Smart ABC Learning System

Capstone Project Report

Mid-Semester Evaluation

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May 2019

ABSTRACT

Today's life is becoming more and more advanced and smart with all the gadgets and smart technology so why not study. In our project we are making study for little children interesting and informative at the same time also our project will make children more friendly and cooperative with the technology along with that it will produce the habit of study in child's brain.

Our project basically works on the tracking and forming the alphabet.

DECLARATION

We hereby declare that the design principles and working prototype model of the project entitled "Smart ABC Learning System" is an authentic record of our own work carried out in the Computer Science and Engineering Department, TIET, Patiala, under the guidance of Dr. Anjali Anand during 6th semester (2019).

Date: 25-05-2019

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ACKNOWLEDGEMENT

We would like to express our thanks to our mentor(s) Dr. Anjali Anand. He/She has been of great help in our venture, and an indispensable resource of technical knowledge. He/She is truly an amazing mentor to have.

We are also thankful to Dr. Maninder Singh, Head, Computer Science and Engineering Department, entire faculty and staff of Computer Science and Engineering Department, and also our friends who devoted their valuable time and helped us in all possible ways towards successful completion of this project. We thank all those who have contributed either directly or indirectly towards this project.

Lastly, we would also like to thank our families for their unyielding love and encouragement. They always wanted the best for us and we admire their determination and sacrifice.

Date: 25-05-2019

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1: Introduction

1.1 Overview

In our project we use fingertip recognition with the help of object on the finger, by detecting that object we will able to draw any shape and alphabet in open space. Backend coding will make the tracking and the image formation possible.

This is innovative and new project that is not used before, that is particularly for kids that will make study interesting.

For making our alphabet we use frame as the boundary for our alphabet .Also after completion of our alphabet there will be sound and image related to that alphabet. The essential aim of building finger gesture recognition system is to create a natural interaction between human and computer where the recognized gestures can be used for controlling a robot or conveying meaningful information. How to form the resulted finger gestures to be understood and well interpreted by the computer considered as the problem of gesture interaction. Human computer interaction (HCI) also named Man-Machine Interaction (MMI) refers to the relation between the human and the computer or more precisely the machine, and since the machine is insignificant without suitable utilize by the human . There are two main characteristics should be deemed when designing a HCI system as mentioned in : functionality and usability. System functionality referred to the set of functions or services that the system equips to the users, while system usability referred to the level and scope that the system can operate and perform specific user purposes efficiently. The system that attains a suitable balance between these concepts considered as influential performance and powerful system.

Gestures can be static (posture or certain pose) which require less suitable for real time environments. Different methods have been proposed for acquiring information necessary for recognition gestures system. Some methods used additional hardware devices such as data glove devices and colour markers to easily extract comprehensive description of gesture features.

1.2 Need analysis

The project mainly revolves around enhancement of fundamentals (alphabets) of the kid. Although, there are traditional ways of practicing and enhancing fundamentals but there exists some limitations in the traditional ways. So, this project fills gaps for these limitations in a smart way by using modern technology.

A lot of paper is used as it is required to do practice. This project removes this shortcoming. As user can draw anything that he/she wants without the use of a single paper. So, this project follows sustainable goal that is to save trees. Moreover, user will gets motivated with the use of system towards smart learning which will inculcates the habit of using technology in the personal development.

This project saves time for the parents and kid. All they have to do is just login in our web app and start practicing. Cost saving as they do not have to buy copies and pencils etc. This project provides detailed performance report for their child. So, they can see which area their kid has to work upon.

Due to the interactive nature of this project, kids will be motivated to do more practice which will definitely be beneficial for them.

This project is a great step towards making “SMART INDIA “at an early age of Indians which will be great push for them.

1.3 Research gaps

The gap in research about user experience of machine learning applications, and the potential of personalisation. Our project lacks the skills to handle complex queries as we are handling questions based on specific keywords. If a customer is not satisfied with the answers after a certain limit, the conversion is handled over to the customer care executive. This shows that there is not sufficient knowledge of how to handle complex queries. The main aim for the Chatbot is to speed up responses and improve customer interaction . However , due to the limited availability of data and the time needed for self-updating, this process can be slow and costly and therefore there are times when the chatbot may become confused and not serve the customer well. As our chatbot is used as

bank customer care chatbot, there is sequence of steps which needs to be addressed and verified first before reaching to a conclusion. This is time consuming.

1.4 Problem definition and scope

- Vision - We want to increase the technological use in the learning process of a child. So, we want to take the concept of interactive learning at higher level and involve it in the fundamental process of learning.
- Issue Statement - The traditional method of learning is not so much fascinating and interactive and it is very time consuming.
- Method - Learning combined with fun and interaction will decrease the learning time by using computer vision methods.

Scope

- Our project mainly evolves around the effective learning of fundamentals (English alphabets, digits etc.) writing for children in a smart way using finger gestures (by moving finger in air).
- This is futuristic way of learning which would help children to inculcate the habit of interactive learning.

1.5 Assumptions and constraints

1. The colour of object which we are using to form an alphabet should not be present in the background. If it does our track algorithm will start track that colour also it will give nothing but distorted image.

2. The size of the object that we are using for tracking will be of reasonable size i.e. not so big, not so small.

3. The mobility of the object should be easy so the child (operator) will not face any difficulty in writing.

4. We can only use cursive alphabets because in 3D we cant uplift our object to make the discontinuity in alphabet.

1.6 Approved objectives

- The sensor that is camera should be configured properly with the object held by user.
- The delay between the object motion and tracking on screen should be minimum.
- The letter/digit tracked by user should be displayed on screen correctly.
- Corresponding output in form of audio and images will be displayed after recognition

1.7 Methodology used

- User will wear an object on finger which is used for drawing on screen.
- Object detection and tracking using webcam to know the position of fingers.
- Showing path drawn by user on screen using image processing.
- The figure drawn will be recognized by using suitable Deep Learning model that is whether user draws alphabet/digit correctly.
- Displaying result of drawing in the form of corresponding audio and images by using Simple Python logic.

1.8 Project outcomes and deliverables

1. Outcomes of our project is knowledge that will be deliver to the child (user).

2. Also we have outcomes in 2 forms:-

a. Audio (through voice)

b. Picture (Image related to alphabet)

3. Make the technology friendly in future for child.

4. Final Product - A web application which will act as a platform for the kids to enhance their fundamentals (alphabets) by drawing on screen by moving finger in air.

1.9 Novelty of work

1. The novelty of our project is that we can draw shape and alphabet in 3D, we don't need any paper or pencil just camera and tracking object and we are good to go.

2. It also uses different methods to teach to students via voice.

3. It uses image tracking program at the backend for process correctly.

Chapter 2: Requirement Analysis

2.1 LITERATURE SURVEY

2.1.1 Theory Associated with problem Area

This project mainly uses the following uses the following concepts:

- Object detection and tracking.
- Image Processing.
- Deep Learning.

1. **Object detection and tracking:** Object detection and tracking are important and challenging tasks in many computer vision applications such as surveillance, vehicle navigation, and autonomous robot navigation. Video surveillance in a dynamic environment, especially for humans and vehicles, is one of the current challenging research topics in computer vision. s. Object tracking based techniques is the most popular choice to detect stationary foreground objects because they work reasonably well when the camera is stationary and the change in ambient lighting is gradual, and they also represent the most popular choice to separate foreground objects from the current frame. Every tracking method requires an object detection mechanism either in every frame or when the object first appears in the video. Object tracking is the process of locating an object or multiple objects over time using a camera. The high powered computers, the availability of high quality and inexpensive video cameras and the increasing need for automated video analysis has generated a great deal of interest in object tracking algorithms. There are three key steps in video analysis, detection interesting moving objects, tracking of such objects from each and every frame to frame,

and analysis of object tracks to recognize their behavior. Therefore, the use of object tracking is pertinent in the tasks of, motion based recognition.

Figure 1: Object tracking

2. **Image Processing:** Apparently, digital image processing is an important aspect of photography considering that technology keeps changing. There are a host of digital image processing techniques that provides a wide application variety in feature extraction and classification. Artificial neural networks are frequently used to undertake character recognition because of their high tolerance to noise. The systems have the capability to realize perfect results. Apparently, the feature extraction stage of OCR is the most significant. Survey represents a study of feature extraction methods with different classifiers implemented in OCR systems for different Indian scripts .Variance between the features should be clearly discriminative and specific so that system can classify the characters with maximum efficiency and minimum error rate.

3. **Deep Learning:** Handwriting recognition has gained a lot of attention in the field of pattern recognition and machine learning due to its application in

various fields. Optical Character Recognition (OCR) and Handwritten Character Recognition (HCR) has specific domain to apply. Various techniques have been proposed to for character recognition in handwriting recognition system. Even though, sufficient studies and papers describe the techniques for converting textual content from a paper document into machine readable form. Incoming days, character recognition system might serve as key factor to create a paperless environment by digitizing and processing existing paper documents.

Table 1: Contribution

S.no	Roll No.	Name	Paper Title
1	101610010	ANMOL DHAWAN	Image processing with open CV
2	101783048	ANKIT SINHA	Deep Neural Networks
3	101603043	ANKUR SHARMA	Design of web front-end
4	101603044	ANKUSH KARARA	Object oriented web application development

2.1.2 Existing Systems and solutions

Our project mainly deals with the object tracking and deep learning. It mainly uses the Convolution Neural networks for recognizing the alphabets. It also contains the facility of vocal learning.

Researchers have been going on object tracking in order to achieve more effective accuracy.

2.1.3 Research Findings for existing Literature

With the continuous development of deep learning, convolution neural network with its excellent recognition performance obtains a series of major breakthrough results in target detection, image recognition and other fields. An improved ReLu segmentation correction Activate function is proposed, by improving the traditional convolution neural network, adding the local response normalization layer, and using the maximum stacking and so on. Based on the Google depth learning platform TensorFlow, the activation function is used to construct the modified convolution neural network structure model, using the EMNIST data set as the neural network input for the model training and evaluation. The experimental results show that using the improved unsaturated nonlinear segment activation function SignReLu, the convergence rate is faster and the accuracy of neural network identification is improved obviously.

2.1.4 The problems that has been identified

Firstly, for training of the model multi-layer perceptron was used which has a less accuracy. So, in order to achieve more accuracy, we have used CNN training model using Keras library. The accuracy which is achieved with CNN model is about 93%.

2.1.5 Survey of tools and Technologies used

Open CV library: - We are using 4.0.1 version of CV library. It is generally used for combining vision task.

CNN using Keras: - CNN is using for alphabet recognition.

Image Processing: - Frame is read and processed using image processing technique.

Python: - We use Python language as it has good collection of image processing libraries also it is used in open CV.

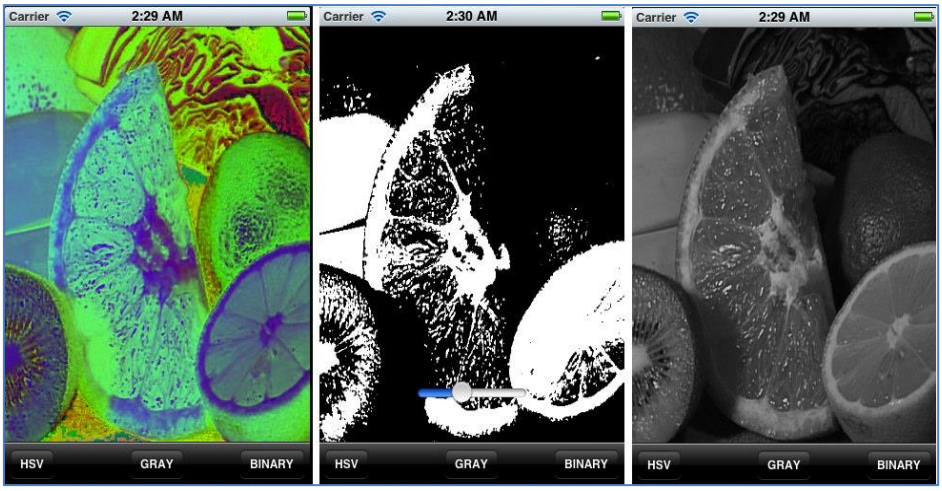

Figure 2: Open CV image Processing

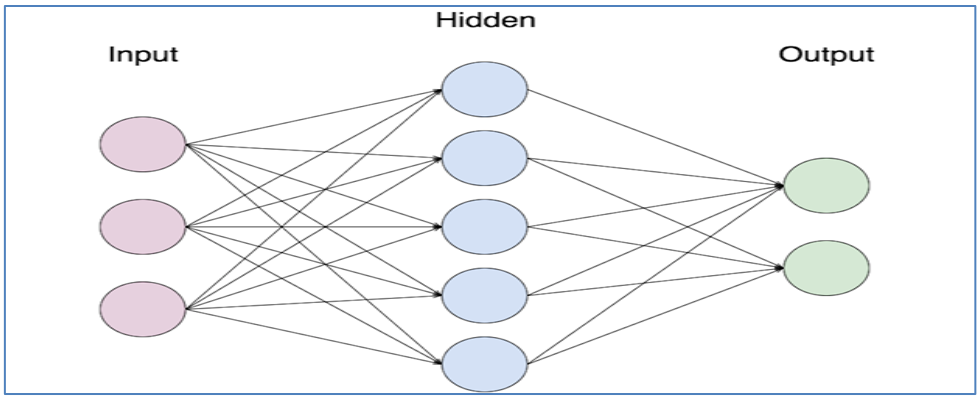

Figure 3: Neural Network

2.2 STANDARDS

- Industry 4.0: An era of automation for nowadays. This project has its attributes.
- Web 2.0: An interactive website that will allow user to use draw using webcam.
- Emnist dataset: High Quality dataset extended-MNIST is used for model training in machine learning.
- Open CV library: Library used for object detection through webcam.

2.3 SOFTWARE REQUIREMENTS SPECIFICATIONS

2.3.1 Introduction

2.3.1.1 Purpose

The purpose of this project is to make the learning process easy and interesting for kids. As we know, paper and pen process has always been a dull technique and every digital and technical advanced approach is a centre of attraction for small kids. Furthermore, man work is also sort of reduced as everything in the project will be handled by autonomous means.

We have decided to build a web app using a laptop as an interface. We will use the object tracking technique in machine learning that will help us to track the object held by the user (kid) and tracks and creates whatever user will make and displays on the laptop screen. The tracked outline will be fed further to neural system and corresponding results will be provided to user.

2.3.1.2 Intended Audience and Reading Suggestions

ABC Learning system is a ABC enhancer/practice system for children (3-5 years). The idea of the project is to fully convert the manual teaching system into a digital one. This is a prototype project as no such thing has been invented yet. We also plan to add digits along with alphabets in our data so that it can detect numbers too.

2.3.1.3 Project Scope

The project mainly revolves around enhancement of fundamentals (alphabets) of the kid. Although, there are traditional ways of practicing and enhancing fundamentals but there exist some limitations in the traditional ways. So, this project fills gaps for these limitations in a smart way by using modern technology.

This project saves time for the parents and kid. All they have to do is just login in our web app and start practicing. Cost saving as they do not have to buy copies and pencils etc. This project provides detailed performance report for their child. So, they can see which area their kid has to work upon.

Due to the interactive nature of this project, kids will be motivated to do more practice which will definitely be beneficial for them. This is futuristic way of learning which would help children to inculcate the habit of interactive learning.

2.3.2 Overall Description

2.3.2.1 Product Perspective and Product Features

Smart ABC learning system is a digital learning system based on object tracking technique which would help children of age range (3 – 5) years to start their fundamental learning steps through this web app. This system provides simple mechanisms for users to acquire knowledge.

Its Features are:

- Interactive Platform – This system provides an interactive platform for the users which would help them in a great extent in fundamental learning through digital techniques.
- User account: The system allows the user to create their accounts in the system and provide features of viewing profiles and performances
- Number of users being supported by the system: Though the number is precisely not mentioned but the system is able to support a large number of users at a time.
- Different kind of learning will be facilitated for the user like digit learning, alphabet learning, fundamental shapes learning.
- There is also an online dashboard would be available which shows the performances of different users using the learning system.

- Recognition of pattern made through finger gesture in real time by the system so the user can see the matched character on the screen in real time.
- Visual and audio representation of recognized pattern which would help to enhance the learning ability of the users.

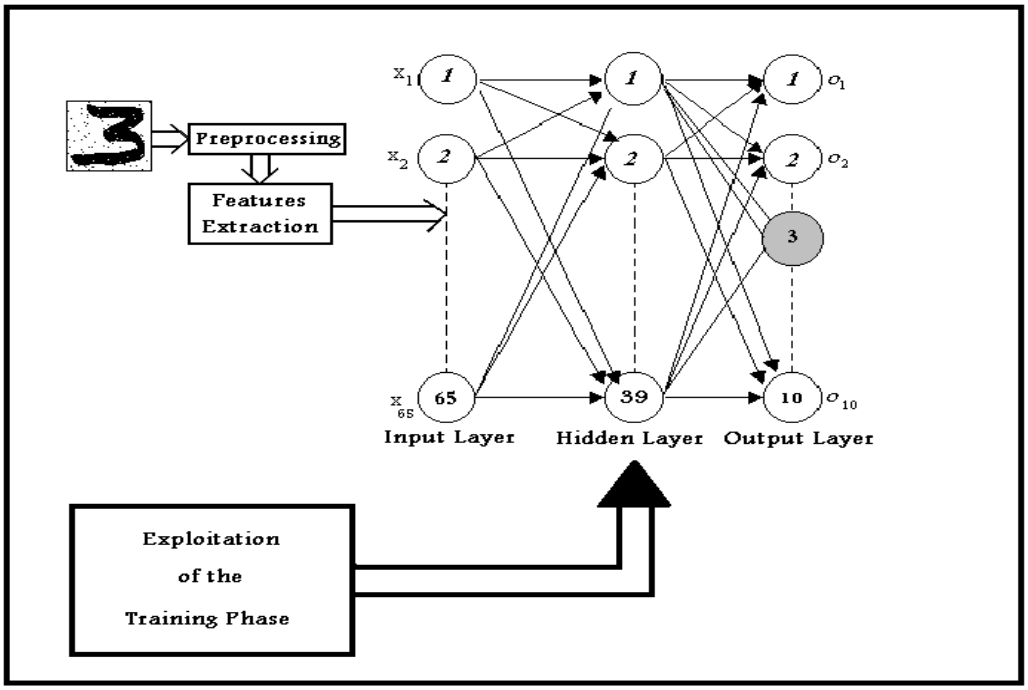

Figure 4: Overall procedure

2.3.3 External Interface Requirements

2.3.3.1 User Interfaces

- Front End Softwares- Web Application using HTML, CSS, JavaScript.
- Back End Softwares- Python, Flask, MySQL.

2.3.3.2 Hardware Interfaces

- Laptop on which the web app can be run on a browser which supports CGI, HTML & JavaScript.
- A working webcam used for functioning of the project.

2.3.3.3 Software Interfaces

Following are the software used for the Smart ABC Learning System.

Table 2: Software Interfaces

Software used	Description
Operating system	We have chosen Windows operating system for its best support and user-friendliness.
Database	To save the user records we have chosen MYSQL database.
Python	To implement the project we have chosen Python language for its more interactive support and wide libraries.
Open CV Python	To implement Computer Vision Tasks, we have used OpenCV python version.

2.3.4 Other Non-functional Requirements

2.3.4.1 Performance Requirements

There would be a minimal time delay between drawing of pattern by user and its recognition by the system. This time delay will be minimized as the accuracy of the trained model is very high approx. 93%. The system must be interactive and the delays involved must be less. So, in every action-response of the system, there are no immediate delays. The refreshing time of the video frames would be very minimal.

2.3.4.2 Safety Requirements

The login credentials of the user will only be used to access the system. No unauthorized person can access the account of the user.

2.3.4.3 Security Requirements

In case of login credentials are not entered correctly, some security questions would be their whose answers should be given by the user at the time of logging if they do not remember the login credentials. These answers should match with the answers given by them at the time of account creation.

2.5 Risk Analysis

Our project outcome is a web application which will act as a platform for the kids to enhance their fundamentals (alphabets) by drawing on screen by moving finger inair.

Now this may get affected in the presence of a weak internet connection or a large database can also involve unexpected delays in output.

Server stability is most important for our project to work completely. As its going to work on-line on a web application, any issues in internet will directly affect working of our project.

Chapter 3: Methodology Adopted

3.1 INVESTIGATIVE TECHNIQUES

The idea began from somehow representing the letters visually to children and let them draw the letters on a white screen. For that we investigated, object tracking techniques, like open CV object tracking that lets you track an object and make a pattern on the screen.

3.2 PROPOSED SOLUTION

Teaching through our web application through a machine learning technique is more attractive to a child and more entertaining than the manual system that is adopted for now. It is obviously an easy way and takes over much of the over head of the teacher and simultaneously provide a better and an interesting way to teach a child.

3.3 WORK BREAKDOWN STRUCTURE

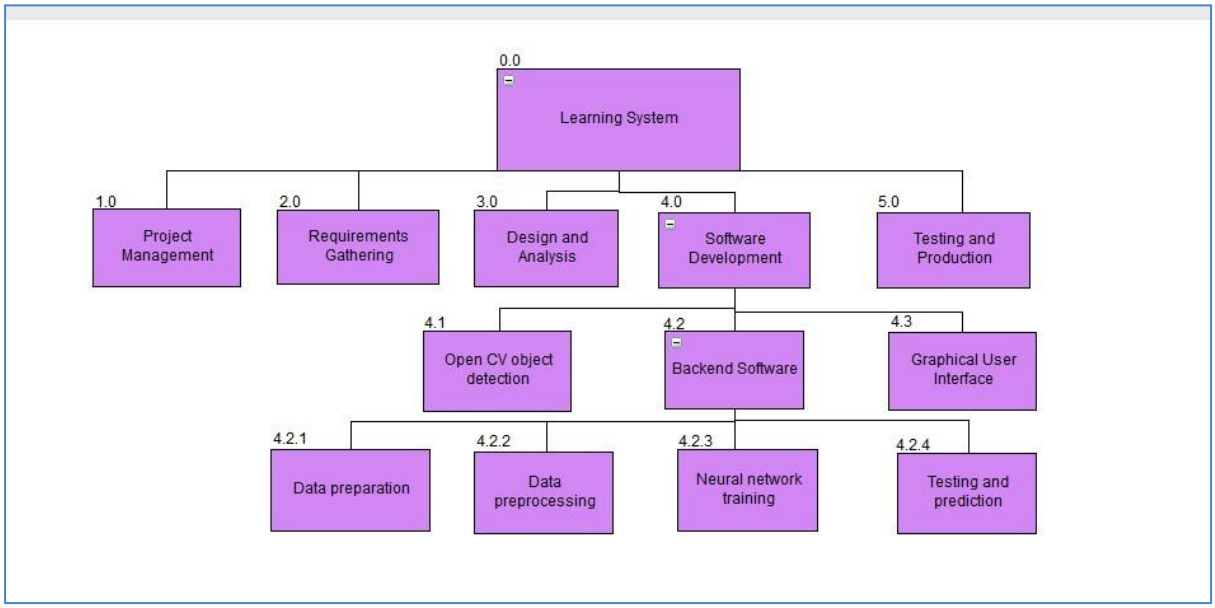

Figure 5: Work Breakdown Structure

3.4 TOOLS AND TECHNOLOGIES USED

Open CV library: - We are using 4.0.1 version of CV library. It is generally used for combining vision task.

CNN using Keras: - CNN is using for alphabet recognition.

Image Processing: - Frame is read and processed using image processing technique.

Python: - We use Python language as it has good collection of image processing libraries also it is used in open CV.

Chapter 4: Design Specifications

4.1 System Architecture-

4.1.1 Block Diagram

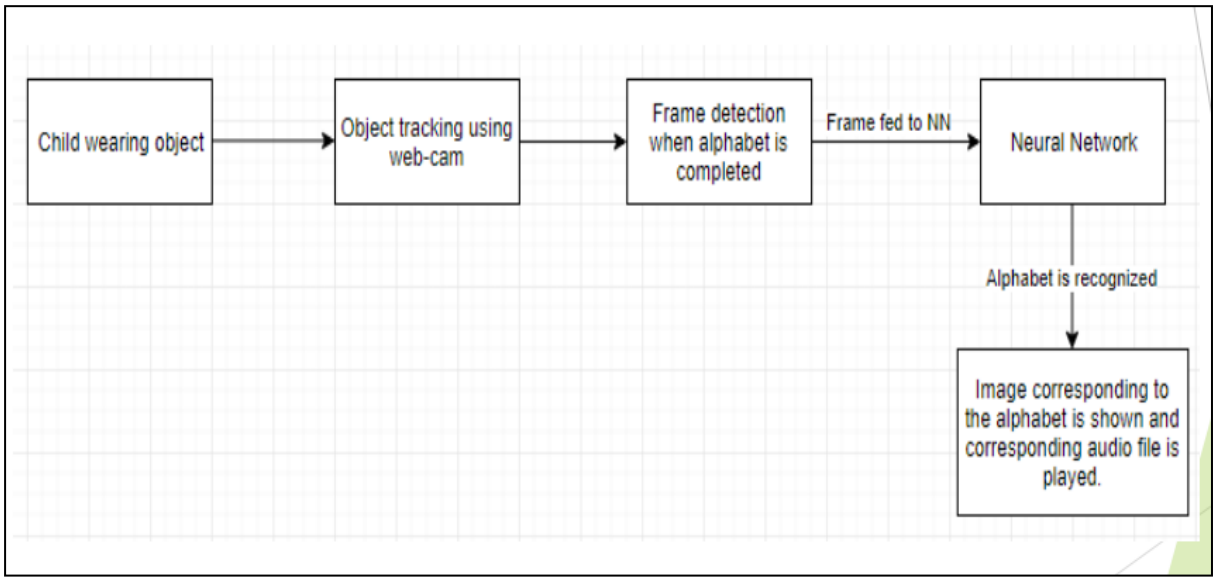

Figure 6: Block Diagram

4.1.2 MVC Architecture

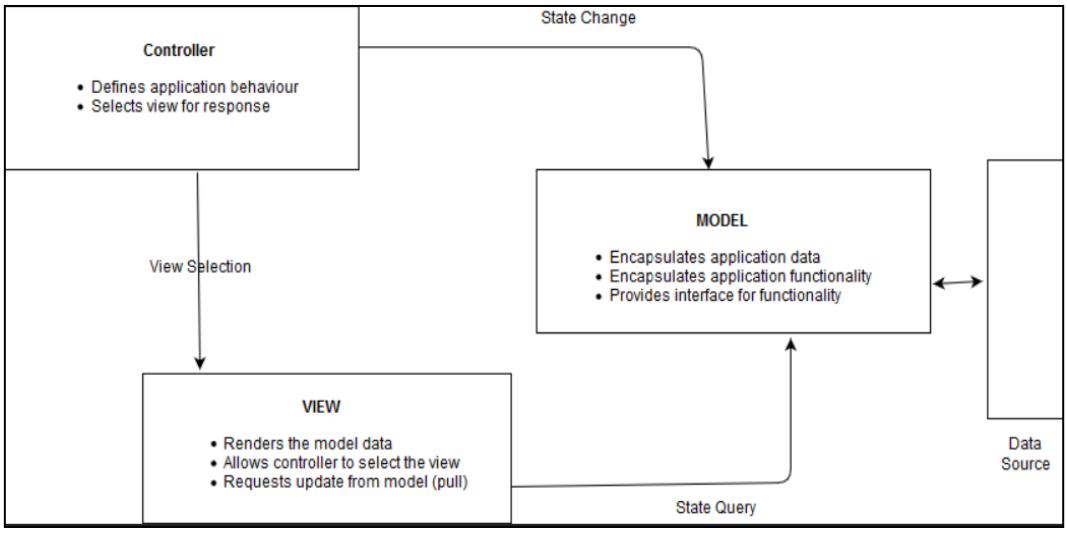

Figure 7: MVC Architecture

4.1.3 Tier Architecture-

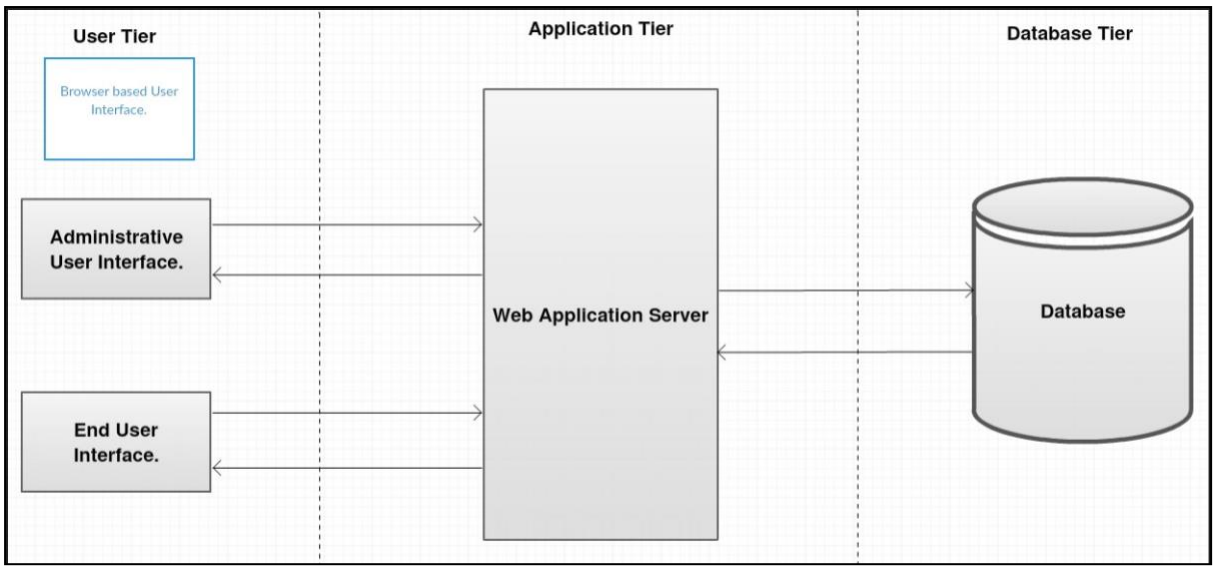

Figure 8: Tier Architecture

4.2 Design Level Diagrams

4.2.1 Component Diagram

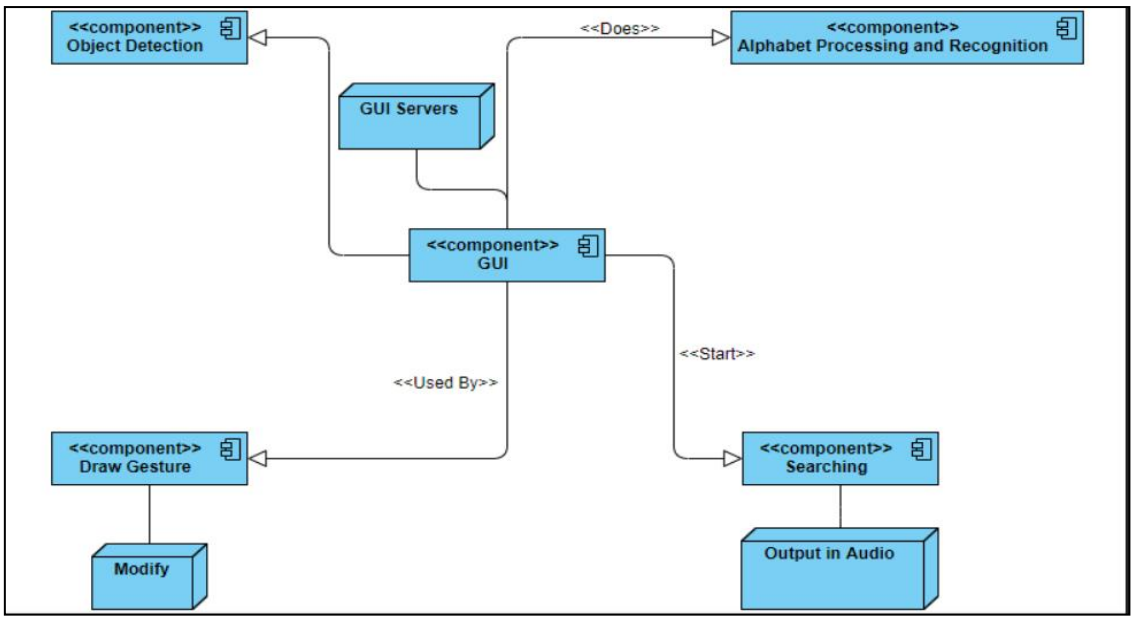

Figure 9: Component Diagram

4.2.2 Data Flow Diagrams

4.2.2.1 Context Level Diagram

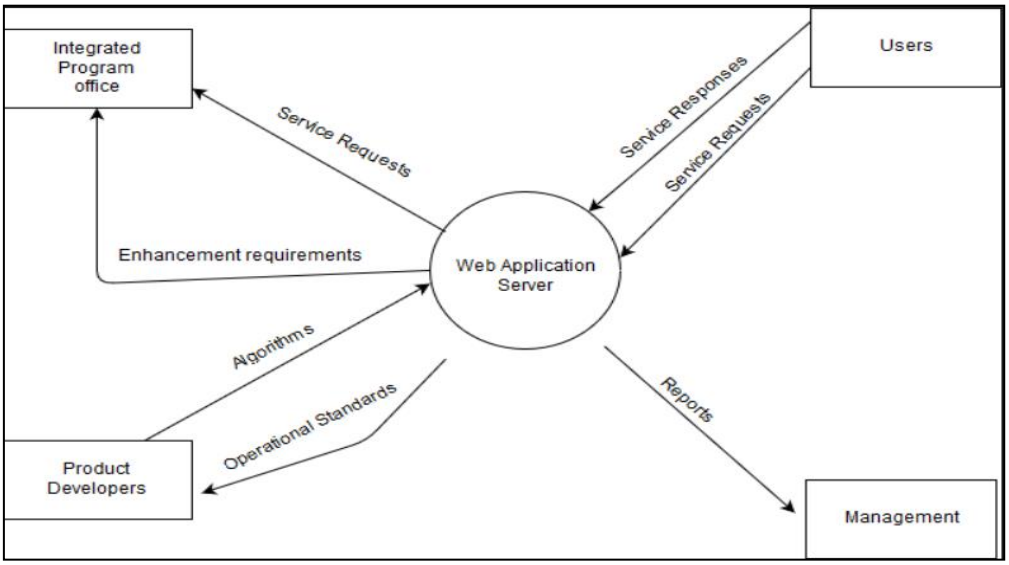

Figure 10: Context Level Diagram

4.2.2.2 DFD level 0

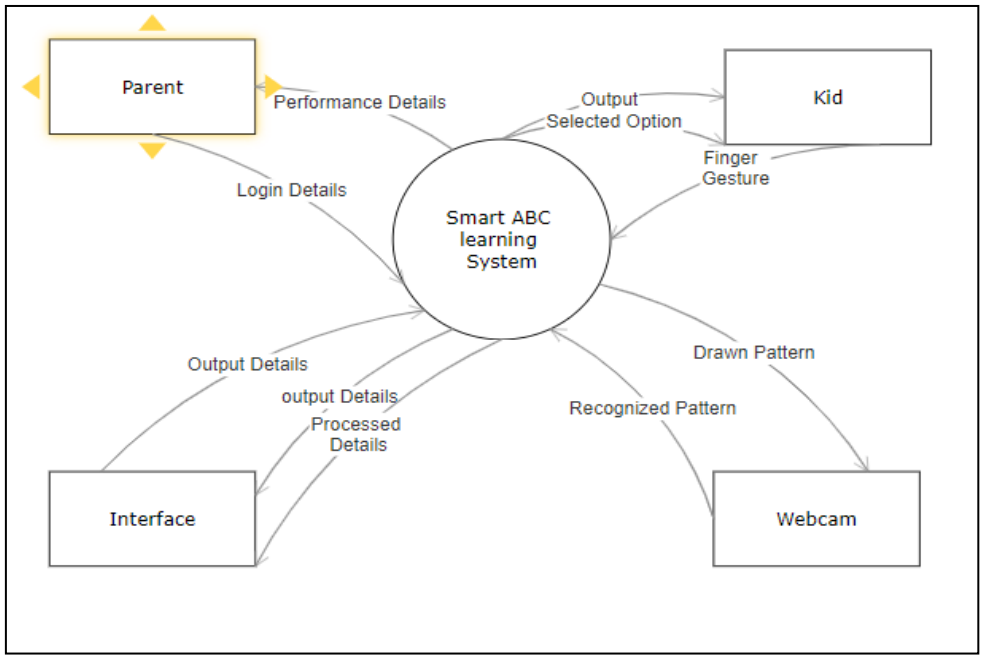

Figure 11: DFD level 0

4.2.2.3 DFD level 1

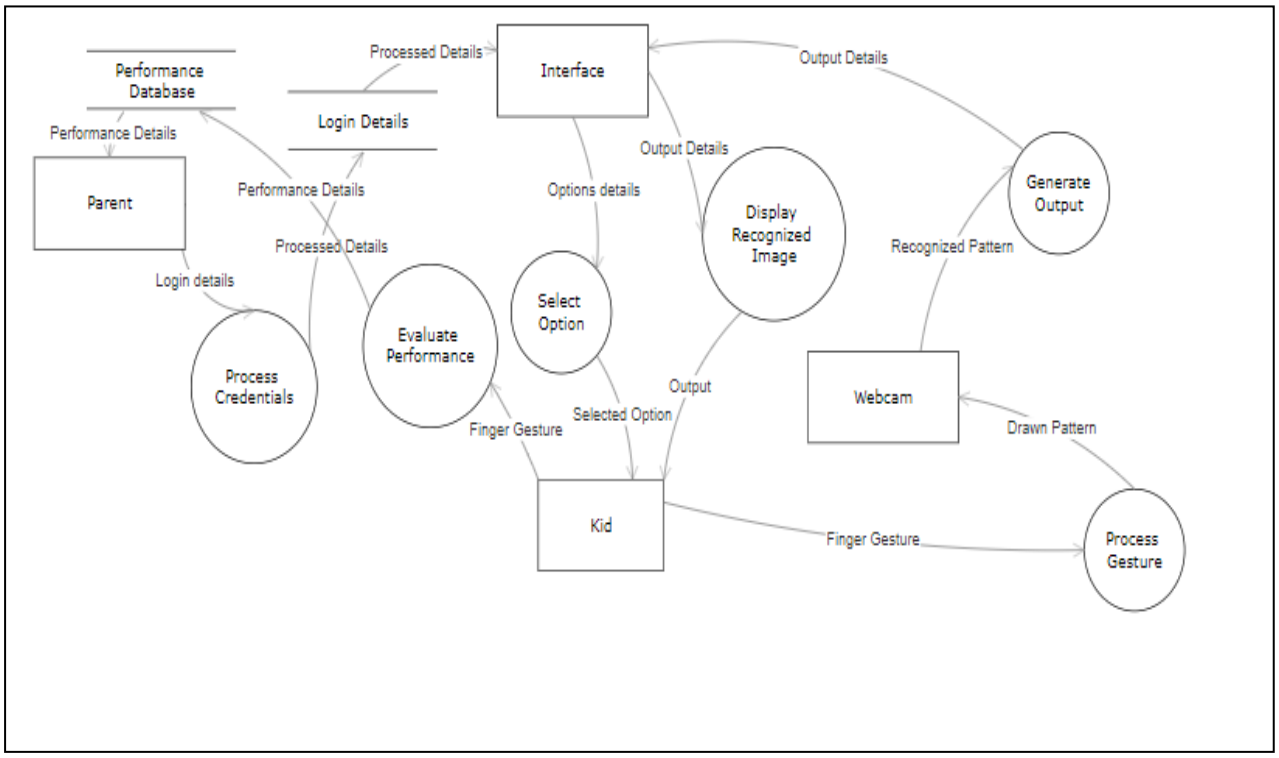

Figure 12: DFD level 1

4.2.3 Other UML Diagrams

4.2.3.1 Use Case Diagram

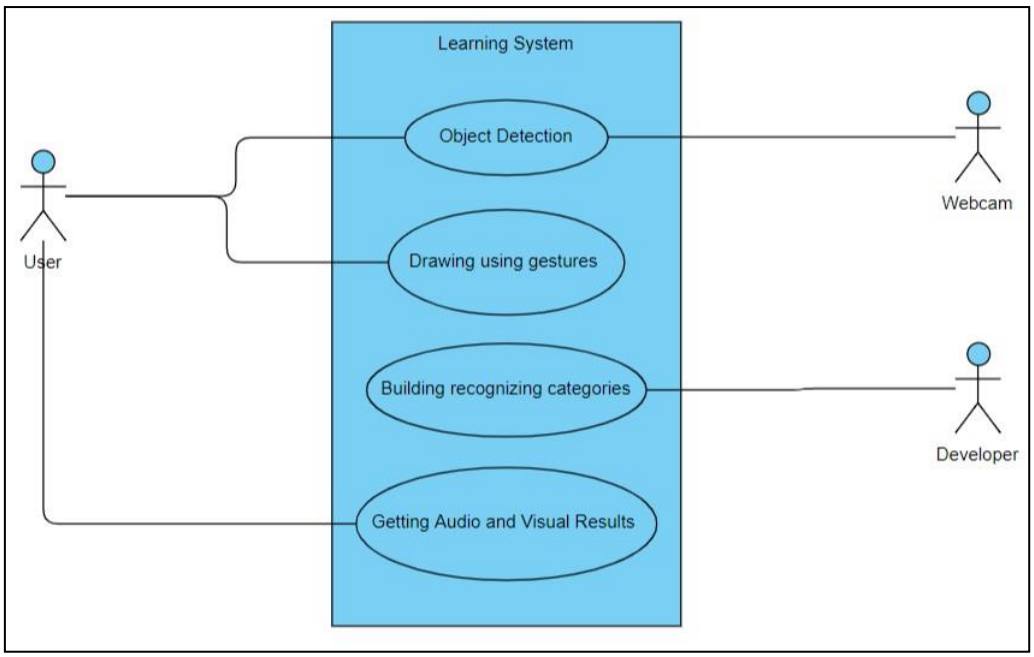

Figure 13: Use case diagram

4.2.3.2 Activity Diagram

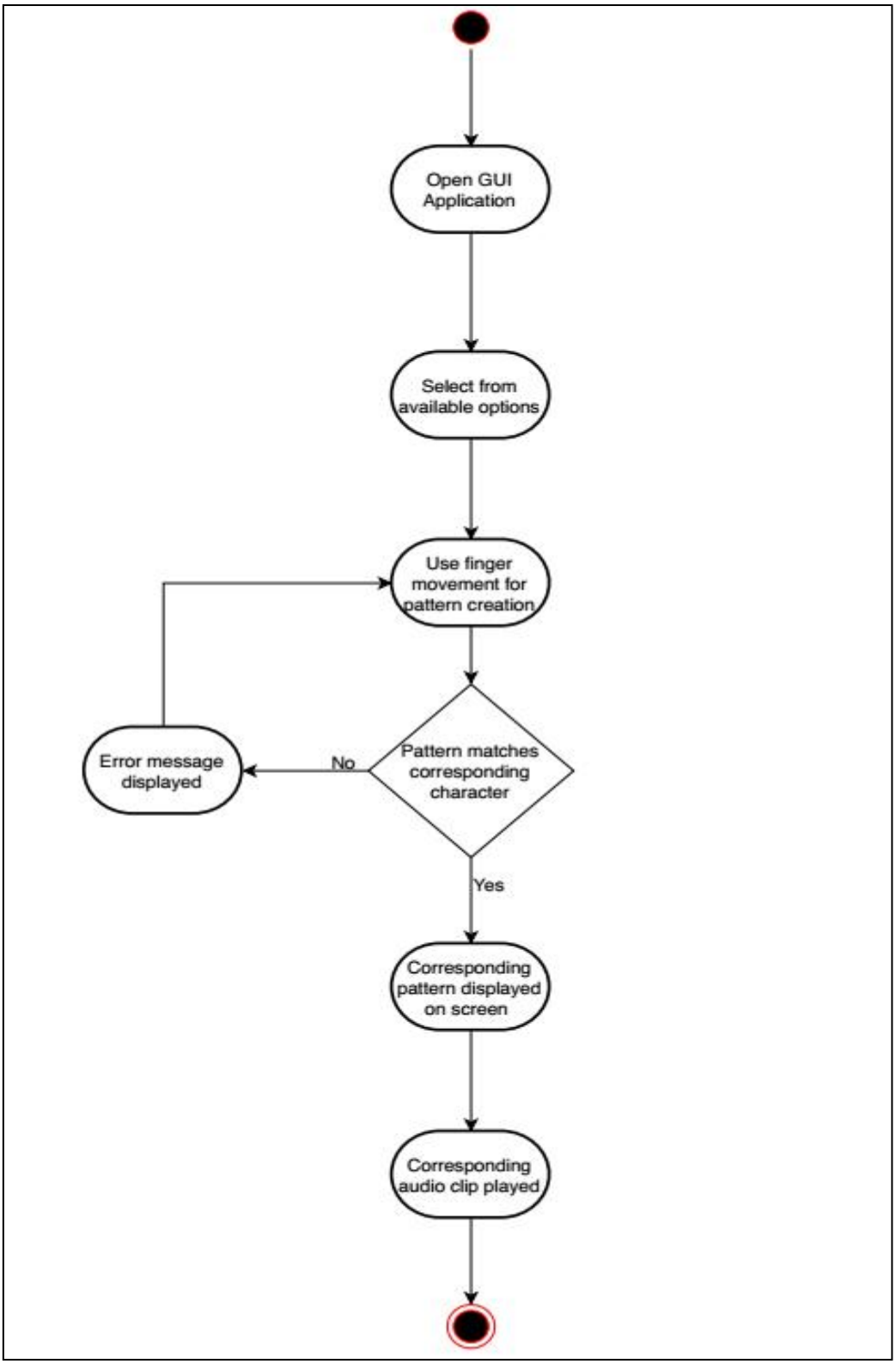

Figure 14: Activity diagram

4.2.3.3 Class Diagram

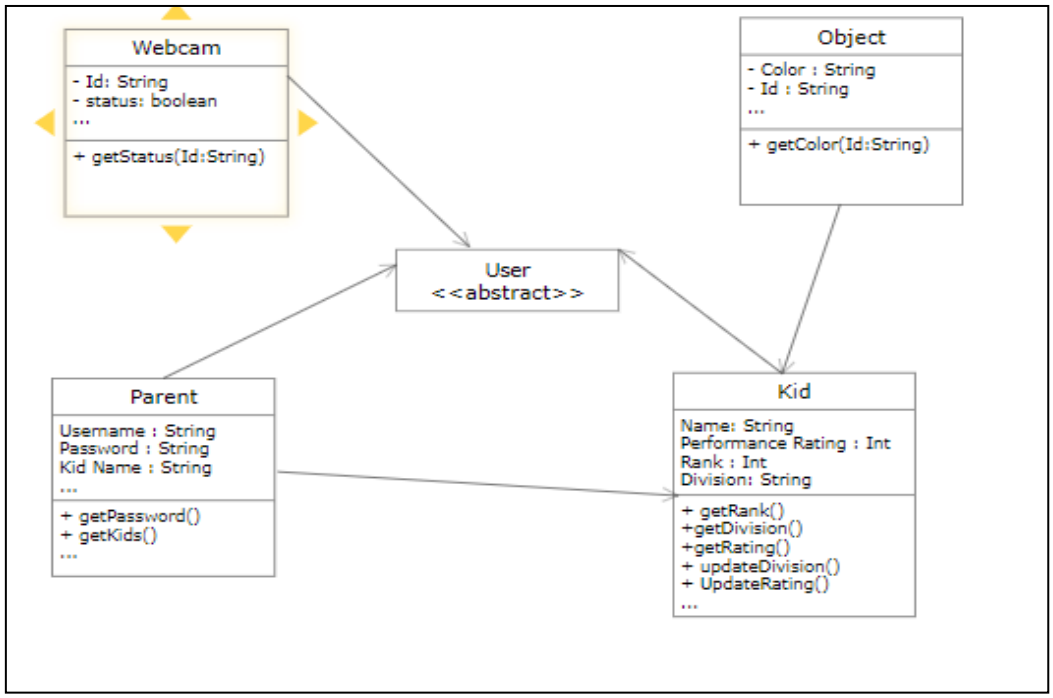

Figure 15: Class diagram

4.2.3.4 Sequence Diagram

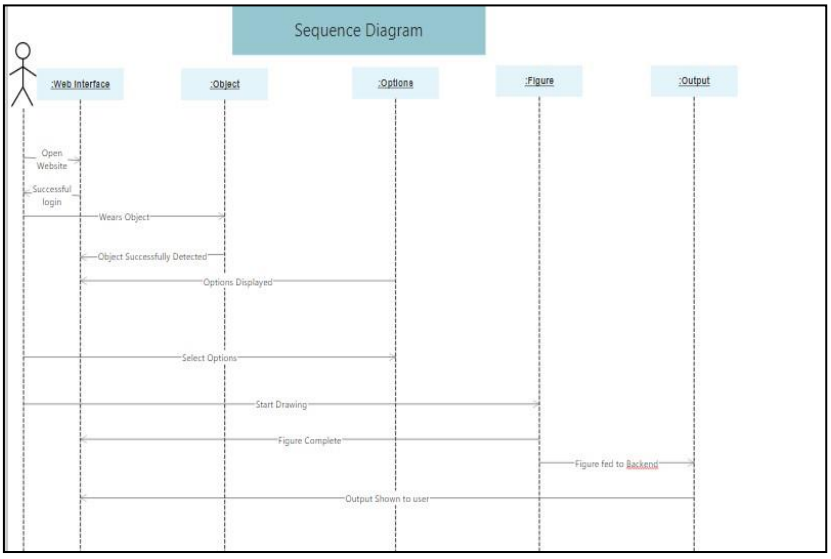

Figure 16: Sequence Diagram

4.3 User Interface Diagram

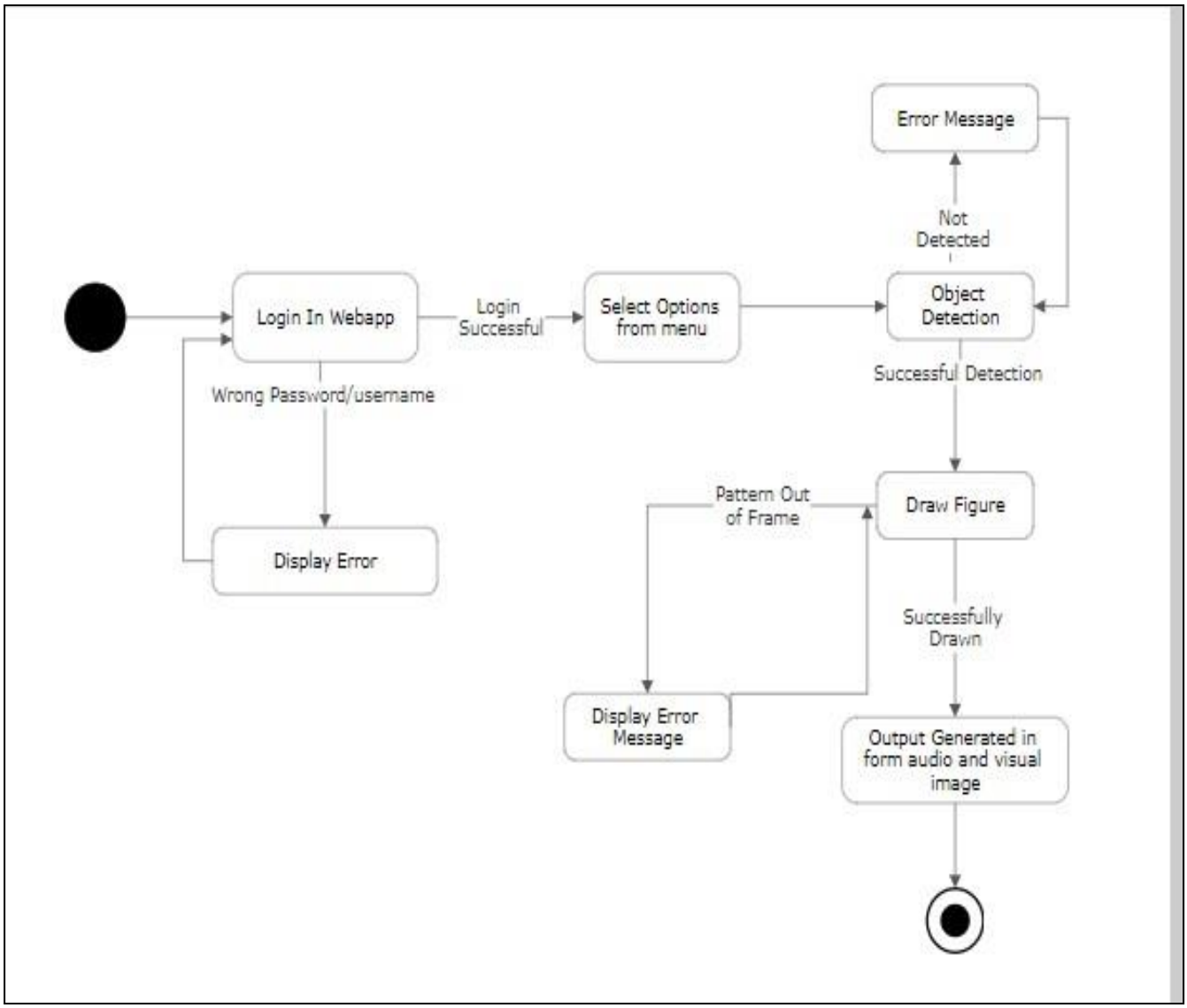

Figure 17: User Interface Diagram

4.4 Snapshots of Working Project Prototype Model-

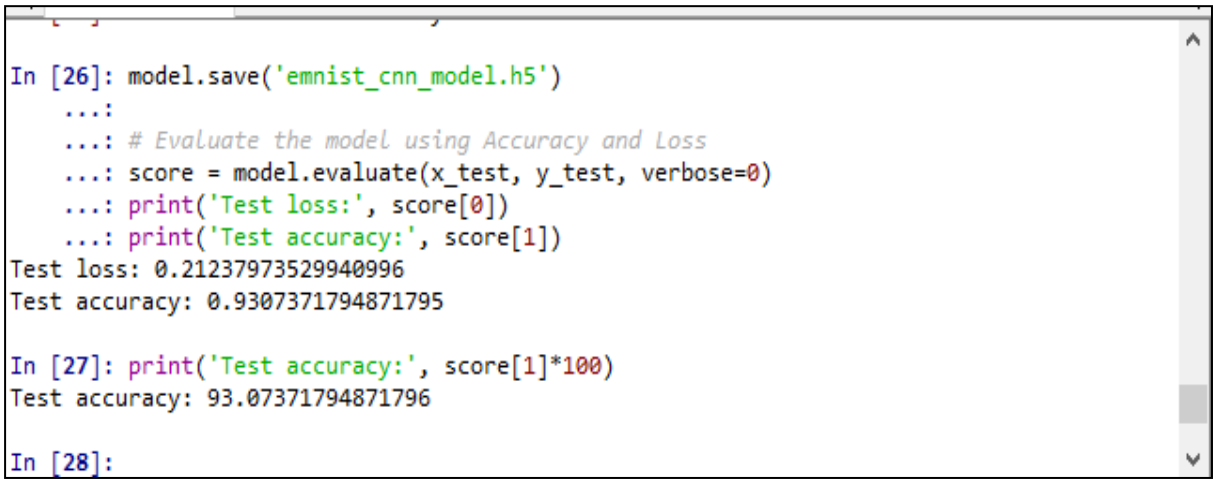

Figure 18: CNN model Evaluation Parameters

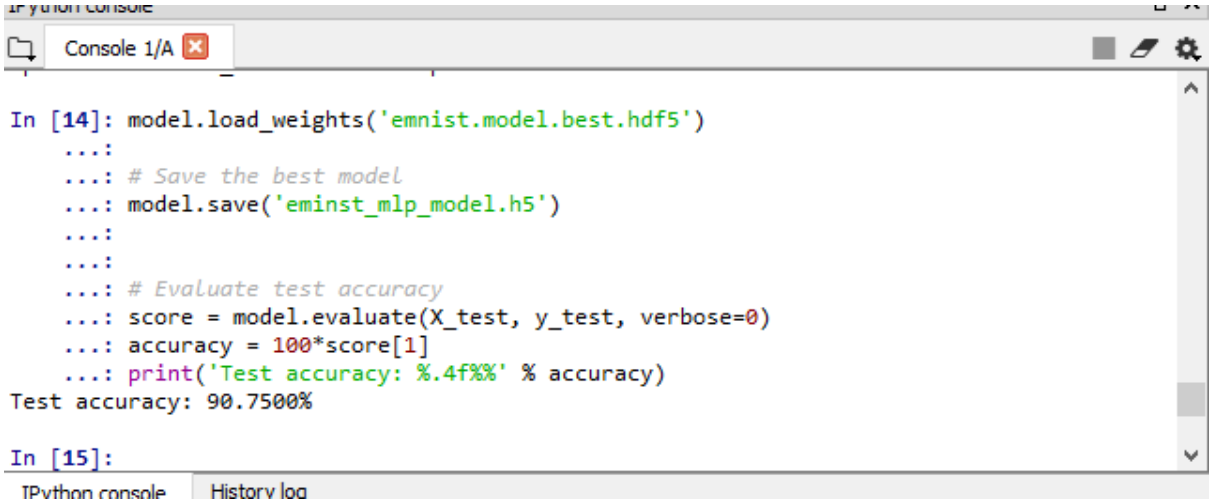

Figure 19: MLP model Evaluation Parameters

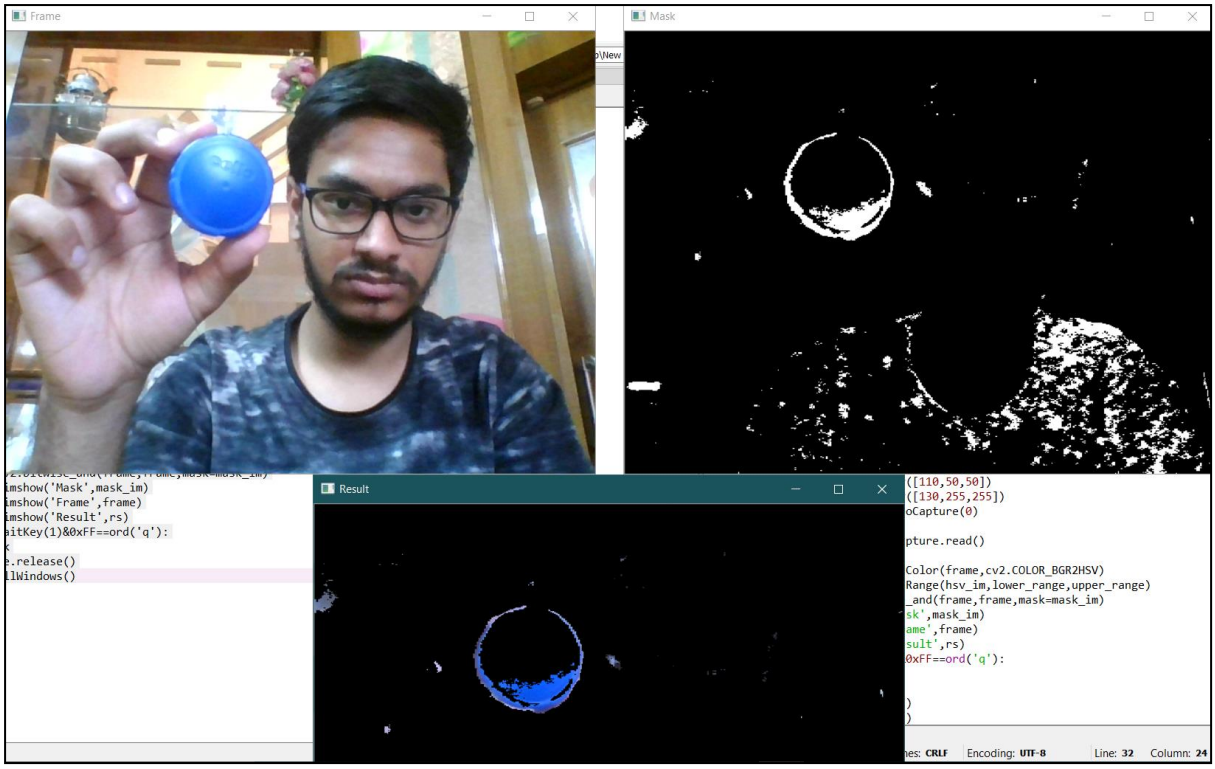

Figure 20: Object detection using Color Filtering

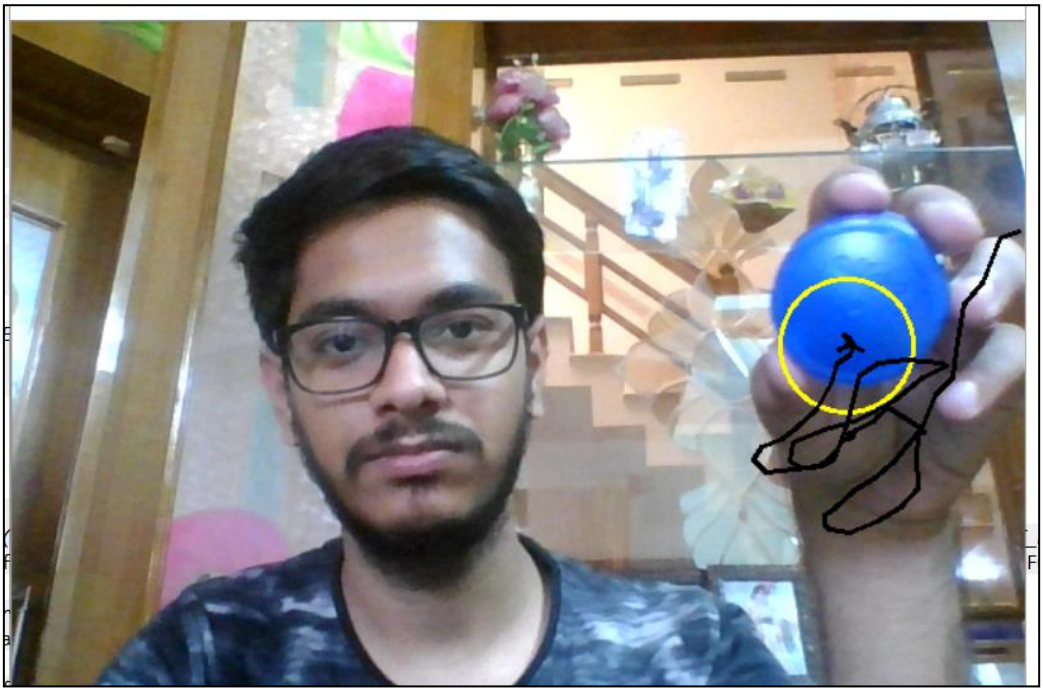

Figure 21: Object tracking using webcam

Chapter 5: Conclusions and Future Directions

5.1 Work accomplished

The work which is accomplished till now is that we trained two models for pattern recognition, one is multi-layer perceptron model and other is CNN model and then both are compared and we found that the accuracy of CNN model is higher than multi-layer perceptron model and its accuracy is 93%. The application code for alphabet recognition is also been written and successful recognition of alphabets have been done. We used a blue colour round object for the tracking of pattern made through hand gesture on the webcam through object tracking technique.

5.2 Conclusions

With the evolving technology, now it is the time to switch from the traditional method of learning to smart way of learning as using this system will help the children to learn new things in fun manner as doing finger gestures only to learn to write something would be a matter of great fascination for them. This would provide a great help in learning to the children of age range 3-5 years. As the learning also include visuals and audio representation about the alphabets, digits and fundamental shapes it would also enhance the learning ability of the user.

5.3 Social Benefits

This project is a great step towards making “SMART INDIA “at an early age of Indians which will be great push for them. Since in traditional learning method, a large amount of copies and papers are used for which a large no. of trees are cut which would harm our environment. But adopting this digital technique of learning will help to reduce the cutting of trees which would improve the condition of our environment.

5.4 Future Plan

The future plan is to develop the application code for the recognition of digits and random shapes and integrate all the models on a web application. It also includes implementation of User Interface which would work as an interactive platform for the user.

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