ALIZA: SMART MIRROR AS AUTISTIC EDUCATION ASSISTANT

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Dissertation submitted in partial fulfillment of the requirements for BSc (Hons) in Information Technology

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DECLARATION

I declare that this is my own work and this dissertation 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 my 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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(Jesuthasan Alosius)

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 [1]. Experts say that children with ASD quite often are diagnosed with attention deficit hyperactivity disorder (ADHD) [2]. 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. 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 and focus enhancing skills. With basic instructions and positive feedback user are encouraged to interact with Aliza in a enjoyable manner. Also, to educate them, their behavior patterns and emotions are observed, activities are swapped based on their emotions.

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

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LIST OF ABBREVIATIONS

ASD	Autism spectrum disorder
ABA	Applied Behavior Analysis
ADSD	Attention deficit hyperactivity disorder
CNN	Convolutional Neural Network

1. INTRODUCTION

This section covers the research problem, planning and technical approaches of emotion detection and focus activities component of "Aliza".

1.1. Background Literature

"Emotions are biological states associated with the nervous system [3] 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" [4]. Most studies classify 7 basic emotions. Such as happiness, anger, sadness, surprise, fear, disgust, contempt. The Table I. shows how an emotion varies with the characteristic change of the face [5].

Table I : Facial Expression description of emotions

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

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" [6]. Thus, lack of communication in learning creates a tough situation to their tutors and parents. However, ASD children are very sensitive to the surrounding environment that they tent to react quickly and get distracted easily. First the subjective experience of the environment is received by the children then behavioral response is shown from the face which are facial emotions then physical responds are displayed such as hand movements and nodding. In order to overcome such impediments, ASD specialists guide to teach ASD students based on their reaction which is a teaching method used in ASD.

Firstly, ASD children are given household objects for example play dough, toys and measures the reaction of the adolescents. This is continuously done until they are familiar with objects. Surprisingly ASD children were more engaging with mirrors, spent more time gazing at their own reflection and treating it like an individual[7]. Even children with ASD level 3 [8] gradually started to initiate a conversation with their own reflection. In fact, mirrors are used to train children improve their screen engagement skills and for teaching. When teaching using a mirror, the child is placed closed to the mirror and the tutor shows different numbers, letters or objects from behind so that ASD children would not feel unconfutable around the foreign object. This therapy is followed at an early stage of a child.

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" trains the ASD children for major 6 emotions and for 12 complex emotion "Interested, bored, exited, worried, disappointed, frustrated, proud, ashamed, kind, unfriendly, joking, hurt"[9]. As these study gives a major importance to emotion recognition in typical development of a child, 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" [10] 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. This system in trained to track facial features to recognize the facial emotions. A success rate of 80% [10] percentage

was achieved in the study when predicting 6 basic emotions. This is a major achievement because autistic kids' emotions expressions slightly differ from non ASD children. This is a solo application that has been introduced for emotion recognition purpose. It states the importance in analyzing facial emotions when interacting. It is the key to non-verbal communication method.

Also "The rationale for computer-based treatment of language difficulties in nonspeaking autistic children" [11] research by Kenneth Mark Colby in 1973 described computer-based methods for level 3 ASD children [8]. "13 out of 17 nonspeaking autistic children have shown linguistic improvement" [11]. This is a computer-based treatment. A self-learning platform for children with self-directed and self-selected instructions with minimalized interference of caretakes.

Not only facial expressions determine the individuals emotions, voice input can also be used to recognize the emotions. a study conducted by authors Marco Paleari, Ryad Chellali, Benoit Huet named "Features for multimodal emotion recognition: An extensive study" [12] enlightens how emotions and voice data can be used to predict emotions of an individual. Similarly, authors M. Murugappan, M. Rizon, R. Nagarajan, S. Yaacob, D. Hazry and I. Zunaidi conducted a research "Time-frequency analysis of EEG signals for human emotion detection" [13] explains how EEG Electroencephalogram signals can be used to detect emotions.where 63 electrods were placed in the scalp sending frequency of 256Hz to determine the individuals emotions.

These are some examples that brings up how technological advancement can affect on ASD child and improve their expressions. These systems are to help understand ASD children's non-verbal communication.

1.2. Research Gap

Even though there are many hands-on applications it only contains few of the aspects of ASD therapies. When considering emotions many systems are there to teach emotions through activities for ASD children rather than a tool to learn their emotions. Learning to predict ASD children's emotions helps us to grasp the child's liking and needs.

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. This is built as a companion for ASD children. “Milo” contains writing exercises, vocal training, math exercises as a basic education platform. Moreover, the robot expresses emotions to create a playful companion for children. Even though these exiting features are introduced concentration development is a missed-out element and emotion recognition is not used. This is built using advanced robotic technology which results as a costly equipment for users to purchase.

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 has concentration activities. However, contains activities for pre-writing skills, numeric, colors, alphabets and emotion teaching. This is a mobile application which is easily accessible. The progress of these activities are recorded and displayed as reports for future use.

Above mentioned both applications are popular examples for autism education. Yet these applications doesn’t contain emotion recognition in order to provide activities children would enjoy depending on their current emotional state. Moreover, these applications doesn’t include any focus enhancing activities as ASD children have low levels of concentration and ASD quite often are diagnosed with attention deficit hyperactivity disorder (ADHD) [2].

Table II: Comparison of existing applications and research

Application	**Type**	**Emotion tracking**	**Swapping activities**	**Focus 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
Research A [10]	research	Yes	-	-	-

Research A - "Real Time Face Expression Recognition of Children with Autism" [10] a tool for emotion recognition built using machine learning concepts. Viola-jones to detect the frontal face Support vector machine to classify the emotion. A video stream is sent to the model then with facial triangular points the emotions are predicted. This research has achieved a classification rate of 80%. Yet miss classifies sadness and disgust due to similar face expressions.

Above Table II depicts how other existing mobile app, humanized robot and the Research A 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 Concentration activity "Coin game" which is a maze game commonly recommended used by ASD specialists.

1.3. Research Problem

ASD is a common cause and has a vast increase in current time, it primarily affects children in their beginning of childhood and prolong as they grow. Early discovery and treatments have clinically proven improvements within these children [16]. ASD affected children commonly 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, instead follow visual concept learning.

Even though they are unable to express themselves in a linguistic way they express themself through their emotions. Emotions determine what states, thoughts or feeling they are in. Since they tend to react for the smallest change it is a basic necessity for tutors to teach according to their emotion changes. However, it is a major question whether existing apps and technologies serves ASD children's educational needs. Neither these apps provide actives based on the user's facial expression to monitor through the activities nor has focus enhancing activities. These available systems initiate every user from a basic level rather than identify the user's standard.

Manual therapies accommodate such needs, yet it is not constantly available, accessible nor affordable for all the children in Sri Lanka. Many ASD centers are only located in specific areas such as Jaffna and Kandy and in western province. There are lack of resources and specialists to educate ASD children through-out the country[17].It is also a known fact that there is an increase of autism children globally which is now affected one in 160 children worldwide[18].

Through "Aliza" gamified smart mirror, it is expected to address all basic education needs of ASD children and to accommodate one or many users through a single mirror which is user friendly and has simple instructions to follow. Tracking and analyzing emotions to teach students according to their emotion change. Focus games are given to enhance user's concentration. Parents and tutors are able to review their children/students' progress through progress reports. A smart companion to the individuals in need.

1.4. Research Objectives

The objectives of attentiveness tracker are as follows;

- To build an emotion recognition teaching model
- Real-time emotion recognition of the user.
- Analyze the emotions though-out the activities.

- If negative emotions received, suggest activity switch.
- Maze game to boost focus level of user.
- Increasing difficulty level by introducing new obstacles in focus game.

1.5. Requirements

Functional Requirements

- User will be able to create many user accounts through one mirror.
- User will be able to swap through activities based on their facial reaction.
- Concentration skill developing Maze game provided to enhance attentiveness.
- Leveling up process in game.
- Positive feedback and positive re-enforcement for completion of activity.
- Evaluation reports to view.
- Game reset option.

Non-Functional Requirements

- Usability
    - A user-friendly system provided with basic English language and simple instructions to follow.
- Security
    - The user's system engaging video is ONLY taken to process and extract the emotions no individual's identity will be exposed.
    - User Authentication for login.
- Affordability
    - Unlike other expensive systems Aliza is at an affordable cost.
- Multi-tenancy
    - Same application is used by the users but separately keeps track of each users.

2. METHODOLOGY

An elucidation of the complete workflow of attentiveness tracker component of Aliza is under this section. Emotions are the major key of this component. Emotions determine the current state of a person. Based on facial emotions the module tracks the user's attentiveness and responds in the game. Teaching according to the emotions of student has been proven very effective that applied behavior analysis recommends teaching according to autism children's emotions. The objective of this component is to detect the emotions of the user in real-time and suggest decisions based on it.

2.1. Dataset

Due to the global pandemic covid-19 situation, data collection of process was postponed since the ASD centers and schools were temporarily shut down. Instead for this component a publicly available facial expression dataset[19] was used. There are 28709 training images and 7178 test images altogether with a count of 35,887 image samples. Each training and test data set contains 7 directories of categorized images within. These categories are the basic emotions happy, sad, neutral, disgust, fear, surprise, angry which is shown in Table I. The data set structure is given below in figure 1.

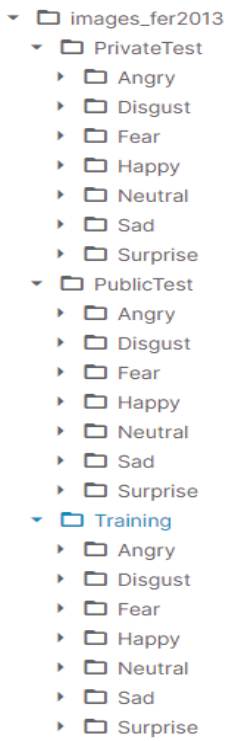


Figure 1: Dataset structure

2.2. Processing and Training

There are many approaches when detecting emotion recognition through facial expression images. CNN was chosen to develop emotion recognition since it has been used in many researches for image recognition which contains massive number of images and sequence data to find non-linear correlations.

The dataset is first preprocessed before taken in to use, as the initial the data set is rescaled and set into greyscale mode. The input layer consists of 48 by 48 images greyscale pixel images. Then the Image generator data augmentation is performed to bring all the images to the same level of consistency. A zooming, rotating and horizontal flip is performed. Same procedure is done to the validation data. These pre-processed data then sent in a sequential stack of layers. These stacks of layers consist a mix of 8 Convolutional layers, 3 dense layers, 4 max pooling leading to 15 layers. Batch sample is set to 64. ELU activation is used to avoid dying neutron issue and it is also the fastest to converge to zero and produce more accurate results.

2.3. High level Architecture diagram

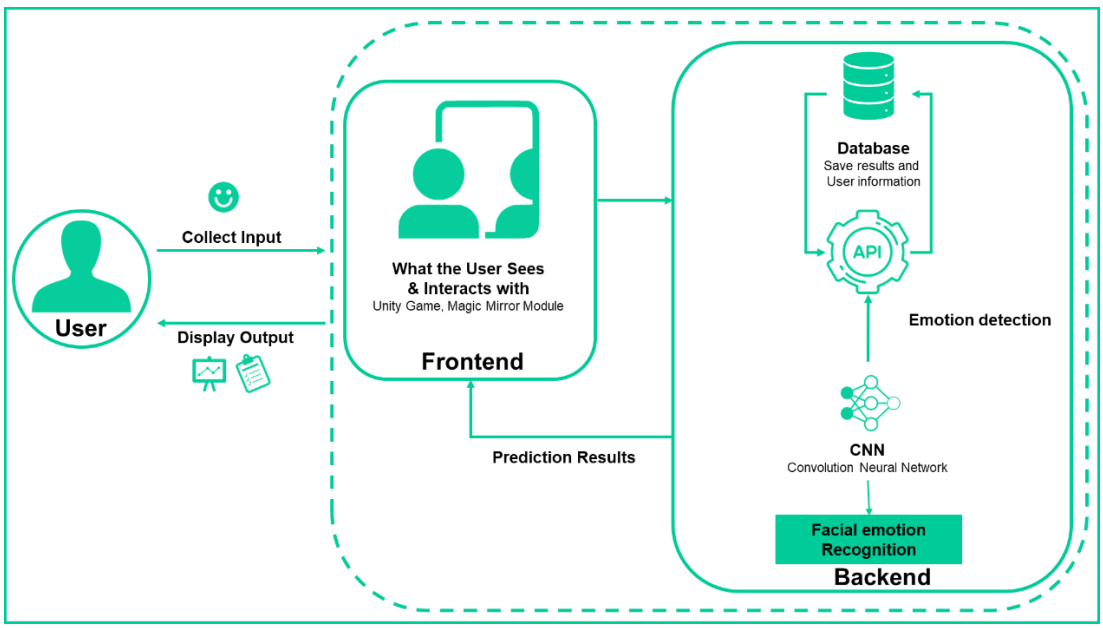


Figure 2: High-level architecture diagram

Above figure 2 displays the high-level architecture of the attentiveness tracker component. The Unity game as the UI interface to the user and throughout the game the smart mirror takes the activity and the real-time video stream as an input and posts it to the REST API endpoint where the model is deployed to a Flask server. The unity game invokes the API service within game for input and output. When the video stream is sent it is sent in greyscale mode frame by frame to the model then it initially detects the frontal face from the captured frame, it sketches a blue frame around the captured image. This captured image then sent inside the pre-trained model and predicts the current emotion and analyses throughout the activity. The predicted result falls into two categories, positive and negative. Positive emotions include happy, neutral, surprise and negative emotions are angry, sad, disgust and fear. This final result is sent to the database and the attentiveness is recorded. Moreover, when negative emotions are predicted an activity swap is suggested based on their attentiveness analysis report. A detailed flow diagram is shown in figure 3.

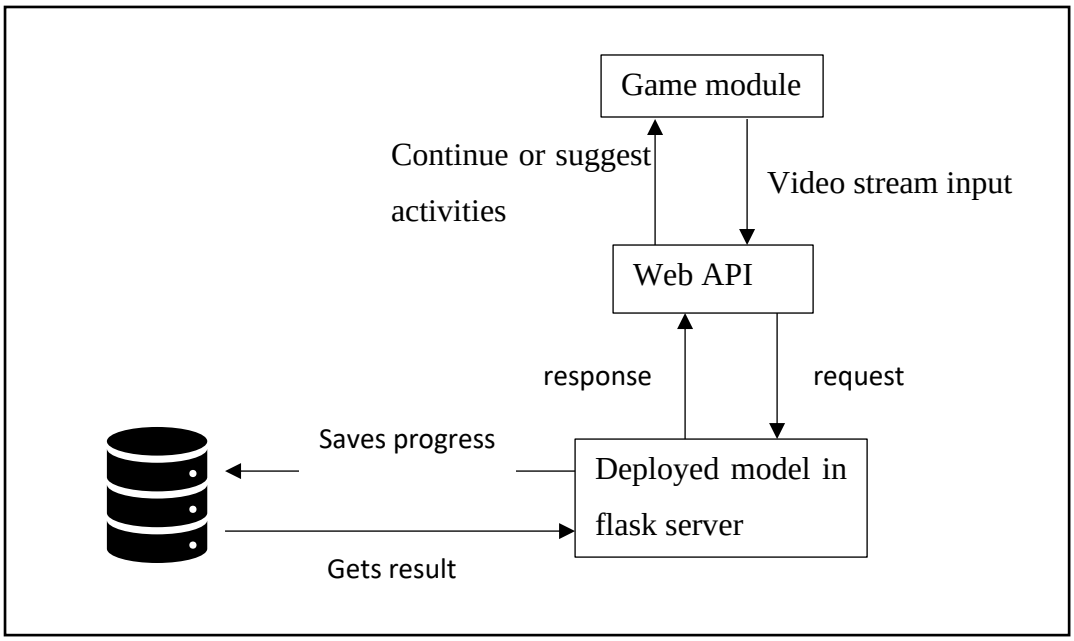


Figure 3: Flow diagram of Attentiveness tracker

2.4. Game Development

A unity game is the User interface for Aliza. It teaches based on a game to be more interactive and fun. This gaming activity is specially designed to boost their interest and

concentration towards learning. A Unity 2D game is developed using animations, color codes, positive feedback soundtracks, game play soundtracks and built as a Linux application which resides inside the magic mirror module.

Figure 4: Aliza main menu

The Main menu of Aliza loads as shown in figure 4, the options from left are respectively the writing mentor, math mentor, verbal trainer, attentiveness tracker, user profile and the user report. The attentiveness tracker holds the gaming module within. As an ASD specialist recommendation a maze game was created for game play. Moreover, a research done by Al Hamidy and fellow authors state that "how maze game could possibly help ASD subjects to learn social aspect, motoric aspects of perception, emotional aspects and intellectual aspects"[20]. Not only does this game benefits ASD children to acquire motoric skills but indeed increase their concentration level as well as the ASD specialist mentioned.

According to the above recommendations, a 10-level maze game was created with leveling up process. Figure 5, 6 is the view of the game levels.

Figure 6 : Maze game Menu (locked)

Figure 5 : Maze game menu (level unlocked)

Each game levels consists of many different obstacles and powerups. Initially it is a basic coin collection game and gradually increases with difficulty. Figure 7 is the level 1 game in which is the basic level of all and contain no obstacles. A timer runs throughout the game and a score counter is also visible in the top right of the screen. Movement of the game is controlled by the buttons visible in the bottom of the figure 7. A reset option is also available to reset the progress of the game.

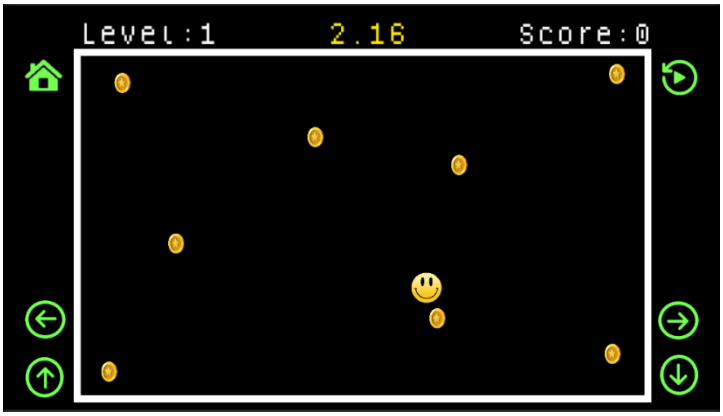


Figure 7 : Maze game Level 1

Figure 8 depicts the levels 2 and 3 of the game which has the same layout as all the others, but the coins and the wall count is higher than the previous. Figure 9 showing Level 4 and 5 which has a health bar introduced, that decreases for every hit against the maze wall and the game resets when the health bar is over. Figure 10 – level 6 and 7 introducing animated enemies affecting the health bar to decrease when player touches it. When the health bar is over the game resets.

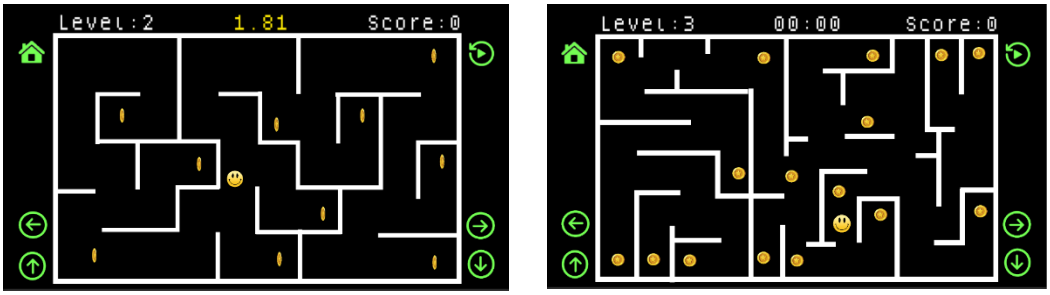


Figure 9 : Maze game Level 2 & 3

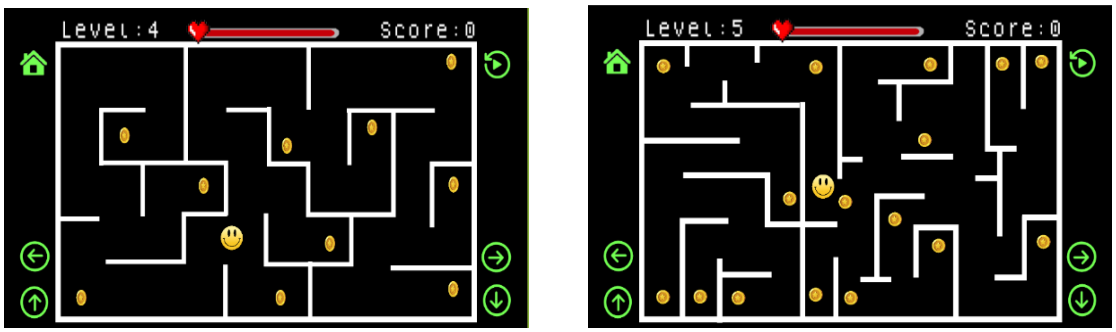


Figure 8 : Maze game Level 4 & 5

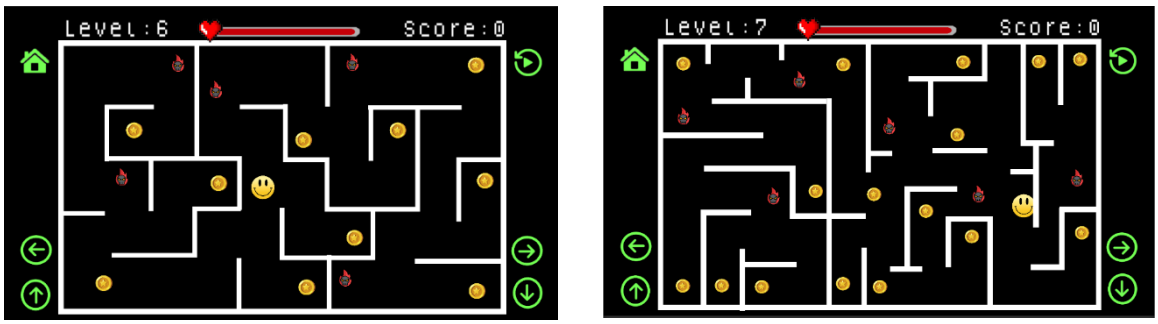


Figure 10 : Maze game Level 6 & 7

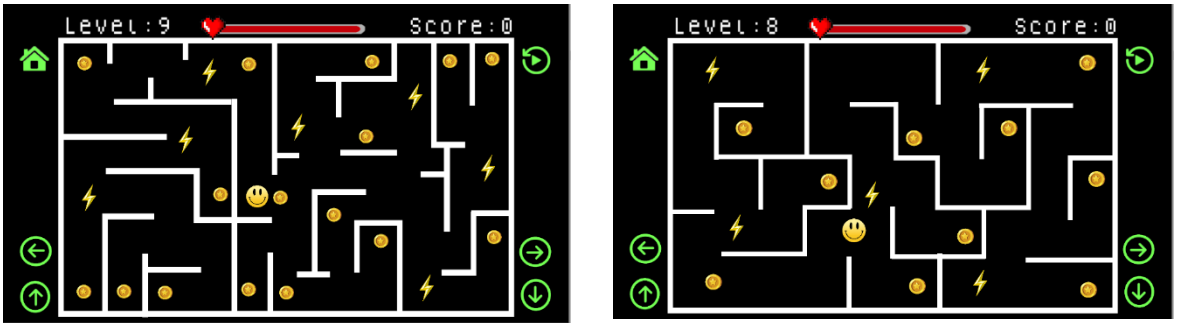


Figure 11 : Maze game Level 8 & 9

Figure 11 – level 8 and 9 introducing lighting bolt increases energy level to the health bar. Figure 12 – level 10 with no health bar resets the game when the player touches the enemy. The difficulty hardest and the last maze game. Figure 13 – level 1 game play report.

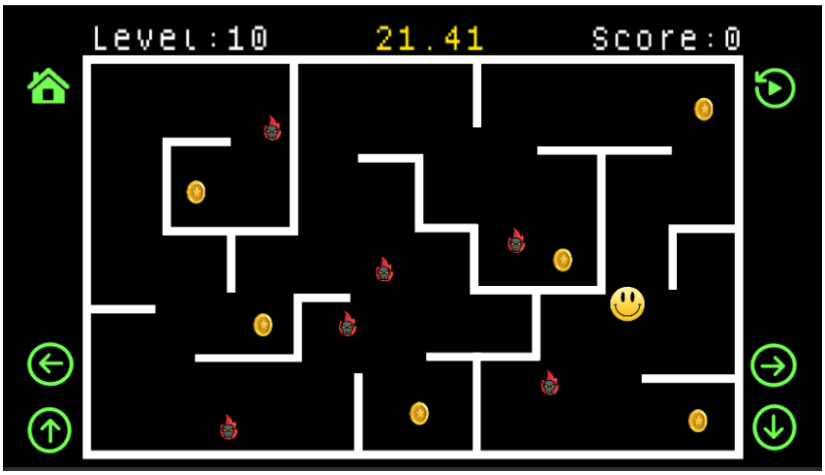


Figure 12 : Maze game Level 10

Figure 13 : Maze game play report

2.5. Hardware Development

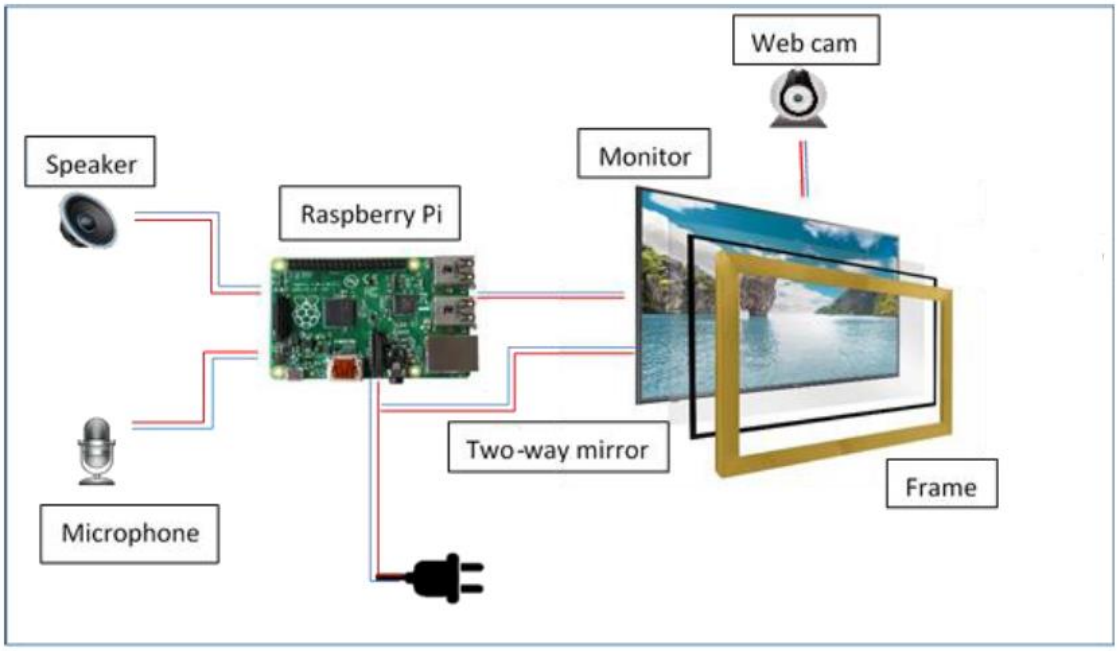


Figure 14 : Hardware Structure diagram

Aliza smart mirror is assembled to the structure given in figure 14 and was built as shown in APPENDIX A & B. The hardware requirements are,

Camera.

- Video Compression Format: H.264.
- Resolution 1920 x 1080.
- USB 2.0
- High Definition:720P (HD)

Raspberry pi 3A+

- wireless LAN, Bluetooth
- memory: 512MB LPDDR2 SDRAM
- 5V/2.5A DC power input
- Processor: Broadcom BCM2837B0, Cortex-A53 64-bit SoC @ 1.4 GHz

The camera is connected to the raspberry pi via a USB hub(2.0). Micro SD card is booted with Linux x64bit OS and it contains the magic mirror, game and the deployed models.

2.6. Limitations

The system takes input from camera and user interface.Visual data are taken using a web camera, the quality and the angle of the image is more important to detect the facial expressions. because low light and external accessories (scarf, mask) it affects the emotion prediction.

2.7. Commercialization Aspects of the product

There are only a few applications for autism children's educational need and most of it doesn't include emotion detection and analysis or focus enhancing skill activities. Even though manually tutors engage students in those activities, locally there are lack of resources. The SWOT analysis depicts the competitive advantage over other systems addressing all strength, weakness, opportunity and treats of "Aliza" as shown below.

Strength:

- Rising awareness of emotion detection importance of autism children.
- A platform to increase children's attentiveness.
- Get to know ASD children's interests in learning.
- Interaction and assistant tool in basic education for ASD children.
- Built using standard protocols in ASD such as Applied behavior analysis.
- "Aliza" is based on a mirror that increases screen engagement skills of children.
- Packages are introduced to fit individual and community needs. (figure 15)

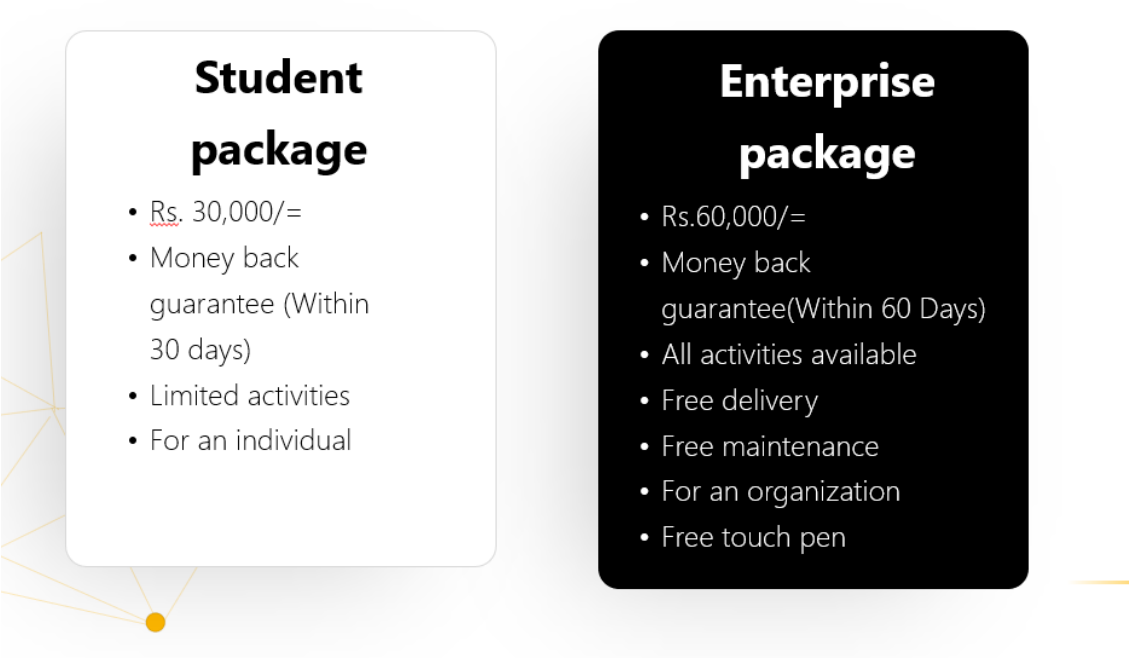


Figure 15 : Aliza package details

Weakness:

- Initial investment cost.
- Limited access for student package.

Opportunities:

- Lack of tools, teachers, specialists, therapists in ASD Field and has a high demand for tools over tutors
- Since the covid-19 pandemic all ASD centers are temporarily shut down that makes a high demand for tools/platforms with standards followed in ASD.

Threats:

- Delay of delivering product due to government regulations.

Identified weaknesses and threats are reduced by the following approaches:

- ✓ To overcome the initial cost installation payments are introduced.
- ✓ For limited access in Student in student package a subscription method is given to upgrade from Student to Enterprise.

2.8. Implementation and Testing

2.8.1 Implementation

The implementation was done in two segments, game development and emotion recognition. These segments were then merged producing the attentiveness tracker module in “Aliza”.

Software Requirements:

- OpenCV 4.1.2
- TensorFlow 2.3
- Keras 2.4.3
- Flask 1.1.2
- Imutil 0.5.3
- Python 3.7
- Magic mirror 2.11
- Ubuntu x64 bit
- Google Colab

- Unity 2019.3.14f
- SonarQube

Unity was used to develop all game sciences with animations and soundtracks. Sonar-project.properties was configured to check the quality of the code.

For model development and testing 2 python notebooks were used.

- emotionRecognitionModel.ipynb
- imageTest.ipynb

emotionRecognitionModel.ipynb contained the logic for pre-processing 28709 training images and 7178 test images. And the model was saved as emotionModel.h5 and emotionModel.json formats for later importing.

ImageTest.ipynb imported the saved model and tested with a folder of images with no categorization randomly chosen emotion images from public sources and private sources regardless of gender, age, lighting and use of accessories in facial area.

RealTimeVideo.py file is the containing the real-time video capture using the saved models.

Deployment.py, home.html, video.html consists of flask web app deployment logic.

2.8.2 Testing

Unit testing

Unit testing phase carried out after each functionality of attentiveness tracker was implemented. For the emotion recognition ImageTest.py was created to check the prediction levels of the model.

Initially the test cases were;

Table III : Test case 01

Test Case 01	Description
Objective	Detect frontal face from an image.
Test Input	Test image with a person facing the camera.
Expected Output	Blue frame around face area
Actual Output	Blue frame around face area.

Table IV : Test case 02

Test Case 02	Description
Objective	Detect frontal face from an image.
Test Input	Test image with a person facing the camera wearing specs and scarf.
Expected Output	blue frame around face area
Actual Output	blue frame around face area.

Table V : Test case 03

Test Case 03	Description
Objective	Detect frontal face from a video source.
Test Input	web camera video stream with a person facing the camera.
Expected Output	blue frame around face area.
Actual Output	blue frame around face area.

Table VI : Test case 04

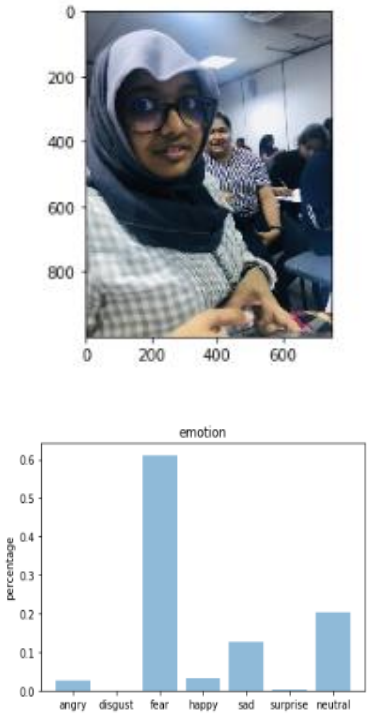
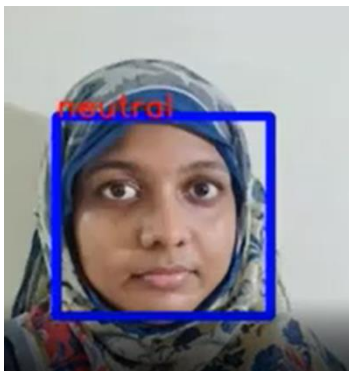
Test Case 04	Description
Objective	Detect emotion in frontal face from an image.
Test Input Data	test image with a person facing the camera.
Expected Output	emotion percentage.
Actual Output	

Figure 16 : emotion percentage

Table VII : Test case 05

Test Case 05	Description
Objective	Detect emotion in frontal face from a video source.
Test Input Data	web camera video stream with a person facing the camera.
Expected Output	Face marked with blue frame and emotion in red tag
Actual Output	 *Figure 17 : Video source output*

The rest of the tests done with the model resulted with the bellow outputs shown in Table VIII.

Table VIII : Attentiveness tracker model output test rates

Emotions	**Success Rate (%)**
Happy	87.50
Surprise	75
Angry	75
Sad	87.50
Fear	62.50
Disgust	62.50
Neutral	100

The Integration test and the functionality tests were done when integrated with the other components of “Aliza”.

3. RESULTS & DISCUSSION

3.1. Results

The Attentiveness tracker component is designed to detect emotions of the users. The model accurately detects the face with different poses (straight, side view). It also detects emotions when accessories are worn (spectacles, jewels, scarfs). Supports emotion recognition under various lighting conditions. Below is the output of emotions recognized with a simple video stream given as an input to the system.

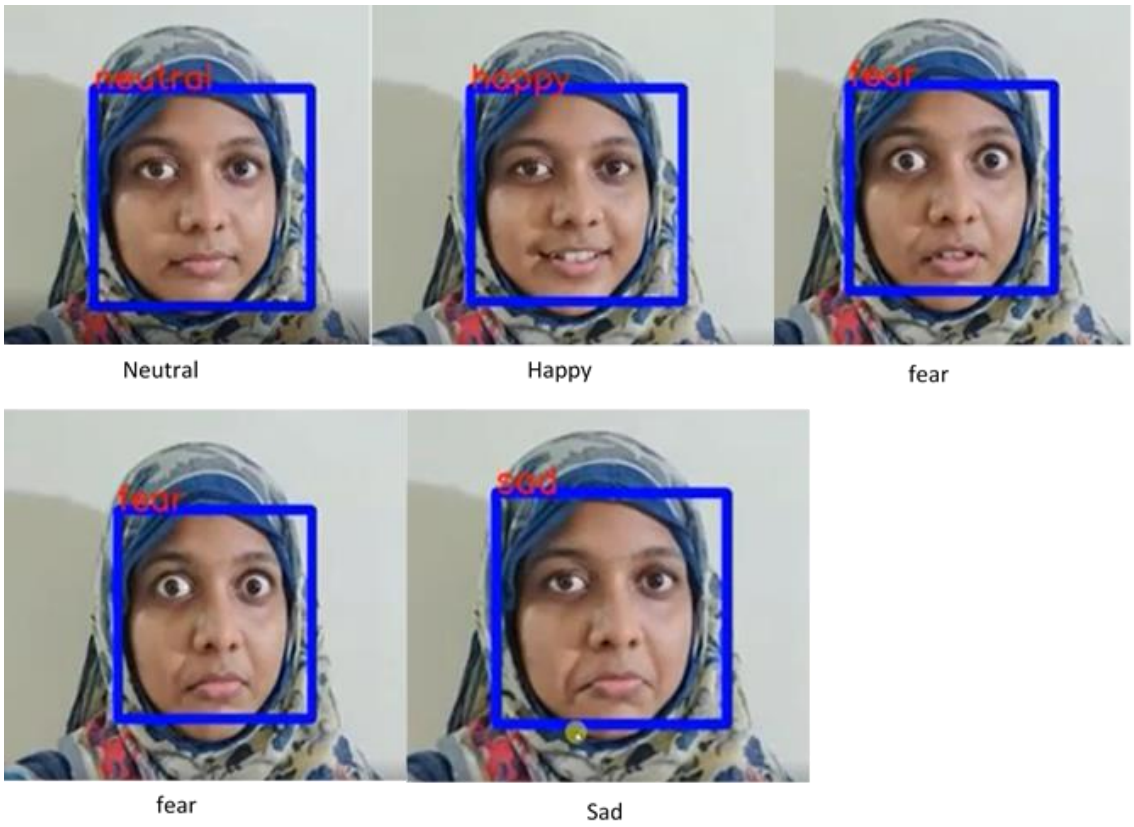


Figure 18 : Attentiveness tracker model output

After Testing the Attentiveness Tracker detected facial emotions in different lights and positions with achieving overall accuracy of 88% . and with validation accuracy of 80%. The test results are according to Table VIII.

3.2. Research Findings Discussion

There are variety of ASD applications existing in the current world, but those applications are focused on teaching the ASD children on how to recognize the human emotions, but none of these systems perceive the ASD students' emotions into count when teaching. Emotions play a vital role as ASD children cannot express their needs in a linguistic manner their emotions help tutors to figure if they are interested or bored. Many researches state how important emotions are and has used may advance technologies in recognizing them. One of which is recognizing emotions through video input streams. All previous research advancements are done for non-ASD people which is vastly different when comparing it to ASD children's emotions.

In this Attentiveness tracker system, the model recognizes the emotions based on the real-time video input and labels the emotions to the current activity. Initially the model was created using 5 convolutional layers, "RELU" activation and Adam as an optimizer which resulted in 93% model accuracy and 62% of test validation accuracy. Due to the poor state of detection the model was enhanced with 7 convolutional layers "eLU" activation and RMSprop optimizer. This enhancement further decreased the model accuracy to 63% and test validation of 53%.

This was mainly due to the imbalance of the categorized images of the dataset. Therefore, the model was improved to increase the data samples by data augmentation then normalized and grayscaled and send the resulting pre-processed data sent into a sequential stacks of layers consisting a mix of 8 convolutional layers, 3 dense layers, 4 max pooling totaled to 15 layers. Early stopping of model training and saving of model was done when no improvement was shown within 9 epochs. This trained model contributed a satisfactory result of 88% of model accuracy and 80% of test accuracy. Yet the model optimizer was changed to RMSprop, and SGD, Adam optimizer resulted with the optimum solution when compared with the others.

3.3. Contribution

- Real-time emotion detection and analyzing
    1. Frontal emotion recognition and from web camera video stream.
    2. Recognize emotions under different lightings.
    3. Recognize emotions with accessories worn. (Scarf, Spectacles)
    4. Suggest activity swap depending on the emotion change.
- Focus game development.
    1. Maze game development.
    2. Introducing obstacles and power-ups to increase difficulty level.
    5. Auto-generated report for the game play.

4. CONCLUSION

With the increase in autism children [21] there is a lack of resource to cater to the needs of all[17]. As a solution Aliza smart mirror is designed and dedicated to ASD children's basic education needs. Thus, Aliza involves enhancing pre-writing, math, verbal and attentiveness monitoring. Attentiveness monitoring is mainly designed to teach ASD children based on there emotions according to the recommendations of ABA therapy. Due to their lack of concentration additional maze game is introduced with fun animations and audio. This attempt is gradually increase ASD users cognitive and focus skills.

Working with a smart mirror would be lot easier for ASD users compared to an android device or a robot, as they previously go through a therapy session in identifying objects. This smart mirror subsequently eliminates the involvement of a tutor with basic instructions and repetitive enforcement and acknowledgement. It develops ASD users to self-learn and self-decision-making.

As future enhancement the attentiveness tracker will expand to a facial recognition login system. And support for local languages such as Sinhala and Tamil. The future enhancements are not only to increase the demand for the product but to give ASD children a better experience in learning with the technology advancement.

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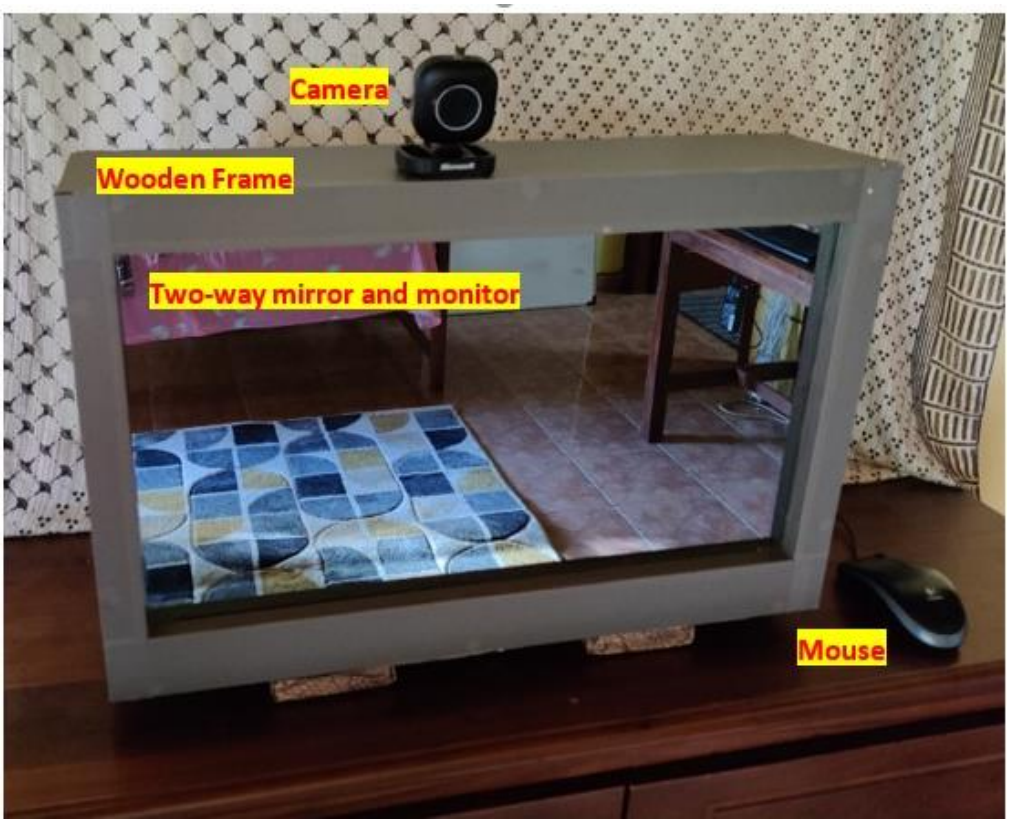
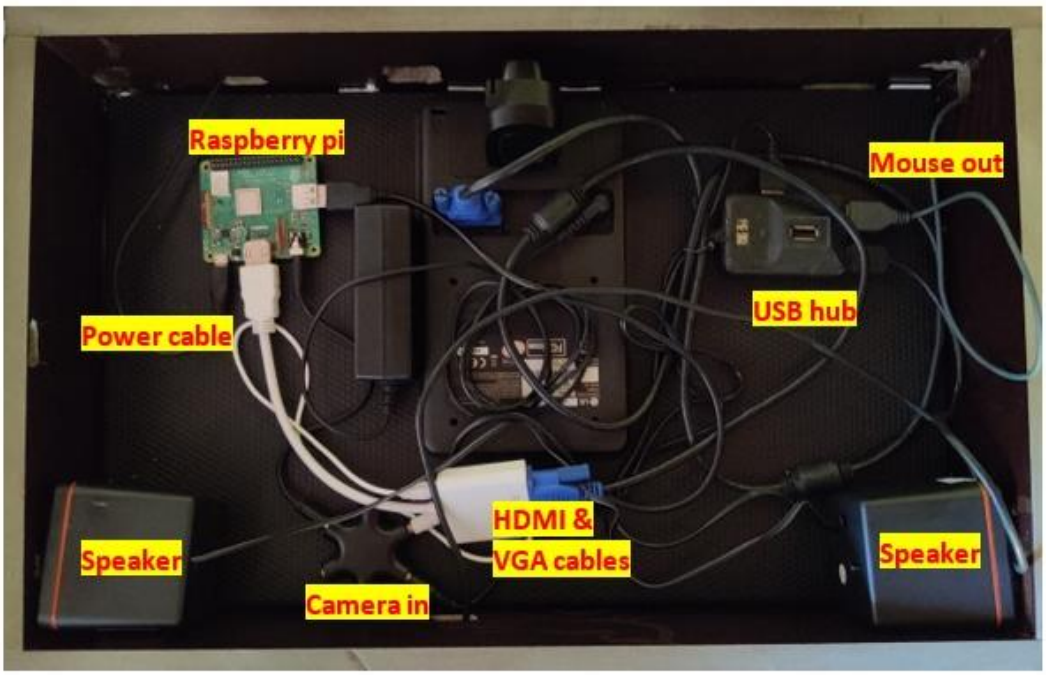
APPENDIX A: Aliza product (Front)



APPENDIX B: Aliza product (Back)



APPENDIX C: Aliza High level Architecture Diagram