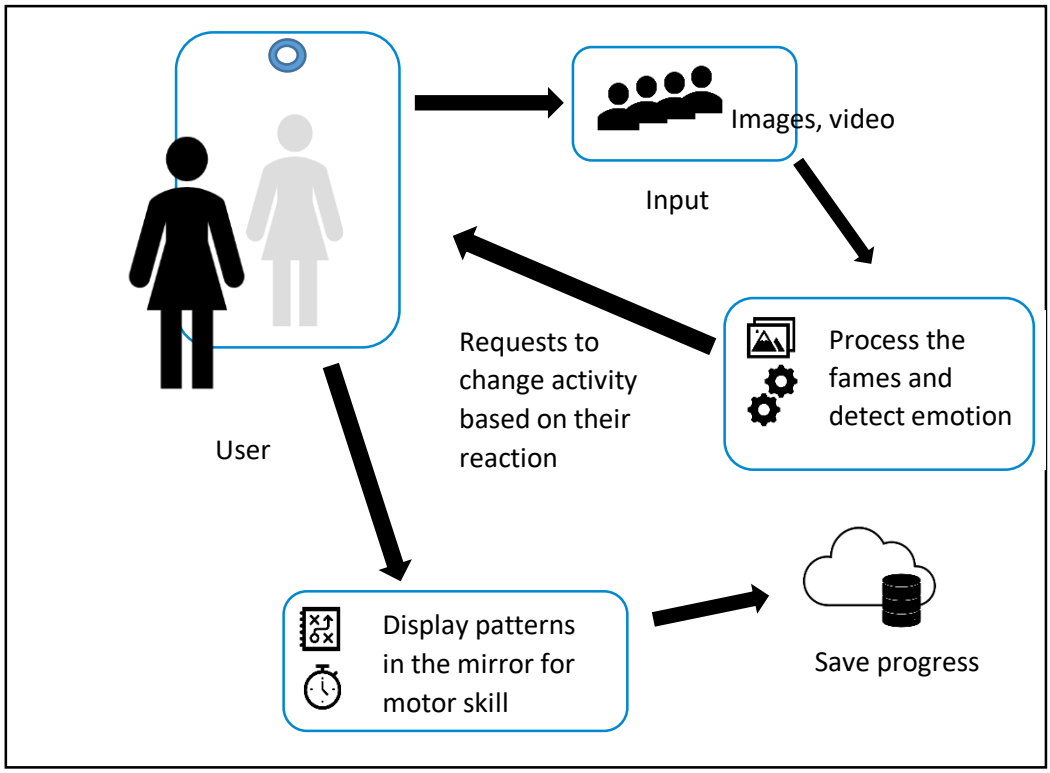

Figure 4.1.High level architecture diagram

5. Description of Personal and Facilities

- Smart mirror construction.
- Process data of the ASD individual's images.
- Train models based on images.
- Get necessary data from the sensor camera.
- Evaluate model with test data.
- Analyze users' facial patterns.
- Utilize the data capturing frequency.
- Specifying which data should be stored in the db.
- Creating motor skill activities.
- Evaluating motor skill activity.

5.1 Work Breakdown Structure (WBS)

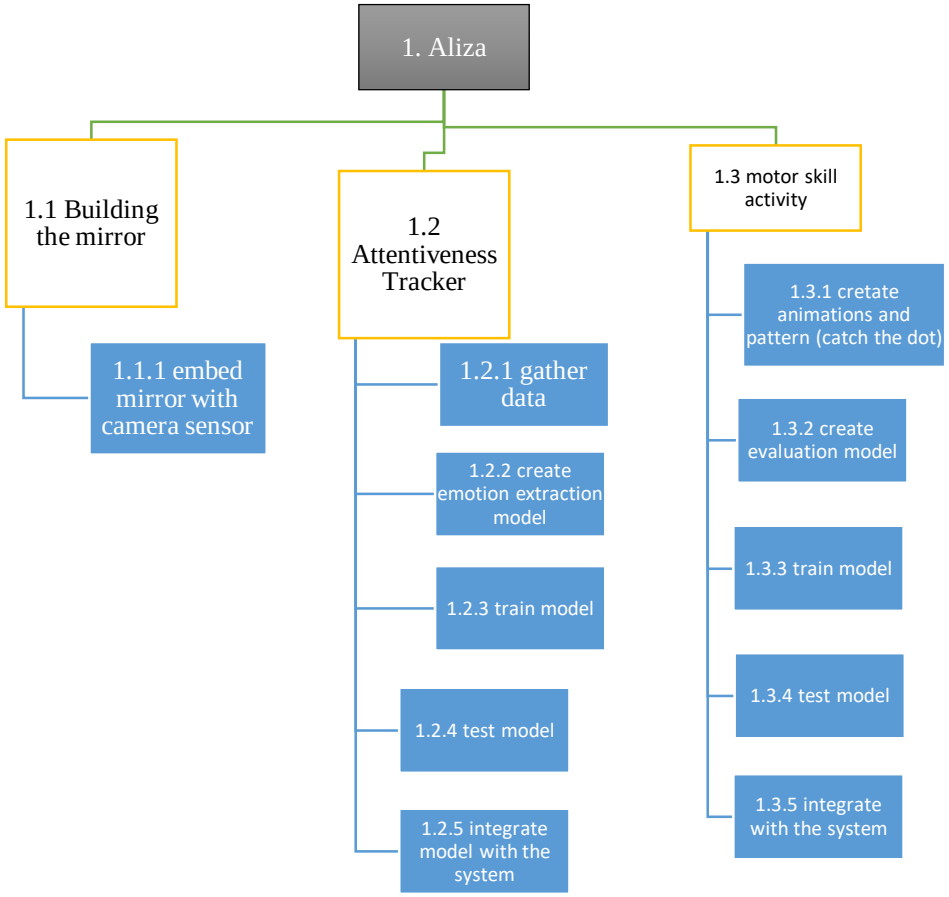

Figure 5.1.Work Breakdown Structure

5.2 Self-evaluation Plan

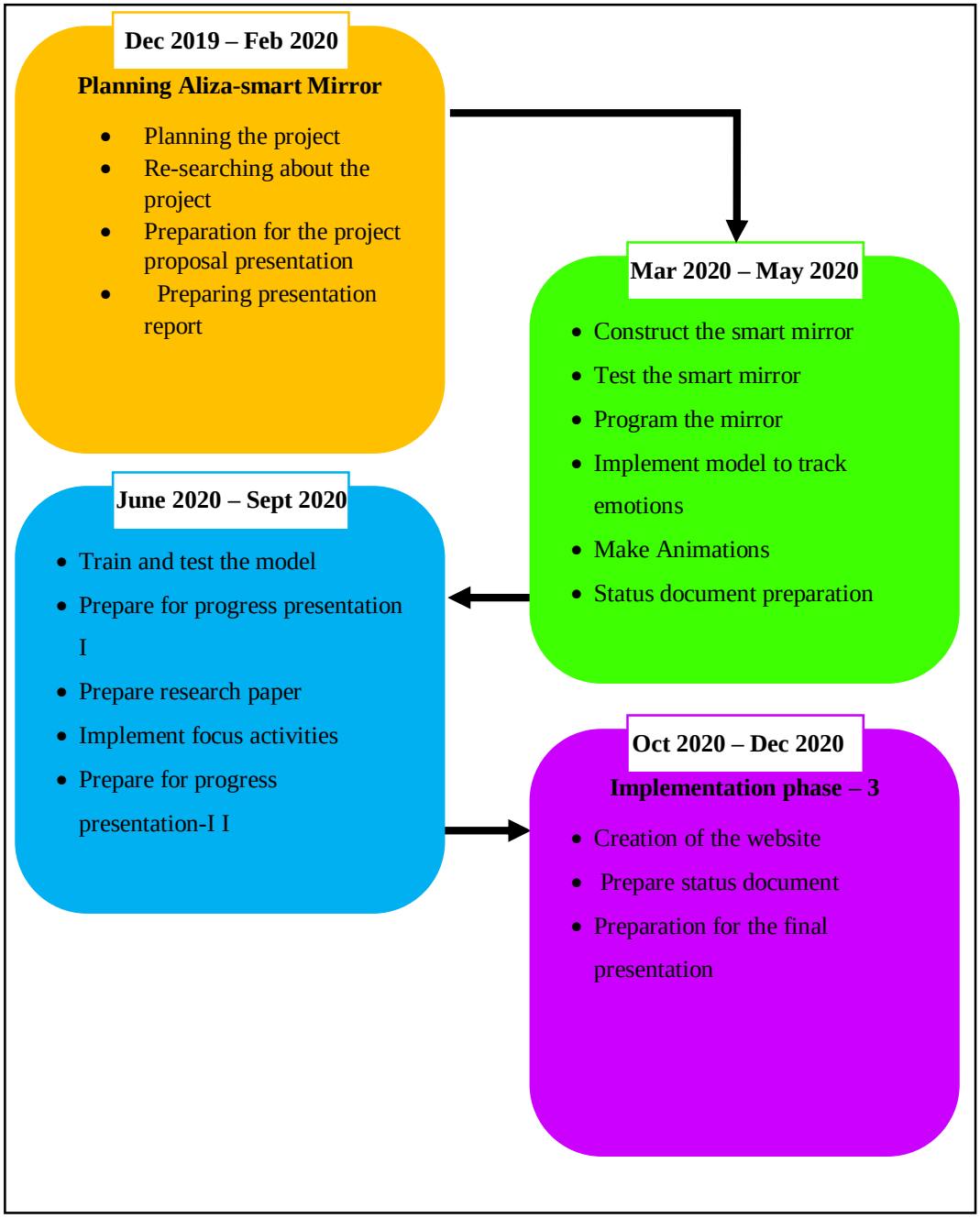

Figure 5.2.Self-evaluation plan

6. Requirements

6.1 Functional Requirements

- Consumer will be able to create many user accounts through one mirror.
- User will be able to swap through activities based on their facial reaction.
- Motor skill developing activities provided to enhance attentiveness.

6.2 Non-Functional Requirements

- Usability

  A user-friendly system provided with basic English language and simple instructions to follow.

- Security

  The user's images are taken to ONLY to process and extract the emotions no individual's identity will be exposed.

- Affordability

  Unlike other expensive systems Aliza is affordable to all.

- Multi-tenancy

  Same application is used by the users but separately keeps track of each users

7. Budget

Expenditure Description	Budget (LKR)	Justification for Expenditures
Wood Frame, two-way mirror, raspberry pi, LCD monitor, IR panel, power supply unit	25,000	Common items to build a smart mirror
IR panel	20,000	To play motor skill activity
Camera	5000	To capture the facial reaction
Others	2000	Printing, photocopy, Internet, Telecommunication
Total	**52,500**	

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 mounted 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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