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# Smart Learning
**(An E learning mobile application based
on Augmented Reality)**
بنیادی تعلیم

**Bachelor of Science in Computer Science**

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Bahria University, Islamabad

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# Certificate

We accept the work contained in the report titled "Smart Learning (An E learning mobile application based on Augmented Reality)" - بنیادی تعلیم, written by Mr. Faiz Muhammad Naeem and Mr. Abdul Ghaffar Khan as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Computer Science.

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# Acknowledgments

# Abstract

E-learning has helped grow the academic sector tremendously. It has carved ways for students and teachers to interact with each other over electronic mediums effectively. Due to the current pandemic situation, in order to keep up with the SOP's the governments around the world have opted for the online medium of education as a means to limit people's interaction. A drawback of online means of collaboration is that it's difficult to engage children at home and to keep them interested in the subject being taught.

Many applications have been developed to help students learn and understand English as it is considered a universal language however very few applications have been developed to learn and understand Urdu. Urdu being our national language there was a need to provide good interactive software applications for children to understand and learn it. Augmented reality (AR) is one of the rising technologies that provide us interaction with 3D content in a real environment. This provides users with additional information using virtual objects.AR helps individuals learn concepts using visual stimuli and animations. This forms the basis for our project, where we developed an E-learning augmented reality-based application for learning Urdu language basics. This interactive application will help kids learn and understand Urdu concepts/basics in an environment that is conducive to learning.

"Think a hundred times before you take a decision, but once that decision is taken, stand by it as one man."

Muhammad Ali Jinnah

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# Acronyms and Abbreviations

| | |
|---|---|
| AR | Augmented Reality |
| E-Learning | Electronic Learning |
| E-Books | Electronic Books |
| 3D | 3 Dimensional |
| SDK | Software Development Kit |
| App | Application |
| VR | Virtual Reality |
| FYP | Final Year Project |
| Web | Website |
| C# | C Sharp |
| Mob | Mobile |
| SVG | Scalable Vector Graphics |
| GUI | Graphical User Interface |

# Chapter 1

# Introduction

E-learning is a way to change the perception about learning. Moreover, everything keeps on shifting online due to pandemics. E-learning is the best way to make use of technology for distance learning. It is a big challenge for teachers and parents to get familiar with modern teaching methods and teach the children effectively [10]. Due to this E-learning mobile application is alternatively being used as a learning medium.

E-learning also hits the current trends of the international market. Interactive learning software is the current requirement of educational institutions. In [11] they have thoroughly discussed the importance of E-learning applications in distance learning scenarios. This gives us the idea for our project, where we want to build an E-learning augmented reality-based application for learning the Urdu language.

This application 'Smart Learning' (بنیادی تعلیم) will work in such a way that the camera will be placed on a book with target images that the application recognizes, and it will generate a 3D model. There are very few Urdu Language-based E-learning applications. They are not commonly developed and used. Creating Urdu language-based applications will create better platforms for learning Urdu.

The main idea is to provide this Application as a learning tool for teachers and parents to make kids learn the basics of the Urdu language easily and effectively. This application will develop the interest of young kids. It will create a more enjoyable way for the kids to learn effectively using a 3D image that is based on Augmented Reality.

## 1.1 Background

Technology plays a vital role in the field of education. Many applications make learning creative and interactive for kids. In this modern era, augmented reality-based application delivers a lot of opportunities. Different applications have been developed to keep the interest of kids over augmented reality applications. Many developers are using English as a teaching medium while not considering the local students.

To cope with this issue, we are focusing on Urdu as a teaching mechanism. So, every child gets an education with the help of this mobile application. Teachers will interactively teach students. It will also increase their interest and learnability skills.

## 1.2 Problem Description

Mobile phones have now become a necessity of everyday life. There are almost 2.5 billion application users in the world. These Applications help us in a variety of ways. But there are very few applications that help kids learn the basics of the Urdu Language effectively. The current pandemic has hit the world in a very bad way and nowadays everything has been shifted online. The Teachers and Parents need to teach the kids effectively. Moreover, for Pakistani kids, it is important to make them learn their national language properly from a very basic level.

The solution to this problem is to make an E-learning via Augmented Reality-based application for kids to enhance their interest in learning the Urdu language and its basics effectively. Every kid can get benefit from this application with the help of their teachers and parents.

## 1.3 Motivation
In Pakistan, the Education system is not up to the mark. Our motivation is to use the latest technology like augmented reality so we can aware learners of new trends and develop their interest in education. Our application uses Urdu as a teaching standard which would provide better education to students in a creative way. Moreover, increase the interest of kids in their national language.

## 1.4 Objective
To design an "Augmented Reality-based E-learning Application" to make kids learn the basics of the Urdu language. The objectives of this application are given below:
- To make kids learn to join Urdu letters (Haroof Joor) & break Urdu letters (Haroof Toor) with 3D models and sounds
- To teach Fruit, Vegetable, and Animal names with 3D models and pronunciation
- To provide a platform where kids can learn to write Urdu alphabets (Haroof e Tahaji) by tracing.
- To teach counting (Ginti) in the Urdu language with 3D models and pronunciation till 50.

## 1.5 Project Scope
The E-learning application 'Smart Learning' (بنیادی تعلیم) will contain joining Urdu letters (Haroof Joor) & breaking Urdu letters (Haroof Toor) with pronunciation. Moreover, fruits, vegetables, and animals' names and pronunciations are also included. Urdu alphabet's tracing (Haroof e Tahaji) and counting (Ginti) in Urdu till fifty. The augmented Reality-based module will track the target image. And on successful tracking of a target image, its specific 3D model in the form of animation will be displayed with sound.
It will be difficult for the kids to use this application on their own. It is recommended that this application should be used by teachers and parents. To make children learn the language and get familiar with the modern learning methods.

## 1.6 Methodology
In this Application Paint, and Pixlr is used for image manipulation and editing. Unity Engine will be used to create the User Interface of this application and features like interactive sounds for 3D models. Vuforia Augmented Reality SDK will also be used to track 3D objects in real-time and create augmented reality applications along with a database. The 3D models for this application will be of joining (Haroof Joor) & breaking (Haroof Toor) of Urdu letters (Haroofs), Fruits, Vegetables and Animals, Digits of Urdu counting (Ginti). To create these models Blender 3D will be used. For 2D target images and Urdu book, Microsoft Word and Inkscape could be useful.

The application software development life cycle will be:
1. **Requirement Gathering**: In this phase, basic requirements will be gathered.
2. **Analysis:** In this phase analysis of requirements will be conducted.
3. **Design:** In this phase, all the modules will be designed.
4. **Implementation:** In this phase, the actual development of the application will be performed.
5. **Testing:** In this phase, we will perform the testing of our application.

The user will open the application and then select from the given options. Depending upon the selected choice the user will be able to learn the desired Urdu language-based thing. Along with voice in an Augmented Reality based environment.

## 1.7 Solution Application Areas
This mobile application will help in building the interest of students of Montessori and Grade 1. We can aware our kids of the new educational trend by using this mobile application. And make them learn effectively.

## 1.8 Proposed Solution
The application 'Smart Learning' (بنیادی تعلیم) will welcome the user and show a set of options to select. These options are the modules that this application will contain. The user will be able to select from these options to proceed further. Once the user has selected the desired option it will lead to that screen. Here the second option which is breaking letters and its working is shown. The user will be able to place the camera on the book and then the book will make the user learn in an Augmented environment.

Figure 1.1 Main Menu            Figure 1.2 Breaking Letters

# Chapter 2

# Literature Review

## 2.1 Overview

Augmented Reality based systems have high potential uses and they can be used to improve learning methods and in benefiting daily life scenarios. E-learning also hits the current trends of the international market. Interactive learning software is the current requirement of educational institutions. This gives us the idea for our project, where we want to build an E-learning augmented reality-based application for learning the Urdu language.

The pandemic has hit the world in a very bad way and nowadays everything keeps on shifting online. The Teachers and Parents need to teach the kids effectively. Moreover, for Pakistani kids, it is important to make them learn their national language properly from a very basic level. It will be difficult for the kids to use this application on their own. It is recommended that this application should be used by teachers and parents. To make their children learn the language and get familiar with the modern learning methods.

The solution to this problem is to make an E-learning via Augmented Reality-based application for kids to enhance their interest in learning the Urdu language and its basics effectively. Every kid can get benefit from this application with the help of their teachers and parents. There are almost 2.5 billion mobile application users in the world. These Applications help us in a variety of ways. But there are very few applications that help kids learn the basics of the Urdu Language effectively. Therefore, we have created this application to contribute to the Urdu language-based learning applications.

## 2.2 Augmented Reality

Augmented reality is one of the rising technologies that provide us interaction with 3D content in a real environment. This provides users with additional information using virtual objects. Augmented Reality is different from Virtual Reality because Augmented Reality provides interaction in a whole new way. The user can have a better understanding of their environment in real-time using actual scenes.

Augmented Reality is not a new thing as this technology was used one way or another. In the 1960s-layer forms of computer data and real-life were used. Ivan Sutherland is the father of both the fields of Augmented Reality & Virtual Reality. In 1968 he created the first head mount which was named "Sword of Damocles". In the 1970s and 1980s, many engineers worked on mixed reality by combining computer-generated graphics with the actual world.

## 2.3 E-learning applications

E-learning has completely revolutionized the way people get education moreover it has ended the traditional ways of using books. E-learning has made education simpler and easier. Access to education content has become much easier and everyone can get benefit from it. E-books are preferred now as compared to actual books. Thus, one does not have the burden now to stuff all the things in a backpack and can access a piece of information on the go. E-learning application allows learner to give their data as input and can have the

expected results through interactions. Any learner or student can access the application with an active internet even from remote areas.

There is some best E-learning application that is used by people worldwide like Word Press, Skill Pill, and Edu creations interactive whiteboard. E-learning has features that provide a solution to modern learner problems. Discussed below are a few advantages of E-learning applications.

**2.3.1 Advantages of E-learning:** Some benefits of online E-learning platforms are stated as follows.

1. **Saves time and money:** E-learning is cost-effective; anyone can save a meaningful amount on travel and accommodation costs, both students and teachers.

2. **Leads to better retention:** Modern learners would watch a video than read through pages of a manual. E-learning tools allow learning designers to make content more interactive. If the content is more engaging, then the learners remember information better.

3. **Consistency:** Every teacher and instructor has its method of teaching in face-to-face sessions. E-learning eliminates these issues and provides consistent and standard learning every time.

4. **Scalable:** E-learning is scalable. Everyone can enroll as many employees as he/she needs and the more learner take the course, the faster you will be able to come up with your expenses.

5. **Personalization:** Every learner has different learning goals. E-learning makes it possible to fulfill individual needs. It gives the learner the authority to choose their learning and can make it at their own pace.

## 2.4 Augmented Reality based E-learning applications

Now a day the usage of Augmented Reality for even a normal user has become easy as this technology can be implemented on a smartphone that can provide enough computational power for the registration of tracking points in our real-life scene, but we certainly have to compromise on the rich graphical virtual component. In this digital era, technologies like Augmented Reality provide a virtual simulation of a real environment so that the learner can know what they are learning. As far as E-learning about augmented reality is concerned, it is all about revolutionizing the way we attain knowledge. It also provides a practical approach rather than just learning dry theory. It is observed that learning something practical by trying out yourself is helpful, thus Augmented Reality provides self-exploration. Augmented Reality is an interactive way of a real-world where things are more enhanced by computer-generated information. Augmented Reality advanced technologies help us to make information about the real world more interactive and manipulated digitally. The focus of any researchers on different techniques about augmented reality application was to compare which technique will suit well according to the application depending on the problem stated i: e marker-based and markerless Augmented Reality Technology. Augmented reality is one of the rising technologies that provide us interaction with 3D content in a real environment. This provides users with additional information using virtual objects. Some of the Augmented reality-based E-learning applications are discussed below.

### 2.4.1 Application of Animal Species:

This is a mobile application based on a Chinese book that contains information about the ancient animals whose species are no longer alive or found rarely. This application teaches the children with the help of flashcards about animals with their 3D models [1]. It also includes a set of instructions/questions about every animal to test the learning of kids. In this way, this helps the kids to learn about those animals in a very realistic environment.

### 2.4.2 Application of Health Education:

This is a desktop application where the picture is clicked with the help of a camera. Then this picture is detected by the system and a 3D model is generated by Kinect SDK [5]. This 3D model could be of a human body muscle or lungs. Then Adobe flash player is used to project it with the help of a projector. The 3D model helps the students to learn the internal working of human organs with the help of 3D models interactively in a very realistic environment.

### 2.4.3 Application for Plant Learning:

This mobile application was made to learn about the plants and their information (text) and their visual appearance via 3D Models (AR). This mobile application scans a specific plant and then generates a 3D model of the plant with text information in real-time [4]. The picture of the plant is captured with the help of a smartphone camera. Then this picture is matched with the images of plants stored in the database. If the extracted features of plant capture by the camera are matched with those stored in the database, then that plant with a visual 3D model and textual information is displayed.

### 2.4.4 Application for Kindergarten students:

This application was made to make children learn tracing and AR by motivating self-learning and guiding children to trace properly.

In this application, marker-based augmented reality is used. Children will choose a letter on the mobile screen, which must be traced. The chosen letter will be augmented over their page. Now, they can trace it while seeing the letter on their mobile screen [8]. The app matches the drawing traced by the children with the input alphabet. In case of a mismatch, the app provides the learner with an indication of the mistake via graphics and encourages him/her to trace it better in the next trial. In this way, the children can learn to write the words in an interactive environment.

### 2.4.5 Application for Chinese Learning:

This game application was created to teach the phonetics of the Chinese language to children. Phonetics in the Chinese language is a very important thing that should be taught before actual writing thing of the language. This application makes children learn Chinese phonetic alphabets with 3D models [2].

It makes use of augmented reality to teach the children of kindergarten the basics of the language with the help of small puzzles (cards). Children make use of those puzzle cards to learn the language with 3D models, sounds, and animations. There are total of 3 exercises (modules) writing, reading, relationship memory. The agent will display the children the relevant 3D model and upon successful learning, the level of the game is increased.

**2.4.6 Sign Language system for Deaf children:**

This application was made for deaf children to teach deaf children the real Chinese words with the help of 3D models and sign language. A learning medium was created, which uses digital scripting language, Three-dimensional modeling, and interactive animation technology [3].

The deaf children know less vocabulary than the same age normal-hearing children. They have the incomplete vocabulary and have the wrong concept. They cannot distinguish homophones; the stimulus of the auditory language center is significantly less than normal-hearing children, so the deaf children learn slow and forget soon. To cater for this, a system is designed in which an ID card is placed in front of the camera and then the system generates the 3D model of the word itself or it generates the animation of that thing. The children will not only read the book but also visualize the 3D model which helps them to learn sign language.

**2.4.7 Semantic Labelling and Object Registration:**

This application was made to recognize the objects in the human environment in real-time (object registration) and label them. To label, the objects properly multiple streamed frames were used to establish an initial estimate of the object's location and then assign a position for the label. The first initial prediction of the network is taken. Then it is searched in the 3D space. After that, the Euclidean distance is calculated and then if the value is above a certain threshold the object registration is performed [7] and a 3D model is generated.

| Table 2.1: E-learning Augmented Reality-based applications | | | |
|---|---|---|---|
| **Year Developed** | **Name** | **Technique** | **Methodology** |
| 27/05/2014 (DAQRI) | AR Anatomy 4D+ | Marker-less | This application uses Augmented Reality to interact with human body parts. This is best app for medical students. Students from anatomy will have information about the various human system. This application gives you a 3D model and allows you to interact with it. |
| 08/10/2014 (Roar Interactive) | ROAR | Marker-based | This application will detect marker and will be able to move around outside the marker. This application has a website that stores the marker. This application gives you high-quality target marker and texture of 3D modeling. |
| 03/02/2019 (Stay Healthy) | Color Quest AR | Marker-based | In this application kids can be bringing a coloring sheet to life using 3D models and AR, their color AR function ensures endless hours of family fun. Kids can have fun while doing color and learn about health using augmented reality. |

## 2.5 Methodology/Framework of Existing Applications

Augmented reality is among the rising technologies. It is widely used in a variety of applications. Clothing stores use AR-based systems to give the customer an experience of how the dress will look like when they are going to wear it. Cosmetic stores use it to show how lipsticks and other cosmetics are going to look on the face. Furniture stores use it to let the customers decide which piece of furniture will look good at a certain place, before buying it. Methodologies of existing applications and 'Smart Learning' (بنیادی تعلیم) are discussed below.

### 2.5.1 Markerless Technique:

Marker-less does not need any pattern as it is opposite from marker-based that makes 3D content into the user environment and will hold it in space at a fixed point. It works by scanning the environment and no trigger image need to recover the Augmented Reality-based content. Instead of being stick to a marker, elements are placed on geometry. It is also very famous in gaming techniques like **Pokémon Go**, in which Pokémon can move around the virtual environment and can be used in live events and virtual product placement. Some applications using the marker-based technique are **science educational AR products** that use image detection markerless technique. The image is acquired with the help of a camera in an environment created by Unity 3D (front end). Then this image is converted using framing concepts and sent to a tracker created in Vuforia to match the image with the local and cloud-based database. Once a suitable match is found for the image then a realistic 3D model of that image is displayed on the screen [1]. **Semantic Labelling and Object Registration** also use the image detection markerless technique. This application is developed using CNN. Which has two functions one is object recognition along with labeling and the second is to generate the 3D model with the help of Hollo lens. The first initial prediction of the network is taken. Then it is searched in the 3D space. After that, the Euclidean distance is calculated and then if the value is above a certain threshold the object registration is performed [7].

### 2.5.2 Marker-based Technique:

It is a technique that will recognize a code or any pattern when a camera is pointed at it which is used to trigger AR content. If the pattern is unique marker will be used successfully and Augmented Reality will work smoothly. Quick response (QR) codes are a common example of a market-based technique. A marker-based technique finds a specific pattern in the environment and superimposes the object on it. The camera of the device will scan the input and will make image pattern recognition and then will make a virtual object. Some applications using the marker-based technique are the **Sign language system for deaf children** which was developed using AR Tool Kit and an image. The markers are designed in a certain way that all the cards should have a black boundary and within that, all the cards should have a white background and Chinese letters (who's 3D model is to be made) written on them. A Chinese language word marker is placed in front of the camera and then the system recognizes the word and generates a 3D model of the word and its relevant Sign word. The computer camera takes the image, then searches for the image, and generates a 3D model [3]. **E-learning Geometric System using AR** is another application in which picture is scanned with the help of a camera in real-time. Then this picture is sent to Vuforia for object detection. Then a 3D model is generated and shown by making use of unity 3D and Vuforia. There are several options like rotation and scaling the 3D geometrical objects to learn them properly. Then at the end, there is a quiz to test the concepts of students [9]. **Snapchat** also uses a marker-based technique [29]. The AR-based Snapchat filters first find the face then scan it and then put a filter on it.

**2.5.3 Methodology of 'Smart Learning' (بنیادی تعلیم):**

'Smart Learning' (بنیادی تعلیم) will use marked based AR. The mobile camera will first scan the target image. Upon successful scanning of the target image, the relevant 3D model of the image will be displayed on the mobile screen.

In this Application Paint, and Pixlr is used for image manipulation and editing. Unity Engine will be used to create the User Interface of this application and features like interactive sounds for 3D models. Vuforia Augmented Reality SDK will also be used to track 3D objects in real-time and create augmented reality application along with a database. The 3D models for this application will be of joining (Haroof Joor) & breaking (Haroof Toor) of Urdu letters (Haroofs), Fruits, Vegetables and Urdu counting (Ginti). To create these models Blender 3D will be used. For 2D target images and Urdu book, Microsoft Word and Inkscape could be useful.
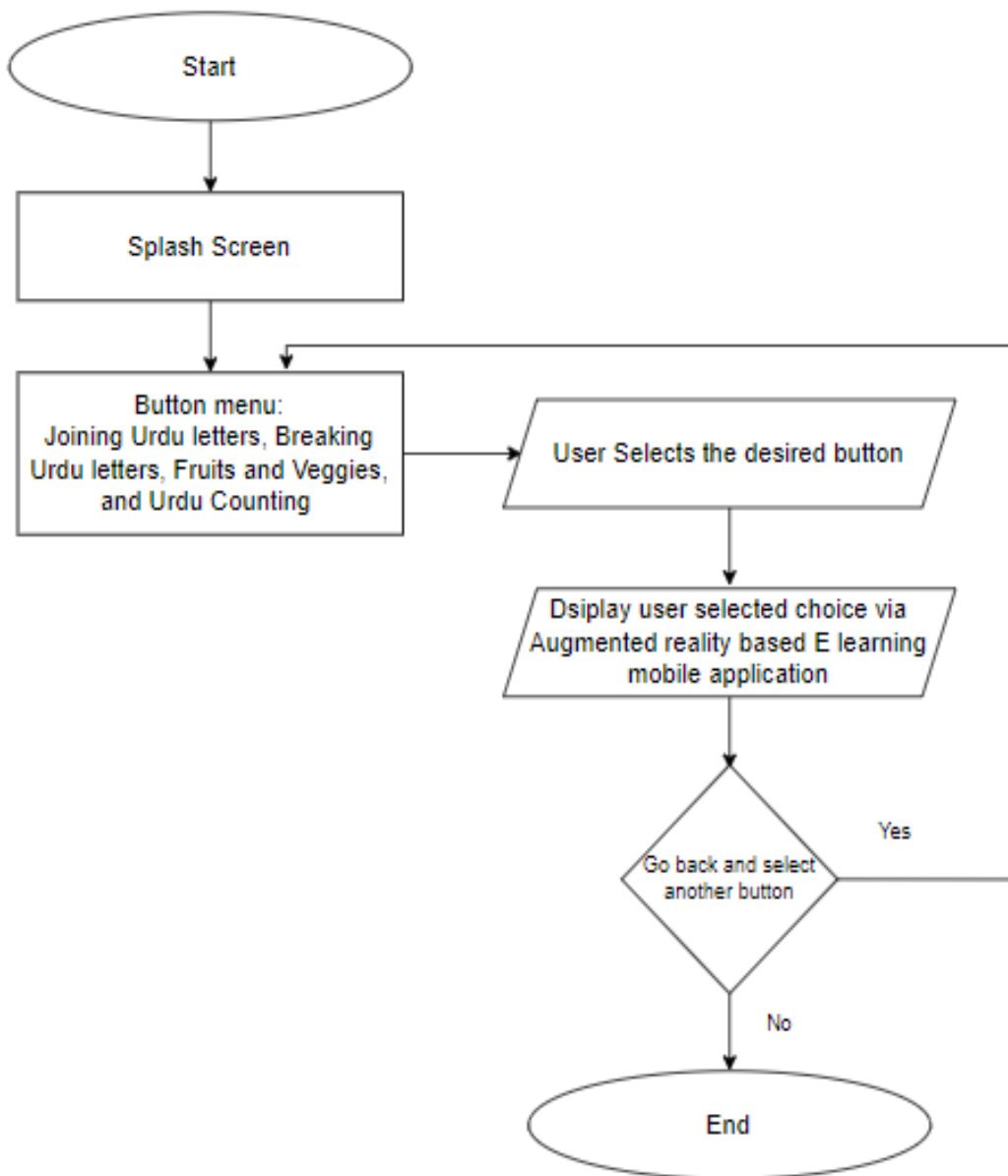


Figure 2.1: Workflow Diagram

| Table 2.2: Comparison table of augmented reality based applications | | |
|---|---|---|
| **Paper Title** | Year | Application Type |
| Applying Augmented Reality Technology to E-learning Science Educational AR Products as an Example | 2016 | E-learning (AR) |
| Augmented Interface for Children Chinese Learning | 2007 | E-learning (AR) |
| The Implementation of Literacy and Sign Language Learning System for Deaf Children Based on the Augmented Reality | 2014 | E-learning for Deaf kids (AR) |
| Augmented Reality Application for Plant Learning | 2018 | Plant learning (AR) |
| Augmented Reality Applied to Health Education | 2013 | E-learning (AR) |
| Augmented reality mobile application and its influence in Quechua language learning | 2019 | E-Learning (AR) |
| Development of Mobile-based Augmented Reality Colouring for Preschool Learning | 2018 | E-Learning (AR) |
| E-learning System using Augmented Reality | 2017 | E-Learning (AR) |
| Semantic Labelling and Object Registration for Augmented Reality Language Learning | 2019 | E-Learning (AR) |
| Design and Development of an Augmented Reality Tracing Application for Kindergarten students | 2019 | E-Learning (AR) |

# Chapter 3

# Requirement Specifications

## 3.1 Proposed System

'Smart Learning' (بنیادی تعلیم) mobile application is based on E-learning via augmented reality used for children's education. It works in such a way that we place our camera at a book containing target images that our application recognizes, and it will generate a 3D model. The generated model appears in the application interface with the background of the room environment. In our system, we will use 3D models of Urdu letters (Haroofs), Fruits, Vegetables, or other objects and develop other features like interactive sounds for every target image in the designed book.

Our E-learning application contains:

* Joining Urdu letters (Haroof Joor) with 3D models and sounds
* Breaking Urdu letters (Haroof Toor) with 3D models and sounds
* 3D models of Fruits, and Vegetables with sounds
* Counting in the Urdu language till 50 with 3D models and sounds

## 3.2 Target Audience

The targeted audience for our project is kids, teachers, and parents to teach basic education with the help of advanced 3D technology. Our project idea is Based on designing a Teaching tool for Teachers or Parents which would use augmented reality technology and a book containing target images. The focus is to develop the interest of students while using our national language Urdu as the teaching medium and to promote it.

## 3.3 User Characteristics

Our primary stakeholders are teachers, parents, and children under the ages of 9. Teachers and parents would be novice users but due to the simplicity of the application, they would easily adapt to it. Once the teacher and student are familiar with the working of the application, they will be able to teach the children through this application easily.

## 3.4 Functional Requirements

Following are the functional requirements of our project:

1. Understanding the generation of a 3D model with a book containing target images
2. The ability of the application to recognize Target Images and display their relevant 3D model with sounds

## 3.5 Non-Functional Requirements

Given below are the non-functional requirement for our system.

### 3.5.1 Usability

Teachers and Parents will interact with augmented reality applications and books containing target images. On successful recognition of the target image, the app will display 3D models with sound. The app contains four buttons. The user can select the button of his/her choice. After button selection camera will open and target image scanning is performed. Then the 3D model is displayed. Users can also on/off the sound played when the target image is scanned. and can go back to the main menu with the help of the back button. The colors of models are matched with the colors of the app to strive for consistency.

### 3.5.2 Performance measure

- **Response Time**: The application will only display the 3D model when the light condition is good, and the camera is placed on the image target
- **Resource Requirement**: This application will require a book containing target images

### 3.5.3 Reliability

E-learning via augmented reality is a mobile application that is used in kids' education. E-learning is a way to change people's perceptions about learning. The application will open a mobile camera and recognize the target image. Only on successful recognition of the target image, a 3D model will be displayed with sounds.

### 3.5.4 Supportability

Our e-learning application supports a book containing target images of Joining & Breaking Urdu letters (Haroofs), Fruits, Veggies, and Urdu counting. The application will open a mobile camera and recognize the target images from this book.

### 3.5.5 Scalability

Our App will be scalable in terms of adding new functionalities or features.

## 3.6    System Requirements

The system consists of two major parts:
- Software Requirement
- Hardware Requirement

### 3.6.1    Software Requirement

**Unity Engine:** In this E-learning application Unity Engine will be used for creating user interface of the application and features like interactive sounds with 3D models and target images.

**Vuforia:** Vuforia will also be used which is an augmented reality software development kit (SDK) for developing Augmented Reality Applications. Vuforia provides a web-based Database for storing target images.

**Blender 3D**: In our case, we will use 3D models like Urdu Letters (Haroofs), Urdu Counting (Ginti), and Fruits, Vegetables, and for making these models, Blender 3D will be used.

**Inkscape:** will also be used for writing Urdu text and creating scalable vector graphic (SVG) images.

### 3.6.2   Hardware Requirement

For the use of this application hardware requirements are listed below:

- 2GB RAM (Minimum)
- Screen resolution (1024 * 768 or above)
- Storage of 8 GB (Minimum)
- Mobile Speakers should be in working condition
- Mobile Camera should be in working condition

## 3.6 System Use Cases

Use case model is used to identify system requirements. Use cases are used to show individual interaction of application. The use cases are given below with specific tables.

### 3.6.1 Use Case 01: Functionality of Smart Learning (بنیادی تعلیم) Application

The respective use case highlights the interaction of three user's teacher, student, and parent with our application. The use case 01 is the first screen for user to interact with the application. The user will select the button to perform a particular operation.
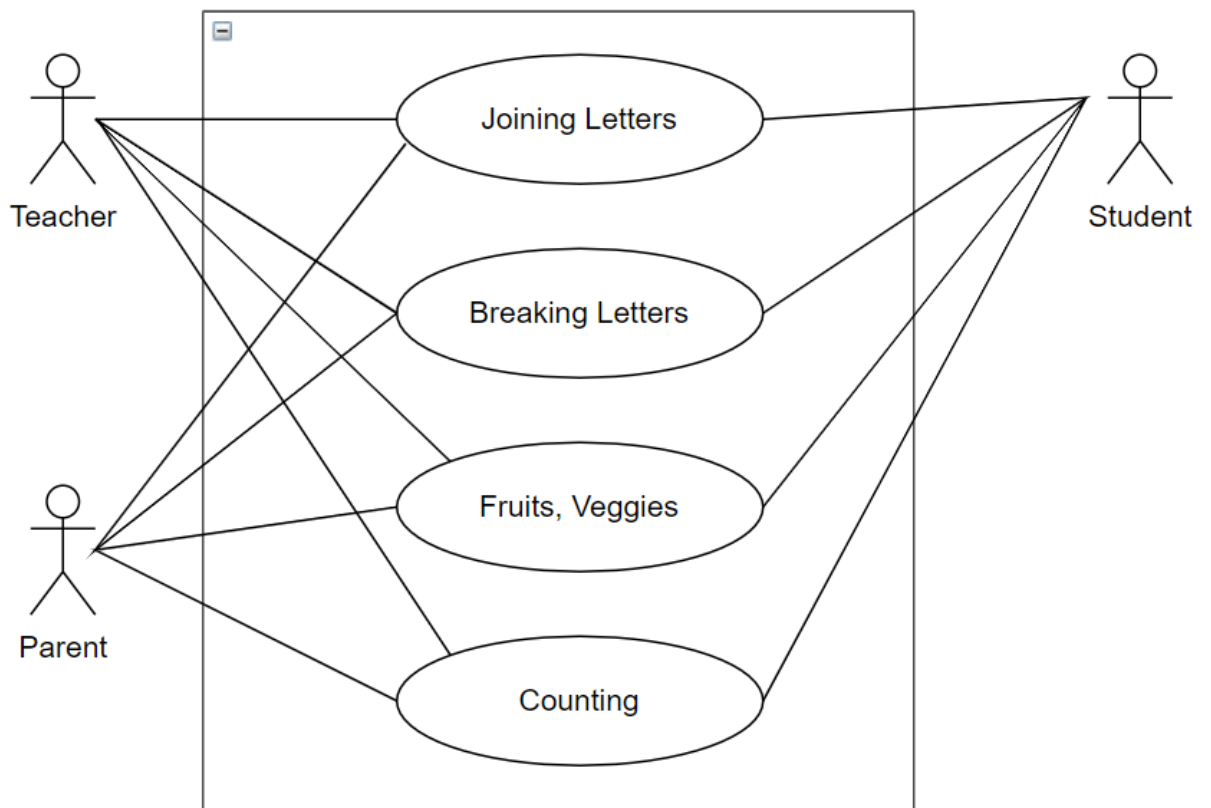


Figure 2.1: Functionality of Smart Learning

**Table 3.1: Functionality of Smart Learning (بنیادی تعلیم)**

| Use Case ID | UC-01 |
|---|---|
| Use Case Name | Functionality of Smart Learning (بنیادی تعلیم) |
| Actors | Teachers/Parents/Students |
| Description | Select button to perform action |
| Activate | Buttons |
| Preconditions | Application must be installed |
| Postconditions | Actions performed on buttons |

### 3.6.2 Use Case 02: Button 1 Joining Letters

The use case 02 holds the functionality of button 1. If user selects button 1, in response the application will open the camera so user place camera at the target images of Joining Letters (Haroof Joor) in the book to generate 3D model with sound.



Figure 3.2: Button 1 Joining Letters

**Table 3.2: Button 1 Joining Letters**

| Use Case ID | UC-02 |
|---|---|
| Use Case Name | Button 1 Joining Letters |
| Actors | Teachers/Parents/Students |
| Description | User place camera at target images in the book |
| Activate | Button 1 Joining Letters |
| Preconditions | Application must be installed and User must select button 1 |
| Postconditions | 3D model is generated with sound |

### 3.6.3 Use Case 03: Button 2 Breaking Letters

The use case 03 holds the functionality of button 2. If user selects button 2, in response the application will open the camera so user place camera at the target images of Breaking Letters (Haroof Toor) in the book to generate 3D model with sound.
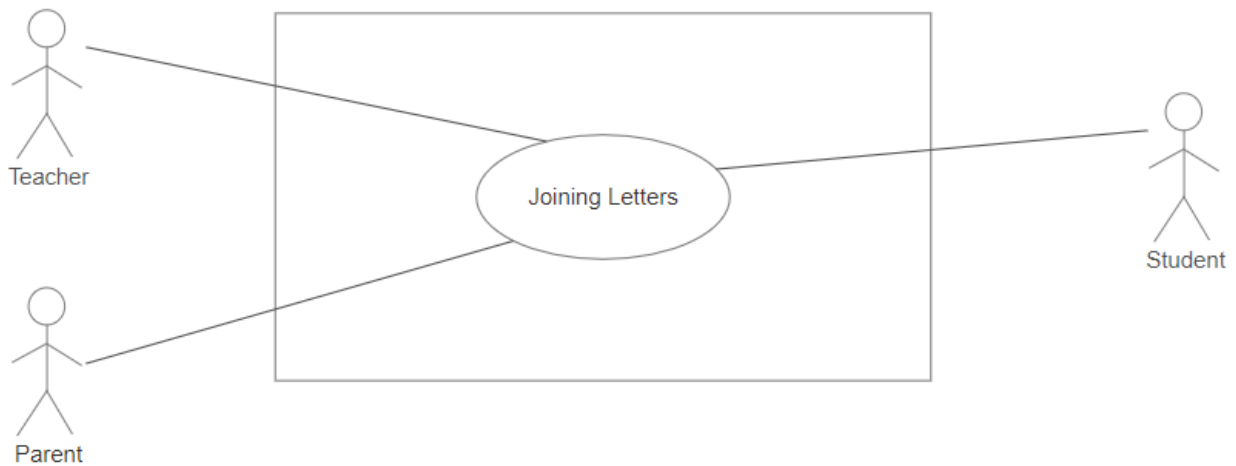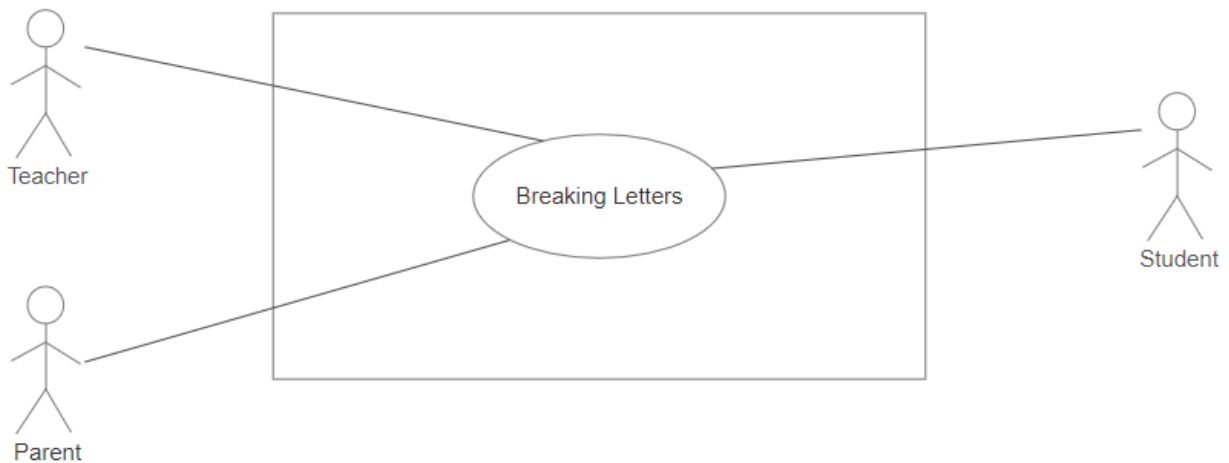


Figure 3.3: Button 2 Breaking Letters

**Table 3.3: Button 2 Breaking Letters**

| Use Case ID | UC-03 |
|---|---|
| Use Case Name | Button 2 Breaking Letters |
| Actors | Teachers/Parents/Students |
| Description | User place camera at target image in the book |
| Activate | Button 2 Breaking Letters |
| Preconditions | Application must be installed, and User must select button 2 |
| Postconditions | 3D model is generated with sound |

### 3.6.4 Use Case 04: Button 3 Fruits, Veggies

The use case 04 holds the functionality of button 3. If user selects button 3, in response the application will open the camera so user place camera at the target images of Fruits, Veggies in the book to generate 3D model with sound.
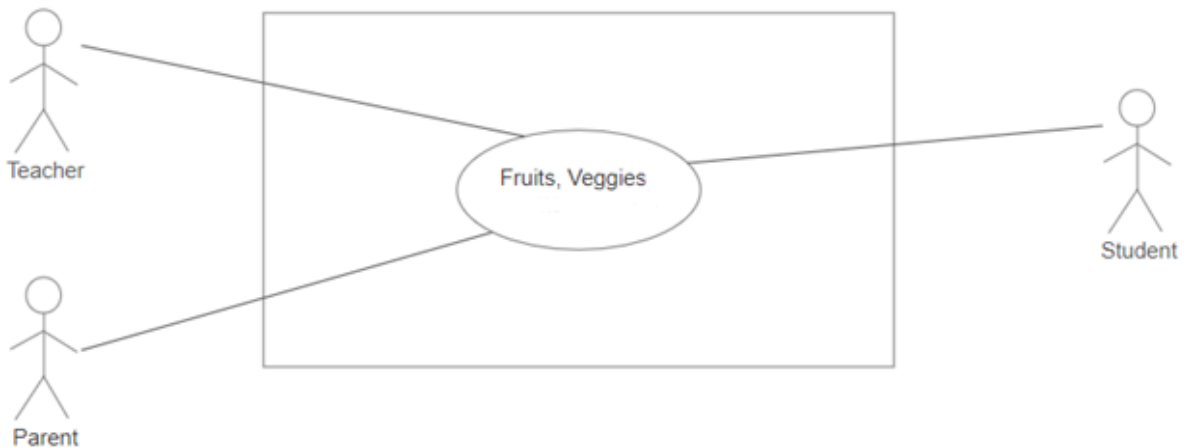


Figure 3.4: Button 3 Fruits, Veggies

**Table 3.4: Button 3 Fruits, Veggies**

| Use Case ID | UC-04 |
|---|---|
| Use Case Name | Button 3 Fruits, Veggies |
| Actors | Teachers/Parents/Students |
| Description | User place camera at target images in the book |
| Activate | Button 3 Fruits, Veggies |
| Preconditions | Application must be installed, and User must select button 3 |
| Postconditions | 3D model is generated with sounds |

### 3.6.5 Use Case 05: Button 4 Counting

The use case 05 holds the functionality of button 4. If user selects button 4, in response the application will open the camera so user place camera at the target images of Counting (Ginti) in the book to generate 3D model with sound.
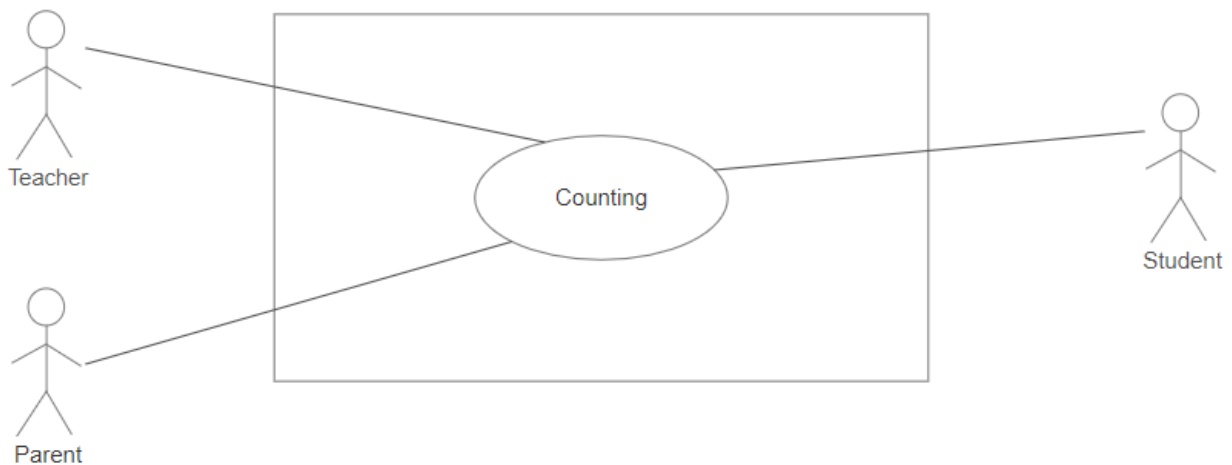


Figure 3.5: Button 4 Counting

**Table 3.5: Button 4 Counting**

| Use Case ID | UC-05 |
|---|---|
| Use Case Name | Button 4 Counting |
| Actors | Teachers/Parents/Students |
| Description | User place camera at target images in the book |
| Activate | Button 4 Counting |
| Preconditions | Application must be installed and User must select button 4 |
| Postconditions | 3D model is generated with sounds |

# Chapter 4

# Design

In this chapter the architectural view of the project is explained. Further-more structure, methodologies, high level design, and graphical user interface (GUI) are also discussed here.

## 4.1 System Architecture

The architectural view of our system is shown below which explains the structure of our system.

The Vuforia camera scans the Target image and detects the features of the target image. The Vuforia database fetches the same target image from the database which is being scanned by the Vuforia camera. Once the scanned image is found in the database then the 3D model is displayed on the image.

Figure 4.1: System Architecture

## 4.2 Design Methodology

In design methodology following method have been used.

### 4.2.1 Incremental build model approach

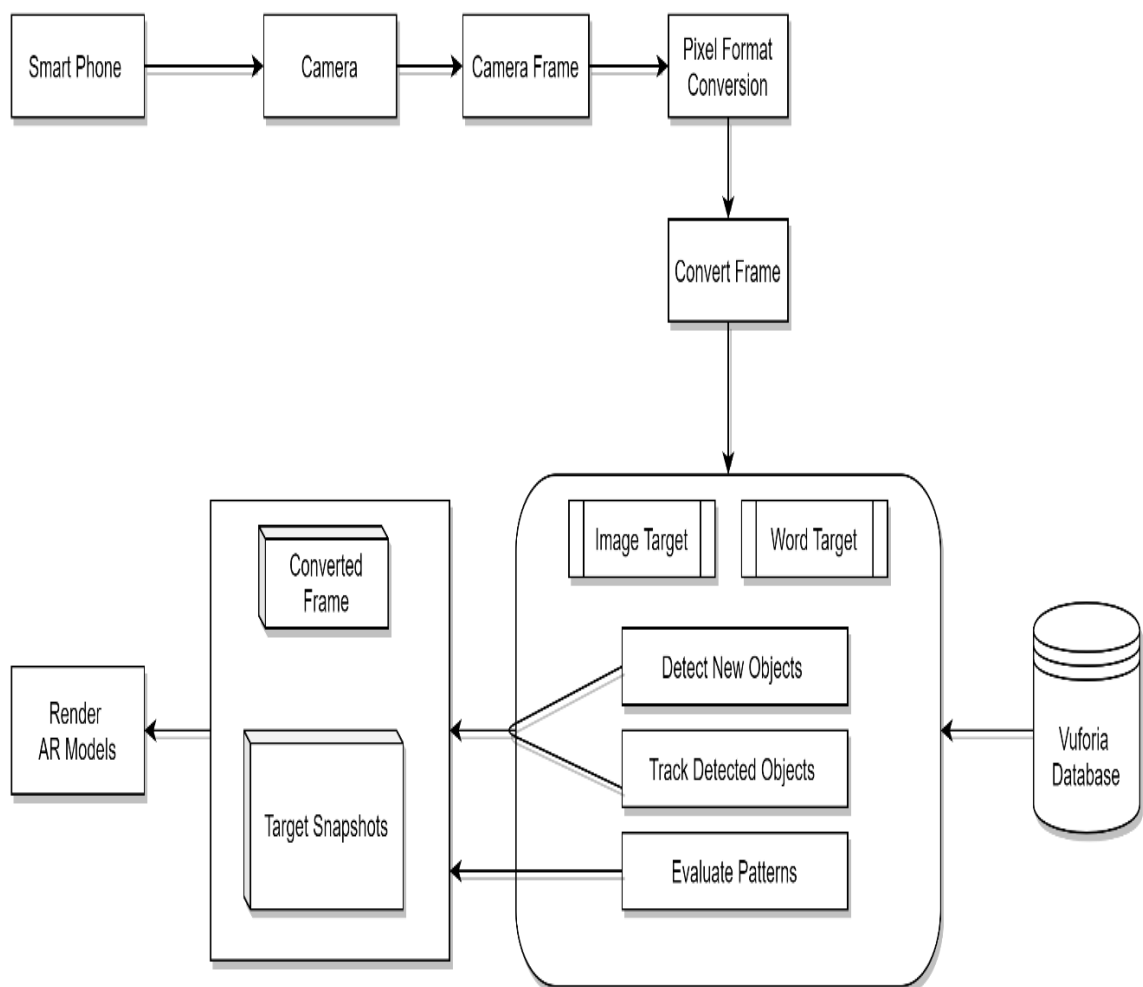Incremental model will be used for the development of this project. Project essentials are divided into various units and every unit is developed distinctively. The already developed units are discriminated from other units. It will provide assist as in object-oriented approach every developed unit is self-contained property and can be released to the users to use it. This Model does not require to wait for all the units to be developed and then combined. This approach goes on until all the essentials are satisfied and entire project gets developed. The work on modules is performed step by step.

## 4.3 High Level Design

High-level design demonstrates the architecture that is used in the development of software product. It provides an analysis of the complete system, recognizing the main elements that is required for the development of the product and their interfaces.

### 4.3.1 Context Diagram

The context diagram explains the variety of interaction with the different users and the whole system as well as the acknowledgment generated by the system is showed in the figure below.
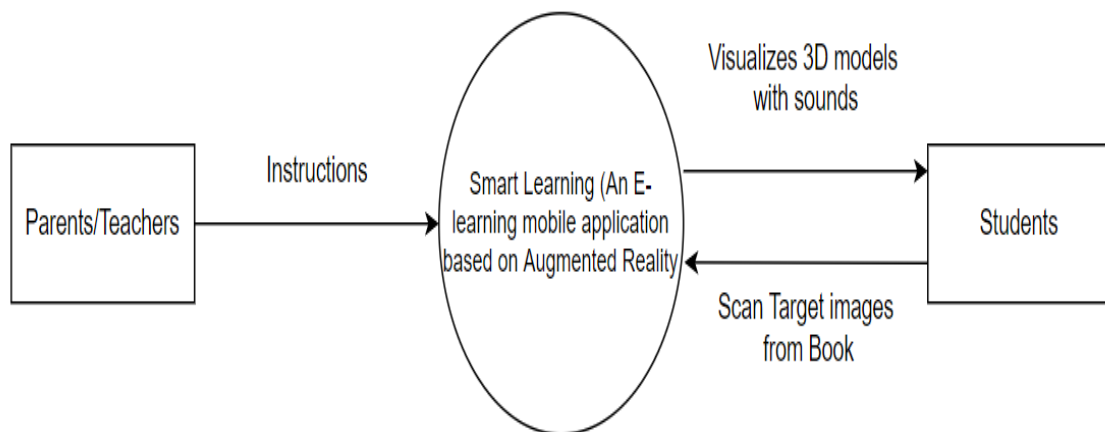


Figure 4.2: Context Diagram

**4.3.2 Activity Diagram**

Activity diagram is an important behavioral diagram to describe dynamic aspects of the system. Given below is the activity diagram of the system.
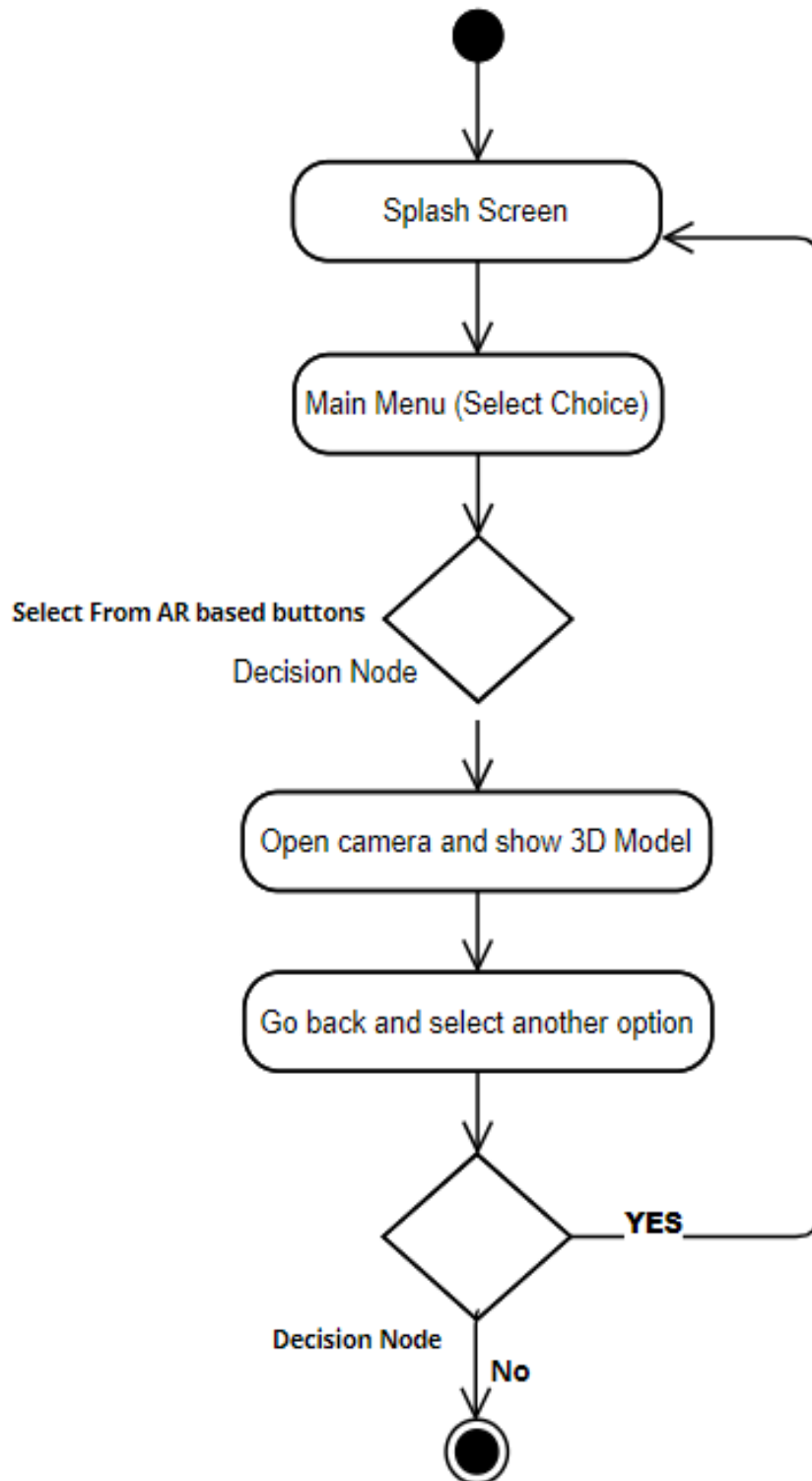


Figure 4.3: Activity Diagram

### 4.3.3 Sequence Diagram

There are different Sequences of the system when user will interact with the system these sequences describe how system will be responding to the requests made. The sequence diagram of main functionality is given below.



Figure 4.4: Sequence Diagram

## 4.4 GUI Design

This portion provides the general idea of our application's user interfaces and main modules buttons.



Figure 4.5: Unity Splash Screen



Figure 4.6: Smart Learning Splash Screen



Figure 4.7: Main Menu
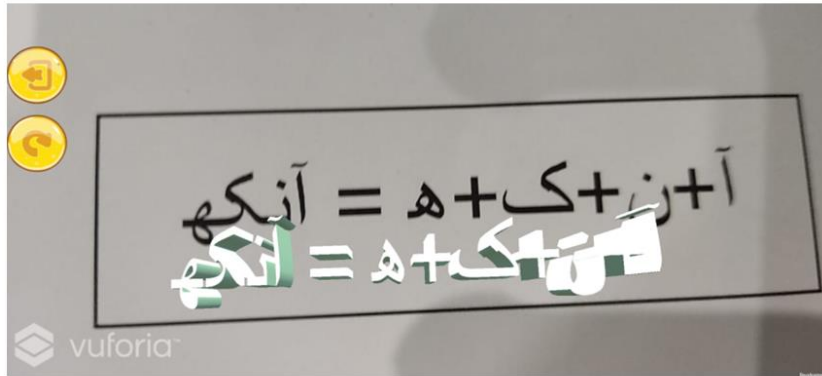
Figure 4.8: Joining Letters
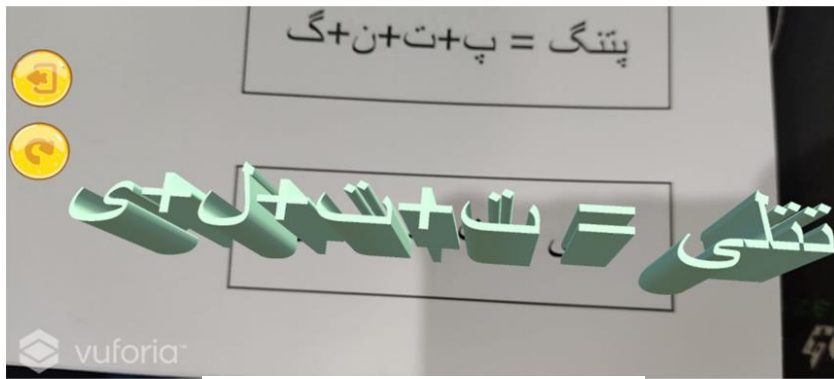


Figure 4.9: Breaking Letters
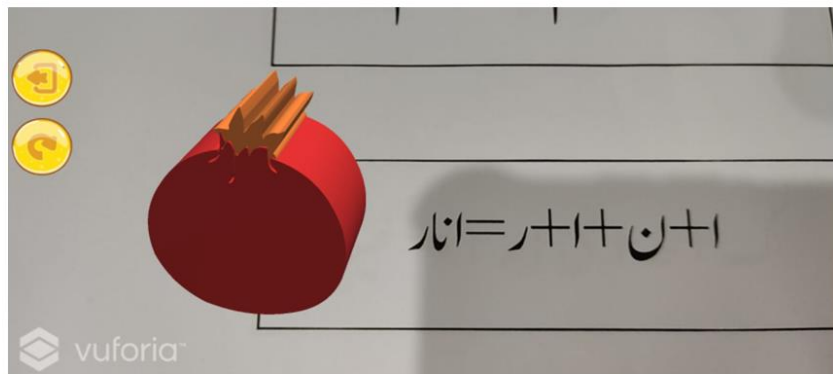


Figure 4.10: Fruits, Veggies
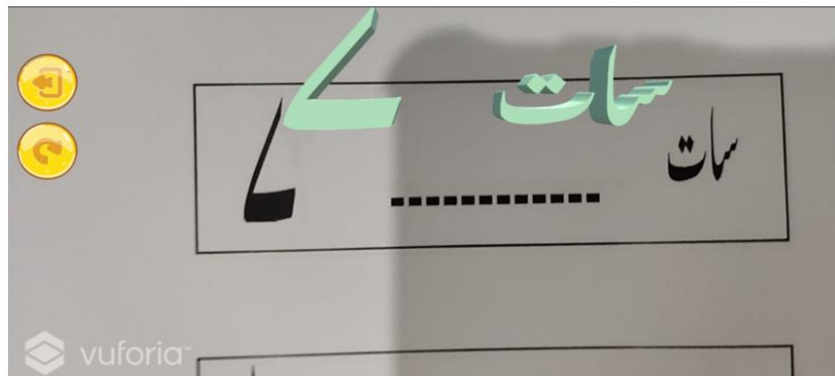
Figure 4.11: Counting

### 4.4.1 Joining Letters
The user can learn the joining letters by selecting this button. After selecting the button, Vuforia AR camera will open. The user will scan the target image with this camera from book. Upon successful scanning the relevant 3D model of joining letter will pop out on the screen with sound.

### 4.4.2 Breaking Letters
The user can learn the breaking letters by selecting this button. After selecting the button, Vuforia AR camera will open. The user will scan the target image with this camera from book. Upon successful scanning the relevant 3D model of breaking letter will pop out on the screen with sound.

### 4.4.3 Fruits, Veggies
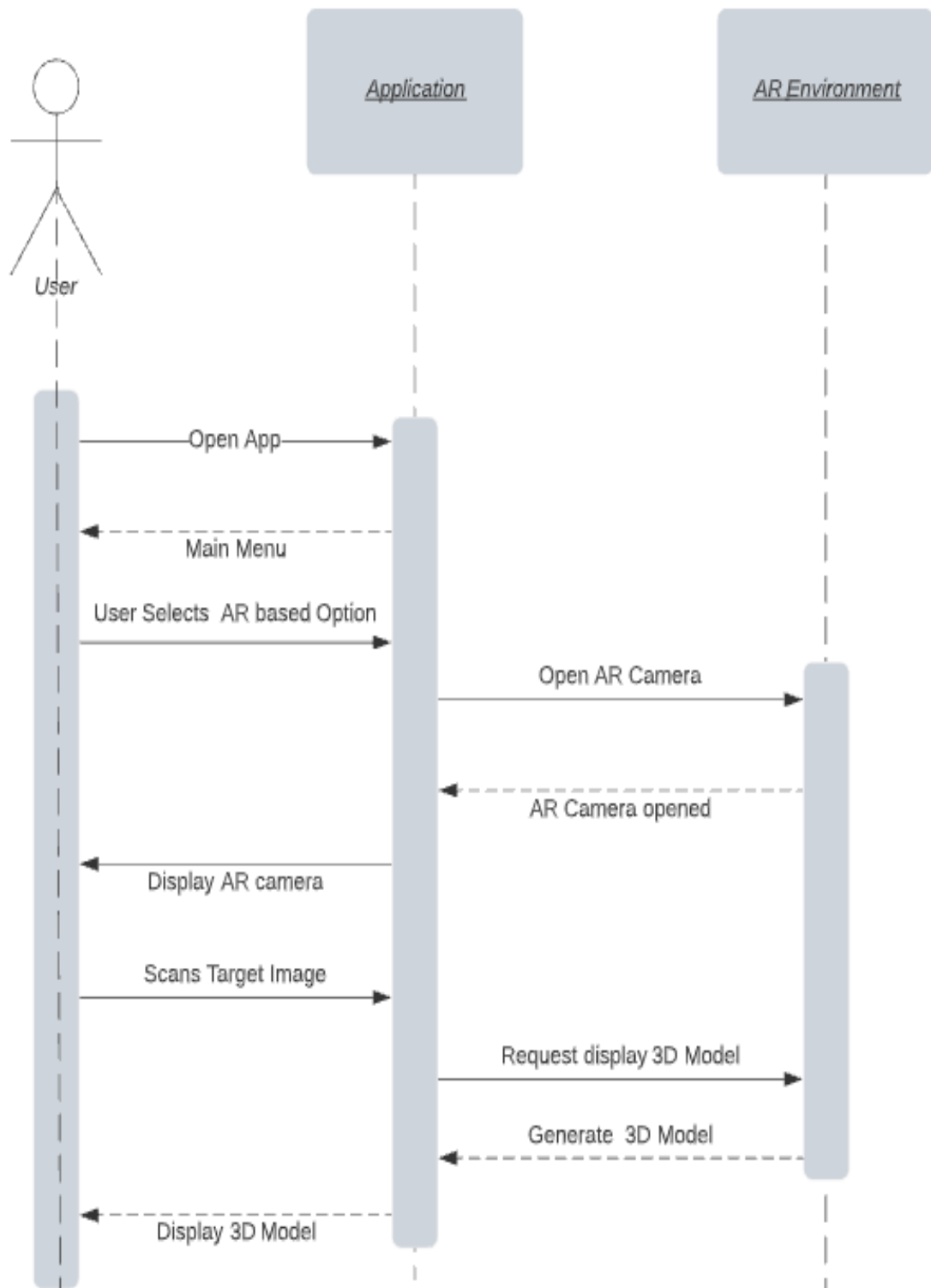The user can learn fruits and veggies by selecting this button. After selecting the button, Vuforia AR camera will open. The user will scan the target image with this camera from book. Upon successful scanning the relevant 3D model of a fruit or vegetable will pop out on the screen with sound.

### 4.4.4 Counting
The user can learn the counting by selecting this button. After selecting the button, Vuforia AR camera will open. The user will scan the target image with this camera from book. Upon successful scanning the relevant 3D model of a counting will pop out on the screen with sound.

# Chapter 5

# System Implementation

In this chapter we define the implementation of our project, tools and technology that were used for the development of the Application.

## 5.1 Tools and Technology Used
The tools used in our project are following:

### 5.1.1 Unity Engine
It is a technology used for the development of mobile Android application according to need. It provides complete environment and functionality that provides ease for the development of our project.

### 5.1.2 Vuforia
Vuforia is an Augmented Reality Software Development Kit (SDK) for Augmented Reality applications. It is a web-based database to store target images which are later used in unity.

### 5.1.3 Blender 3D
We used Blender 3D for making 3D models of Urdu letters (Haroofs), Urdu counting (Ginti), fruits and vegetables.

### 5.1.4 Inkscape
Will be usable for creating SVG Images and writing Urdu text.

## 5.2 Language Used
The main language used for this application is C Sharp (C#). To create the splash screen, main menu screen and add functionality on buttons. Unity 3d has its own IDE called Mono Developer which compiles the C sharp scripts.

## 5.3 System Architecture
A System architecture describes how a system is implemented and become to the reality so that it can be useful by the public. We created a mobile application based on Augmented Reality for making kids learn the Basics of Urdu language. These basics include joining letters, breaking letters, fruits, veggies and counting. This application will provide a platform where kids can learn the Urdu language basics by also visualizing them.

First, we created SVG files of Urdu text, fruits, vegetables, counting words and digits using Inkscape. Then 3D models of the Urdu text, fruits, vegetables, counting words and digits were created on Blender 3D. First the SVG created on Inkscape were imported to Blender 3D. Then Scalable transformation function was applied to change the size. Then the Extrude function was applied to transform the SVG 2D model into 3D model. Then the materials were applied to change the colors of 3D models.

Then we created the user interface (UI) of our application using Unity Engine. This UI

includes the Splash Screen, the Main Menu Screen with buttons and AR camera screen with buttons of our application, which will be used by users to interact with the system. Then in-order to add functionality to the four AR based buttons, Database was created using Vuforia web-based database service. Then the Target images from our book, which were created using Inkscape and MS-word were stored there. After the creation of 3D models and 2D images, these were imported to unity scenes in-order to add functionality to the four AR based buttons. The 2D target images were added to unity by importing the Device target database of Vuforia and the 3D images were then set on these target images by importing them in the assets folder. Then sounds were added to the target images in Unity.

## 5.4  System Components

Our system consists of different components. These components help the kids to learn different things in Urdu. The components are listed below:
- Joining Letters (Haroof Joor)
- Breaking Letters (Haroof Toor)
- Fruits, Veggies (Phal, Sabziya)
- Couting (Ginti)

# Chapter 6

# Testing

In this chapter we are testing our project according to the requirements.

## 6.1 Selecting Testing Methodology

For the testing of our project, we have followed the Test-case based testing method. Each test case that is mentioned below is thoroughly checked by the developers and supervisor.

## 6.2 Software Testing Technique

Software testing is a process to make sure that Software does what It should do. Its functionality is compared against the specifications for assurance that it is secure, correct, verified, validated. Testing of software is a branch of software quality assurance and in this branch a software being made is thoroughly analyzed for the purpose of finding errors and fixing them. Below is the list of testing which is performed.

### 6.2.1  White Box Testing

In white box testing the tester must look inside the code and should have detailed knowledge of each components working and how  they are integrated with each other. Knowing the whole inside structure is essential for him/her to find any abnormalities in the program. White box testing is also called glass box testing as glass is see through and so is the case with a program in white box testing. Its synonym is open box testing, transparent box testing, structural testing, logic driven testing and design-based testing.

### 6.2.2  Black Box Testing

In case of black box testing, the tester will not have any access over the software coding. The tester can't view or access the code of the program so, there is no question of changing the code. Tester can only have the access     to the inputs and their respective outputs obtained after being  processed.

### 6.2.3  Unit Testing

Unit testing is focused on the smallest element of software design like modules or software components. The complete structure is divided into different levels. It makes heavy use of white box testing. All the testing on each component is done independently.

s

### 6.2.4  Performance Testing

Performance testing is testing the stability and response time of an application by enforcing load. It is non-functional testing. This type of testing  measures the quality attributes of the system. It is done to provide information about products like speed, reliability, stability etcetera.

### 6.2.5    Acceptance Testing

Acceptance testing is done to make sure that software completes all the requirements specified in SRS. It is the last stage of testing and conducted when a software is developed for a specific customer.

## 6.3 Test Cases

Test cases are used to measure the functionality across a set of actions or conditions to verify the output. Given below are the test cases performed on project to verify the functionality.

### 6.3.1    Test Case 01: Joining Letters

Given below is the test case for button 1, Joining Letters.

**Table 6.1: Joining Letters**

| Test Case ID | 01 |
|---|---|
| Description | Open the application |
| Initial State | Application is running |
| Requirement | Right light condition |
| Pre-Condition | User must select Joining Letters |
| Input | After selecting Joining Letters, the camera will open and user will place camera against target Images in book |
| Expected Output | 3D model will appear on successful tracking |
| Actual Output | On successful tracking 3D model pop-out with sound |
| Result | Positive Pass |

### 6.3.2  Test Case 02: Joining Letters
Given below is the test case for button 2, Breaking Letters.

**Table 6.2: Breaking Letters**

| Test Case ID | 02 |
|---|---|
| Description | Open the application |
| Initial State | Application is running |
| Requirement | Right light condition |
| Pre-Condition | User must select Breaking Letters |
| Input | After selecting Breaking Letters, the camera will open and user will place camera against target images in book |
| Expected Output | 3D model will appear on successful tracking |
| Actual Output | On successful tracking 3D model pop-out with sound |
| Result | Positive Pass |

### 6.3.3 Test Case 03: Fruits, Veggies
Given below is the test case for button 3, Fruits, Veggies

**Table 6.3: Fruits, Veggies**

| Test Case ID | 03 |
|---|---|
| Description | Open the application |
| Initial State | Application is running |
| Requirement | Right light condition |
| Pre-Condition | User must select Fruits, Veggies |
| Input | After selecting Fruits, Veggies the camera will open and user will place camera against target images in book |
| Expected Output | 3D model will appear on successful tracking |
| Actual Output | On successful tracking 3D model pop-out with sound |
| Result | Positive Pass |

### 6.3.4 Test Case 04: Counting

Given below is the test case for button 4, Counting.

**Table 6.4: Counting**

| Test Case ID | 04 |
|---|---|
| Description | Open the application |
| Initial State | Application is running |
| Requirement | Right light condition |
| Pre-Condition | User must select Counting |
| Input | After Counting, the camera will open and user will place camera against target images in book |
| Expected Output | 3D model will appear on successful tracking |
| Actual Output | On successful tracking 3D model pop-out with sound |
| Result | Positive Pass |

# Chapter 7

# Conclusion

Our project idea served in the mobile application domain in which we created an Augmented Reality based E-learning application for kids. This application focusses on our National Language Urdu as a teaching medium. In Pakistan the Education is not up to the mark. This application plays a vital role for kids' education as an edutainment tool. We can aware our kids about this newly  trend and develop their interest. Moreover, now a days everything keeps shifting online due to the SOPs of pandemic. It is very difficult to make children learn effectively in online system. This application provides an environment which develops the interest of young kids, and they can study enjoyably at home during online sessions.

By using this application teacher would be able to assist their child in learning through new and better way in which they'll be educated and have enjoyment at the same time. Using this technology,  the  possibilities  are endless,  and  it  might  can  even  replace  libraries.  Mostly  E-learning Augmented  Reality  apps  on  the  play  store  are  currently  using  English language as the learning method but now we can change that as we used our local language Urdu throughout the application.

## 7.1 Future Work

Every system has its pros and cons while keeping in mind that no system is perfect. So, despite that the members of this group would like to work further more on this project so that we can make this application even better, flexible, and as responsive as possible so that it can meet user expectations also the members can improve the learning in this field of work. More and more trackable books can be developed for the display of learnable 3D objects for kids moreover the children can have the experience of what they are learning in the real world.  We would like to implement further functionalities like more list of languages so that the application can be used by a child of any local region. Moreover, we would also like to add 2,3,4 words Joining (Joor) and Breaking (Toor) Letters (Haroofs) to the application. We would also like to embed the tracing module in the  application in the future. We can also add story/poem telling with AR in the application.

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