

# **Augmented Reality Application For Smart Phones**

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## **Certificate**

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS (CS).

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## **Dedication**

We dedicate this project to our parents without their support and guidance we would never have been able to complete this project.

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## **Acknowledgements**

We are highly indebted to our supervisor Ma'am Saima Jawad who helped us shape this project out in its proper form .From the inception of this project she was always the source of guidance and lent us our support on every problem we faced. We would like to express our utmost gratitude for her support in completing this project.

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Last but not the least dedicated to my nephew and niece who gave us the idea to pursue this project and always appreciating whichever small milestone we achieved.

## **Abstract**

Educational mobile applications are widely developed but they lack the interactivity hence providing rigid learning experience by providing total virtual environment. Augmented reality applications help to bridge the gap between virtual and real world thus providing a more natural and appealing learning experience especially for children.

The main motivation behind this project is to develop an augmented reality based application for smart phones. The application provides children augmented reality environment with tasks to complete and interconnecting a story with the tasks. The application reads patterns and provides tasks related to it. The tasks include alphabets detection and simple numeric characters detection. There are User Interface objects to select the answers.

The necessary augmented reality functionality is provided using the Vuforia platform.

The main objective is to utilize augmented reality to enhance the learning experience and interest of the children in basic skills development. This application is intended to be the platform for the development of educational mobile applications with visually appealing Augmented Interface elements.



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# **Chapter # 1**

## **Introduction**

## **1.1. Overview**

This project is about building an Augmented Reality based interactive application. This application will help in highlighting the benefits of interactive augmented reality in the field of education and also the effectiveness of augmented reality in imparting more unambiguous knowledge.

This application reads patterns of alphabets and then adds a layer of virtual content containing 3D models in the view of camera, hence giving users (children) more realistic look. The virtual buttons are triggered by bringing the finger in front of camera to the location of their placement in the environment of the user. Pressing the buttons apart from user input, and also changes the virtual content.

## **1.2. Problem Description**

The purpose of making this application is to deal with augmented reality in real time environment. Augmented reality is a field with great potential with the ability to the change the perspective of our lifestyles in all domain most of all in education. Augmented reality is under progress is the reason we have choose to develop this application.

Because of the blended reality, AR can move learning from the formal to the informal and has the potential to move mobile technology from social and recreation activities to learning and education. This project will focus on innovation that can be achieved with augmented reality in educational fields developing interactive books. Educational experiments can also be shown in real time environments. It can be used in medical studies to give more realistic learning experience. Its industrial uses can be harnessed in many fields such as designing magazines using augmented reality. Big stores can design their products with augmented reality giving customers more realistic demonstration of their products.

Game based learning has grown in recent years and research demonstrates that is an effective learning tool.

### **1.3. Objective**

The objective of the project is to design a real time interactive augmented educational application for smart phones using 3D modeling. The application will teach children the English alphabets with more immersive and close to reality experience. The user will read alphabets image patterns in camera view which will place virtual content in the live camera feed of user and user will be able to see the content from different angles and close-ups like there are live models placed in front of the user. Pressing the button will take user to the task related to the alphabets in which user will have to select one of the two models. The project is intended to lay the base for more augmented reality applications for education.

### **1.4. Project Scope**

This project does not deal with the marker less augmented reality. This is a single user application and this system is not providing user defined image target option. This application is only for the android users.

This project targets the smart phones applications market giving an interactive environment which can be used in enhancing leaning of children. The application can be used for the demonstration of any concept with more visual clarity and reality.

# **Chapter # 2**

## **Literature Review**

Augmented Reality (AR) has been around for some years. It is one of the most promising technologies which are expected to take over in the near future. Augmented reality allows realistic visualization of contents to users by superimposing them on the real world [1]. It has inspired many applications for game, advertisement, education, navigation, medical and industrial sector. With widespread use of handheld devices and Smartphone, AR on mobile phones has recently become very attractive and strongly demanded in the mobile application market and industry.

Augmented reality enhances user perception of and interaction of the real world. The virtual elements display information that user can not directly detect with her own senses [2].

The most innovative aspect of augmented reality is not the technology; it is the objective. Instead of replacing physical objects with a computer, we create systems that allow people to interact with the real world in natural ways and at the same time, benefit from enhanced capabilities from the computer.

Augmented Reality (AR) technology is capable of addressing the challenges of virtual reality (VR) by superimposing virtual objects onto the physical world, in which the users can interact with virtual and real objects using their hands directly compared with VR systems [3].

### **2.1. Augmented Reality Basics**

The term augmented reality is used for overlaying virtual information on top of real world adding AR element to applications can enhance the realism and impressiveness. Technically speaking augmented reality is the combination of physical spaces with digital spaces in semantically linked contexts for which the objects of associations lie in the real world [4].

Augmented reality has the following three characteristics [5]:

- It is a Combination of real and virtual.
- It has Real-time interactivity.
- It has three-dimensions.

Augmented Reality is a crossover between the real and virtual world, as illustrated by Paul Milgram's famous Reality-Virtuality (RV) continuum diagram shown below [6]:



Figure 2.1-1 RV Continuum

The basic workflow of augmented reality is shown below [7]:

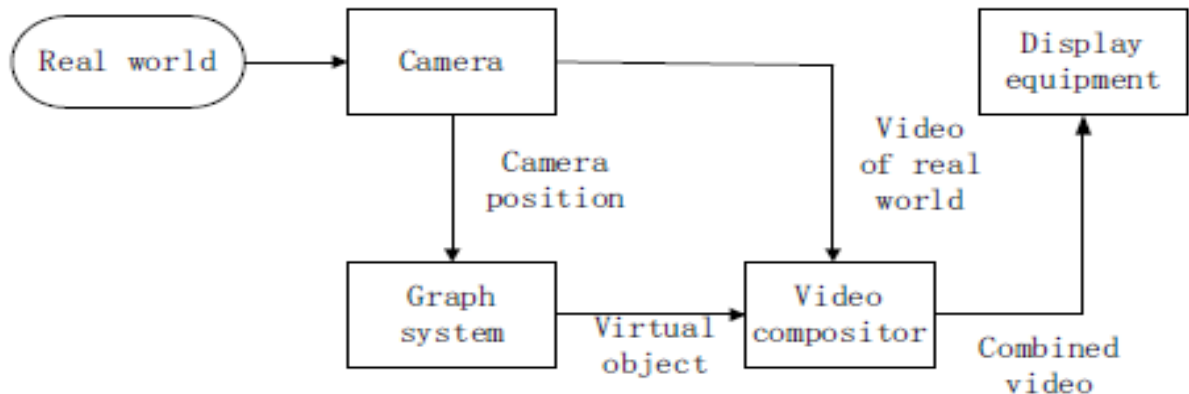


Figure 2.1-2 Workflow of Augmented Reality

There are mainly two types of augmented reality:

- Marker based Augmented Reality
- Marker-less Augmented Reality

It is further divided into two classes:

- Marker less vision based
- Marker less GPS based



Marker-less AR typically uses the Global Positioning System (GPS) or digital compass feature of mobile devices to locate and interact with surroundings. The information gathered is then superimposed on the camera view of the mobile device providing enhanced view of the environment to the user.

Marker based relies on marker sometimes a Quick Response (QR) code but the technology has developed to deal with pictures the device camera is used to gather information about the QR code or the picture which is analyzed and the model or information related to it is displayed. User can move the device to view the virtual model in different angle.

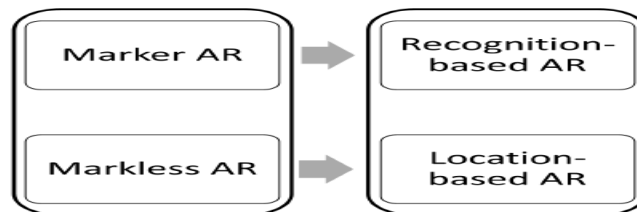


Figure 2.1-3 Types of augmented Reality

Augmentation is mainly of two types:

- Augment the user

Obtain information about the physical objects, the user wears or carries a device.

- Augment the environment

Augment the environment surrounding the user and the object neither the user nor the object is affected directly. Instead, independent devices provide and collect information from the surrounding environment, displaying information onto objects and capturing information about the user's interactions with them [8].

Given the potential and futuristic appeal, it has the power to be widely used. Currently AR is being employed in varied areas of implementation.

Augmented Reality (AR) superimposes generated virtual objects onto real world images. It appears to the user that the rendered objects supplement reality and coexist in the same space. The virtual world should be properly aligned to the real one to produce this illusion.

Augmented reality technology is very interesting and interactive and therefore there is a vast range of potential applications of Augmented Reality (AR) such as in the field of medicine, manufacturing, urban planning, architecture, archaeology, education and many more [9] [10] .

Nowadays with the rapid developments in web and mobile computing technologies AR will further enhance the learning experience. There has been a debate going on the use of mobile devices for e learning Augmented reality is found to be very effective in the field of teaching and this can be used to build interest of students and young children to the study concepts which are Imaginary and are difficult to understand [1]. The project is to develop an interactive mobile augmented reality application based on the best learning practices and merging the two concepts of Augmented Reality and mobile.

## **2.2. Domains of Augmented Reality Applications**

Some of the broad Domains in which the augmented reality applications fall are:

### **➤ Education**

AR for education is emerging providing interactive augmented contents to the user, and with the availability of portable devices with cameras and wireless technology this content can be easily accessed providing more in depth view of visualize able concepts.

### **➤ Advertisement and Marketing**

Marker based AR technology used for presenting virtual products to the customers the customers can get more detailed information about the product they are buying.

### **➤ Travel and Tourism**

Location based services using AR Technology giving the user the information about the vicinity on the camera view of their screen.

Some of the other applications provide translation facilities for the written text.

### **➤ Entertainment**

Innovation brought by the augmented reality to field of games is revolutionary. It brings the gaming environment to the real world out of the virtual world. Just imagine characters moving on your desk or table to imagine the charm of augmented reality.

### **➤ Medical**

AR technology will not only be able to enhance medical surgical and clinical procedures by improving cost effectiveness, safety, and efficiency, medical AR

systems may also assist in the invention of new surgical procedures. AR systems have potential to support surgeons with navigation and orientation before, during, and after surgery. Medical AR applications will allow for more advanced pre-operative imaging studies, letting doctors and surgeons examine a holographic view of patients internal anatomy compiled from CT, MRI, and ultrasound data. After a surgical procedure has been planned, AR systems can use streaming input data to create virtual superimposed images in real-time.

➤ **Mobile Augmented Reality (MAR) Applications**

Instances of MAR usage models and applications are already emerging. For example, Wikitude shows the potential of such applications built on Android platforms by using a combination of location, web cam and Qype content to achieve augmented reality. There are several other efforts also already investigating MAR applications.

➤ **Geo-navigation e.g. Spyglass**

Spyglass is a walking compass and GPS navigation. It shows direction arrows and distance to user's custom points of interests. Finding a needed spot later is as easy as just following an arrow pointing in targets direction [11].

➤ **Informative e.g. Google Sky map, wikitude**

This is an augmented reality app which makes learning about astronomy interesting and fun. Instead of looking at descriptions of constellations in a book and then attempting to identify them in the sky, you can use Google Sky Map to directly identify stars and constellations using the camera on your Smartphone. The app enables you to explore your surroundings using your phone's camera. It gives you access to plenty of info including Wikipedia articles, restaurants and location-based

tweets; or you can search for specific places and it will give you directions on the map view [11].

➤ **Utilities e.g. Word Lens, Augmeasure**

Word lens is an application used to translate words in the real world. The result will be displayed directly on the same place and same location on the screen. What the user sees is the language is translated into their preferred one.

Augmented reality measuring arrives with AugMeasure which lets you gauge short distances using on your phone's camera. AugMeasure displays distances (up to 30 centimetres or 12 inches) on the screen overlaid onto the live image which will change as you move the phone [11].

➤ **Sampler e.g. the Sampler by Converse**

This kind of applications usually is developed by product resellers. Customers can view the virtual object on device. The device can be rotated and transposed by moving the real marker in front of the camera. These applications bring new experience to costumers and it is a quite attractive advertisement method [11].

➤ **Heads-up Display (HUD)**

Augmented content is projected onto a surface in the real world environment so that augmented information is displayed without the viewer having to look away from their usual view point [12].

### ➤ **Mobile AR Edutainment Applications**

Augmented reality is found to be very effective in the field of teaching and this can be used in order to build interest of students and young children to the study concepts which are imaginary and are difficult to understand. Due to advancements in the mobile technology and the presence of strong mobile platforms, it is now possible to use augmented reality technology in mobiles. The users shall be able to open the augmented science book, and will be able to witness related supportive matter popping up on the screen of the mobile with 3D models, pictures and voiceovers. These augmented objects will be interactive and can be played around with.

In history and science subjects giving students more visually understandable view of concepts Users can simply rotate the marker to see different views AR in education has a major benefit above other more traditional methods of learning as it integrates creativity which can inherently gain the interest of students.

However it is not without its limitations:

Like more time to produce applications, augmented content has problems in terms of controls and complexity.

Augmented reality in educational environment is further subdivided into:

### ➤ **Training**

AR training applications provide step by step instructions to guide user through completing a complex task with virtual information helping them to identify targets and improve decision making. Most systems employ a head mounted display so that the user's hands are free to perform tasks such as the BMW workshop application.

### ➤ **Discovery Based Learning**

In Discovery Based Learning users are able to find their own route to achieving learning goals and augment the learning experience by accessing virtual information at their own initiative. This category often involves handheld devices, for example, the Google Sky Map.

### ➤ **Educational Games**

The few educational augmented reality experiences that have already surfaced on smart phones have been “windows to the past”, offering users an opportunity to discover the hidden history of the landscape, buildings and environment during field trips.

### ➤ **Creating 3D models**

AR has also been used in education as a visualization tool helping students bring 3D models to life.

### ➤ **Augmented Books**

The 3D book is a form of electronic book displayed on a screen which can flip to the next page. The pop-up feature of a book has been designed to increase children’s interaction with the AR media. The AR pop-up object is intended to enhance children’s engagement. The learning deepens with the emphasis possible with AR bringing the book to an enhanced life. The difficulty of combining enjoyment with learning can never be underestimated. It is complex to achieve and extremely valuable when it occurs. AR assists this process and taps into multiple learning styles. Work is underway to design systems to assist teachers in learning environment allowing them to obtain information from students on their current level of

knowledge and the teacher can see that information through AR equipped device providing the information close to student [13].

It is clear that there are both opportunities and challenges in integrating AR into mobile learning; however it is very clear that there is something very compelling in doing so. Studies have shown that using AR for educational purposes can appeal to students at a much more personal level, promoting both engagement and motivation amongst its users [10].

These attributes of AR helped us to work on project which embeds AR for teaching basic alphabets and numbers to children in a fun and engaging manner and hence enlighten the benefits, and push for the use of AR for educational purposes.



# **Chapter # 3**

## **Requirement Specifications**

### **3.1. System Overview**

The system is an augmented reality based learning book for children. It will provide an interactive and engaging learning experience for children for alphabets and numeric learning. The system will develop the interest of children in learning of alphabets and numeric, by providing tasks and merging the results of tasks using augmented story telling with the use of animations.

There will be a printable book containing augmented patterns. Viewing those patterns through camera view in application will present user with task to solve alphabets numeric and word puzzles in the form of interesting story of an animated character capturing alphabets which the user have to rescue by solving the task given to them on completing a task a victory or defeat animation sequence will take the story forward.

## **3.2. General Description**

### **3.2.1 Product Functions**

The general functionality of the product is given below:

- Read the target pattern through the device camera.
- Selecting correct animation/image corresponding to the read target pattern.
- Rendering the animation/image in the camera view of the user for every angle.
- Presenting a animation/image task to the user solve.
- Retrieve information from the user in the form of virtual buttons corresponding to the augmented scene.
- Display Successful and unsuccessful information according to the user results.
- Presenting user the next task in the story line

### **3.2.2 User Characteristics**

Following are the users of our application with the defined characteristics.

- Children will have Basic knowledge about smart phone touch system. They should know the desired application to run on the smart phone.
- Teachers and parents should know how to download and install android application. They should know how to run that application. They should have some knowledge of how mobile augmented applications work i.e. guiding smart phone camera towards the pattern.

### 3.2.3 User Problem Statement

Some of the problems users currently face in the android learning applications are.

➤ **Applications are purely Virtual**

Currently all these type of applications are totally virtual in nature, which gives user a constrained learning environment.

➤ **Interest**

It is hard to gain and maintain interest in a simple virtual application for long time.

➤ **Interactivity**

Current applications relying entirely on computer graphics provide a rigid unrealistic experience to the user cutting them out of the real world.

### 3.2.4 User Objectives

The objectives user is intended to gain from this project unavailable in the current educational applications are as following.

➤ **Fun to use the application**

As the intended users are children the application should not be boring it should be a blend of education with entertainment.

➤ **Realistic**

Combine reality and computer graphics to enhance the realism and impressiveness of user experience in the Augment Reality

➤ **Interactive**

In learning environment interaction with the surrounding is preferred so the system should be interactive by mixing real and virtual world.

➤ **User friendly**

The application should be easy and simple to use and provide tips.

➤ **Develop interest**

The system should build interest and keep the children engaged in learning.

### **3.2.5 General Constraint**

➤ The system is to be used on smart phones so design team should keep in mind the available memory and speed on general smart phones and design the system according to that.

➤ The Images and Animations should not be of very big size to make the rendering execution smooth.

### **3.3. Functional requirements**

The functional requirements of the system are listed below:

- a) To read the pattern.
- b) To display Images and animation against patterns.
- c) At least one animation images against each pattern.
- d) To display correct image and animation.
- e) To display Multiples animation on one pattern.
- f) To connect the tasks results for the flow of story.
- g) To read user inputs in the form of virtual dynamic buttons

h) To analyze user input and showing result animations

### **3.3.1 Reading the pattern from the camera**

➤ **Description**

Use the smart phone camera to read/scan the pattern.

➤ **Criticality**

It is highly critical it is one of the foundation blocks of the system.

➤ **Technical issues**

The target pattern is not distinct or clear.

➤ **Cost and schedule**

It is the first task in the system implementation schedule.

➤ **Risks**

- The image pattern is blurred or missing pixel data or the camera can't focus properly.
- Sharp clear pattern should be used.

➤ **Dependencies with other requirements**

Images and animation against patterns

### **3.3.2 Images and animation against patterns**

➤ **Description**

displaying the animation/images against the pattern at least one image/animation against one pattern.

➤ **Criticality**

It is highly critical it is the basic single most important feature of the system.

➤ **Technical issues**

Animation are not in a correct format.

➤ **Cost and schedule**

This task follows ‘reading the pattern from the camera’ in the system implementation schedule.

➤ **Risks**

If the animation or images or not shown the system will not move forward. So the proper images and animation to be show by the system.

➤ **Dependencies with other requirements**

- Flow of story
- User input

### 3.3.3 Correct image and animation

➤ **Description**

Display the correct animation/images corresponding to the read pattern.

➤ **Criticality**

It is critical in order to run the system properly.

➤ **Technical issues**

Animations are not in a correct format.

➤ **Cost and schedule**

This task follows ‘reading the pattern from the camera’ in the system implementation schedule.

➤ **Risks**

If the animation or images or not shown the system will not move forward. So the proper images and animation to be show by the system.

➤ **Dependencies with other requirements**

- Flow of story
- User input



### 3.3.4 Multiple animations on single pattern

➤ **Description**

Display multiple animations/images on a single pattern.

➤ **Criticality**

It is not critical but is important to keep the system interesting

➤ **Technical issues**

Ordering of animations and controlling the animations over time.

➤ **Cost and schedule**

This task follows ‘correct image and animation’ in the system implementation schedule.

➤ **Risks**

If there are multiple animations for single pattern fails the system will have to deal with extra pattern to differentiate it will make the flow of system slow.

➤ **Dependencies with other requirements**

flow of story

### 3.3.5 User input

➤ **Description**

Read input from the user on the augmented scene.

➤ **Criticality**

It is highly critical for the system as it is one of the most important task to take user input and make decision according to that and move the story forward.

- **Technical issues**  
Implementation of visual buttons.
- **Cost and schedule**  
This task follows ‘animation /images against patterns’ in the system implementation schedule..
- **Risks**  
Proper input platform for the user and this is done by implementing the proper visual buttons.
- **Dependencies with other requirements**  
Analyzing user input

### **3.3.6 Analyzing User input and showing result animations**

- **Description**  
Analyze the input from user and showing the appropriate results
- **Criticality**  
It is mildly critical for the system it is needed to take user input and make decision according to that and move the story forward..
- **Technical issues**  
Retrieving information from the visual buttons
- **Cost and schedule**  
this requirement is done after the user input requirement is completed.

➤ **Risks**

If user input is not properly read and wrong result animation is shown this result in wrong learning.

➤ **Dependencies with other requirements**

It depends on user input requirement.

### 3.3.7 Flow of story

➤ **Description**

the system is intended to mix education and entertainment in an augmented environment and lay out the task for the user in the form of story to complete.

➤ **Criticality**

it is critical for the system to be successful and provide an enriching and refreshing learning experience to the user.

➤ **Technical issues**

none

➤ **Cost and schedule**

this requirement is done parallel to all requirements.

➤ **Risks**

user gets stuck and story doesn't move forward or becomes repetitive.

➤ **Dependencies with other requirements**

It is dependent on all requirements.

### **3.4. Interface Requirements**

#### **3.4.1 Diagnostics or ROM**

Debugging information and device diagnostic data can be retrieved from the eclipse console and LogCat features. Console provides with debugging information where as LogCat handle the device diagnostic while the application is run on the Smartphone.

#### **3.4.2 Hardware Interfaces**

The system will interact with the device camera to gather the real world information

### **3.5. Performance Requirements**

Following are the two performance requirements for the system from the user:

- For optimal performance of the system it will require 1GB of ram as we will be dealing with lots of animations.
- For the system to run smoothly it should have 1.2GHz of processor so that the tasks don't take extra time.

### **3.6. Design Constraints**

Product should be used on smart phones so design team should keep in mind the available memory and speed on general smart phones and design the system according to that.

The system should be designed keeping in mind that the system will run on android operating system so should ensure the compatibility.

### **3.7. Other non-functional attributes**

The non-functional attributes of the system for it to be efficient are

#### **3.7.1 Clarity of information**

Display information and that should be unambiguous and easy to understand.

#### **3.7.2 Reliability**

The learning imparted to the children should be correct and should not teach anything wrong to the children.

#### **3.7.3 Maintainability**

Distinct patterns should be used and as much possible patterns should have multiple animation so that the system is easily maintained with less patterns

#### **3.7.4 Portability**

Design of the system should be easy to port the system to ios in future.

#### **3.7.5 Extensibility**

The system should cater for the additional patterns added in future and that they can keep the flow of story providing more task hence learning.

#### **3.7.6 Reusability**

The design of the system should be generic so that other story books on the same line can be launched for children by changing the tasks list.

### **3.7.7 Application Compatibility**

Application should be compatible with the jelly bean and above operating system

### **3.7.8 Interface design**

The interface should be perceptible to use and help the user find the desired function fast

### **3.7.9 Response time**

The system should be fast to read the patterns and respond to user inputs.

### 3.8. Operational Scenarios

#### 3.8.1 Use Case 1: Setting up the Camera

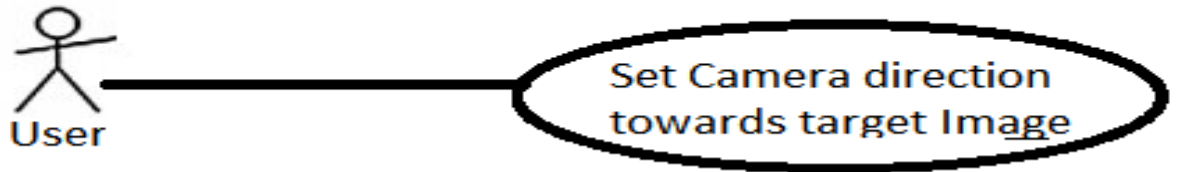


Figure 3.8-1 Use Case for setting up the camera

<b>Title</b>	Setting up the Camera	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	User will set the camera direction towards the target image so that camera will read the target image.	
<b>Trigger</b>	User will start the application and turn camera direction towards target image.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Camera is started successfully by the application.
	3.	Camera read the pattern.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Error in starting the camera
<b>Special Requirements</b>	Nil	
<b>Assumptions</b>	Camera is pointed towards the pattern. The camera should be right angle to the pattern.	
<b>Pre-conditions</b>	Application is started.	
<b>Post-conditions</b>	Main menu is displayed.	

3.8-1 Use Case Setting up the Camera

### 3.8.2 Use Case 2: Main menu

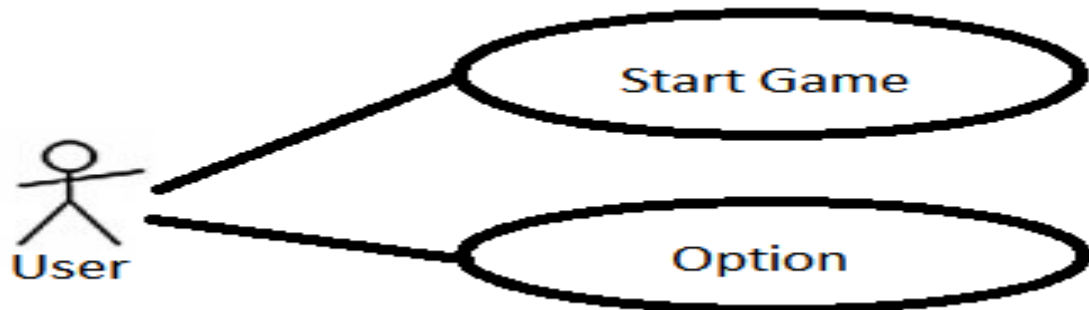


Figure 3.8-2 Use case for main menu

<b>Title</b>	Main menu	
<b>Version No.</b>	1.0	
<b>Actors</b>	Users	
<b>Description</b>	User will start the application. Main menu is displayed on the screen. User will select from the menu what to do next.	
<b>Trigger</b>	User will chose the start game option to play the game or chose options for settings.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Main menu is displayed
	2.	System will read the user choice by buttons correctly
	3.	System will respond to user choice.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Augmentation not displayed.
	2	User input not detected.
<b>Special Requirements</b>	NIL	



<b>Assumptions</b>	Camera is directed towards the pattern
<b>Pre-conditions</b>	The application is running.
<b>Post-conditions</b>	Respond to the user choice.

Table 3.8-2 Use Case Main Menu

### 3.8.3 Use Case 3: Learning from Animation

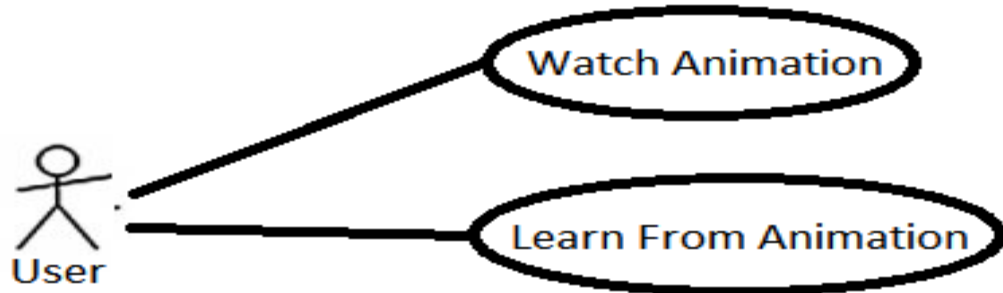


Figure 3.8-3 use case for learning from animation

<b>Title</b>	Learning From Animation	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	After reading the target image, the application will show the target resources on the screen. The user will watch the target resources and try to learn things from the resources. The resources are designed in a way to provide an interactive learning.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Correct Animation/Image is displayed.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Animation/Image is not displayed.
<b>Special Requirements</b>	Nil	
<b>Assumptions</b>	Camera has read the target image correctly.	
<b>Pre-conditions</b>	User has selected the start game option.	
<b>Post-conditions</b>	Task is displayed	

Table 3.8-3 Use Case Learning From Animation

### 3.8.4 Use Case 4: Task

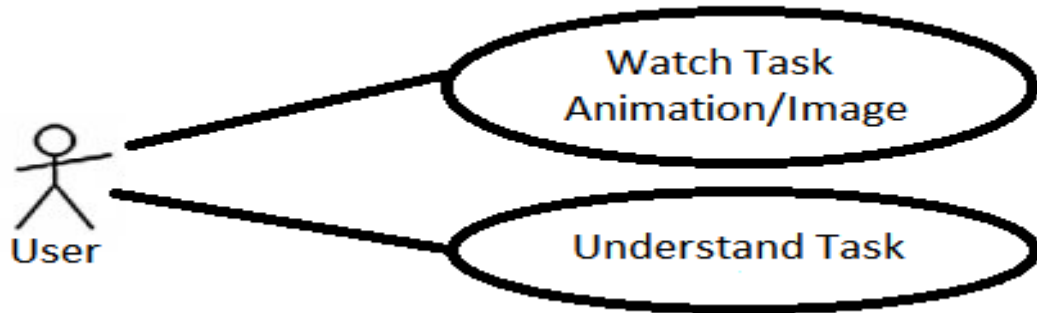


Figure 3.8-4 use case for tasks

<b>Title</b>	Task	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	The task is given to the user in form of animation or image. The user will understand the task.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Correct task is displayed.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Task is not displayed
<b>Special Requirements</b>	Nil	
<b>Assumptions</b>	Correct task is displayed	
<b>Pre-conditions</b>	User has learnt about this from the animation.	
<b>Post-conditions</b>	User will give input	

Table 3.8-4 Use Case Task



### 3.8.5 Use Case 5: Input



Figure 3.8-5 use case for input

<b>Title</b>	Input	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	After task is displayed the user will give input to solve that task.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Virtual Buttons is correctly placed for input.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Virtual Buttons is not placed.
<b>Assumptions</b>	Correct Task is displayed	
<b>Pre-conditions</b>	Task is displayed	
<b>Post-conditions</b>	Result animations are shown.	

Table 3.8-5 Use Case Input

### 3.8.6 Use Case 6: Result

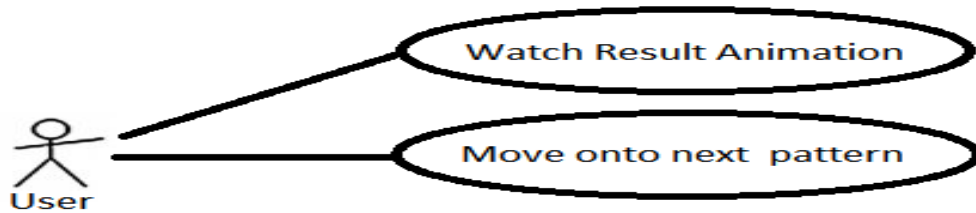


Figure 3.8-6 use case for result

<b>Title</b>	Result	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	After the task is done by user, the user’s input is analyzed and the results are produced. If the user gives the correct answer the user will get some points and if the answer is not correct the user will have a choice to retry the task. After completing the task the user will go onto the next level by replacing the target image with the next one.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Analyze the user input correctly.
	2.	Proper Result animation is displayed
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Not correctly analyze the input
	2	Result animation is not displayed
<b>Assumptions</b>	User has given the input.	
<b>Pre-conditions</b>	User has given the input.	
<b>Post-conditions</b>	Move onto Next pattern	

Table 3.8-6 Use Case Result

### 3.8.7 Use Case 7: Options

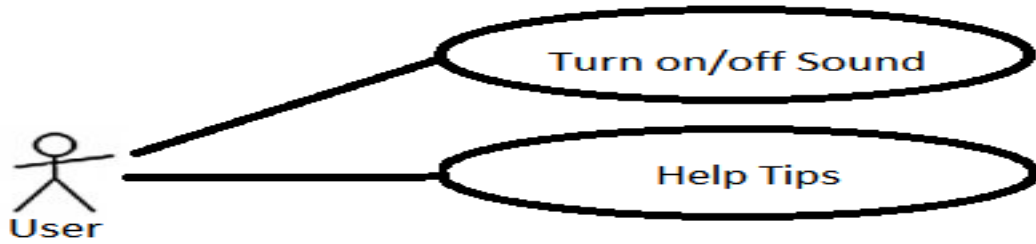


Figure 3.8-7 use case for options

<b>Title</b>	Options	
<b>Version No.</b>	1.0	
<b>Actors</b>	User	
<b>Description</b>	There are some options provided for the users. The user will turn on/off the sound according to his/her requirement. There are some useful tips are also provided in the options to give user a better understanding about running the application.	
<b>Trigger</b>	User will select option from the main menu.	
<b>Main Success Scenario</b>	<b>Step</b>	<b>Action</b>
	1.	Option menu are displayed for setting.
	2.	Correctly respond to user choice.
<b>Alternate Flows</b>	<b>Step</b>	<b>Action</b>
	1	Menu is not displayed.
<b>Assumptions</b>	Main menu is displayed and user select option button.	
<b>Pre-conditions</b>	Main menu is displayed	
<b>Post-conditions</b>	Respond to user choice for setting.	

Table 3.8-7 Use Case Options

# **Chapter # 4**

## **System Design**



#### **4.1. System Overview**

The idea of the system is to build interactive augmented reality application for developing the interest of children in learning. The system will provide user with an augmented story book with task placed for alphabets detection and mathematical problem for the completion of story.

System will make use of android phone with a camera. the camera to detect the pattern. The pattern will be analyzed and the animations will be generated according to that, to show user the user the virtual world on top of real world view the virtual objects will be rendered on the camera view.

#### **4.2. Design Map**

The requirement of the system is clearly known and there is very less chance of changing in any requirement so waterfall process model is used to develop the system. Requirements are gathered through surveys to school and by meeting with the teachers and parents. Unified modern language (UML) notations are used to specify the requirements. The main advantage of UML is it helps to keep a proper standard in system development process. UML helps to keep a understanding of system among the developers. It can be applied to any implementation platform. Block diagrams are made to show the basic structure of the system.

### **4.3. Design Considerations**

#### **4.3.1 Assumptions**

- User will have the Smartphone with a properly working android operating system.
- User will have the smart phone with a proper working camera.

#### **4.3.2 Constraints**

Product should be used on smart phones so design team should keep in mind the available memory and speed on general smart phones and design the system according to that.

Design team should keep in mind that the system will run on android operating system so should insure the compatibility.

For optimal performance of the system it will require 1GB of ram as we will be dealing with lots of animations.

For the system to run smoothly it should have 1.2GHz of processor so that the tasks don't take extra time.

#### **4.3.3 System Environment**

The system will run on smart phone with a camera having android operating system.

## 4.4. Architecture

### 4.4.1 Overview

The general architecture of the application follows the general pattern in alignment with the QCAR (vuforia) SDK

- a) Device camera is used to capture the real world frames.
- b) Camera frames are converted into pixel format which is passed to the tracker.
- c) Tracker deals with three main areas of implementation.
  - Tracking image targets, Multi Targets and virtual buttons
  - Detect new target patterns or track already detected patterns.
  - Handling and evaluating virtual buttons.
- d) The input from tracker is used to develop virtual world state object which uses the converted pixel frame and added virtual objects.
- e) The virtual world state object is passed to the application and the renderer.
- f) The renderer displays the augmented virtual world on the device.
- g) The application uses the virtual world state objects to keep track of user inputs(actions)

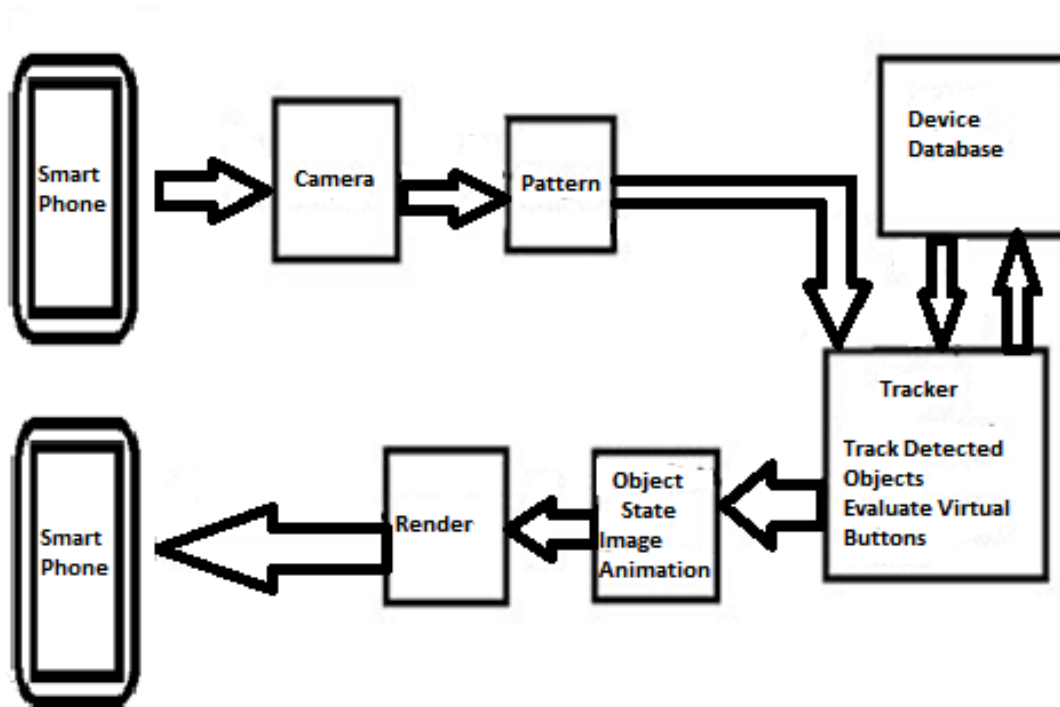


Figure 4.4-1 Architecture

#### 4.4.2 Rationale

The architecture provided above forms the core of the augmented reality application using vuforia Software development kit (SDK) as it caters all the needs of augmented reality applications.

## 4.5. High Level Design

### 4.5.1 Conceptual View

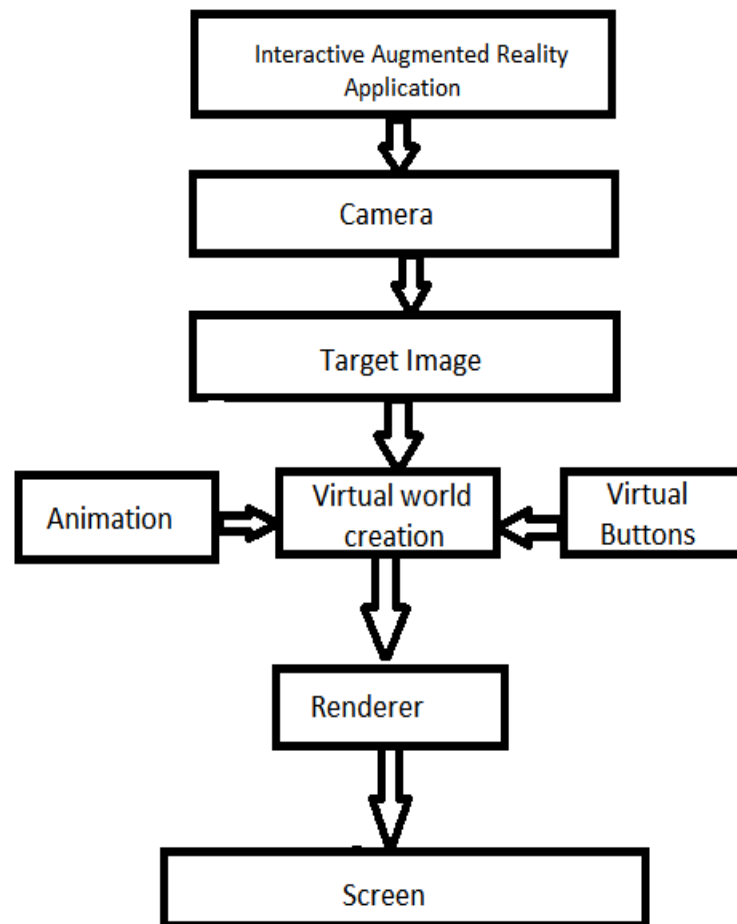


Figure 4.5-1 conceptual view

Running on the android operating system the application will use the camera resource and gather target pattern data by scanning the environment in the view of camera. The target pattern data will be used for virtual world creation which will make use of animations and virtual buttons placement databases. Virtual world creation will pass its input to the renderer to be displayed on screen. Input back from the screen will result in reconstruction of virtual world

## 4.5.2 Process view

### 4.5.2.1 Sequence Diagram 1: Reading Target Image

User will start the application. The Application runs the camera of the smart phone. The target image is placed in front of camera so that camera would read the target image. After reading the target image target resources are checked and target resources are given back to user.

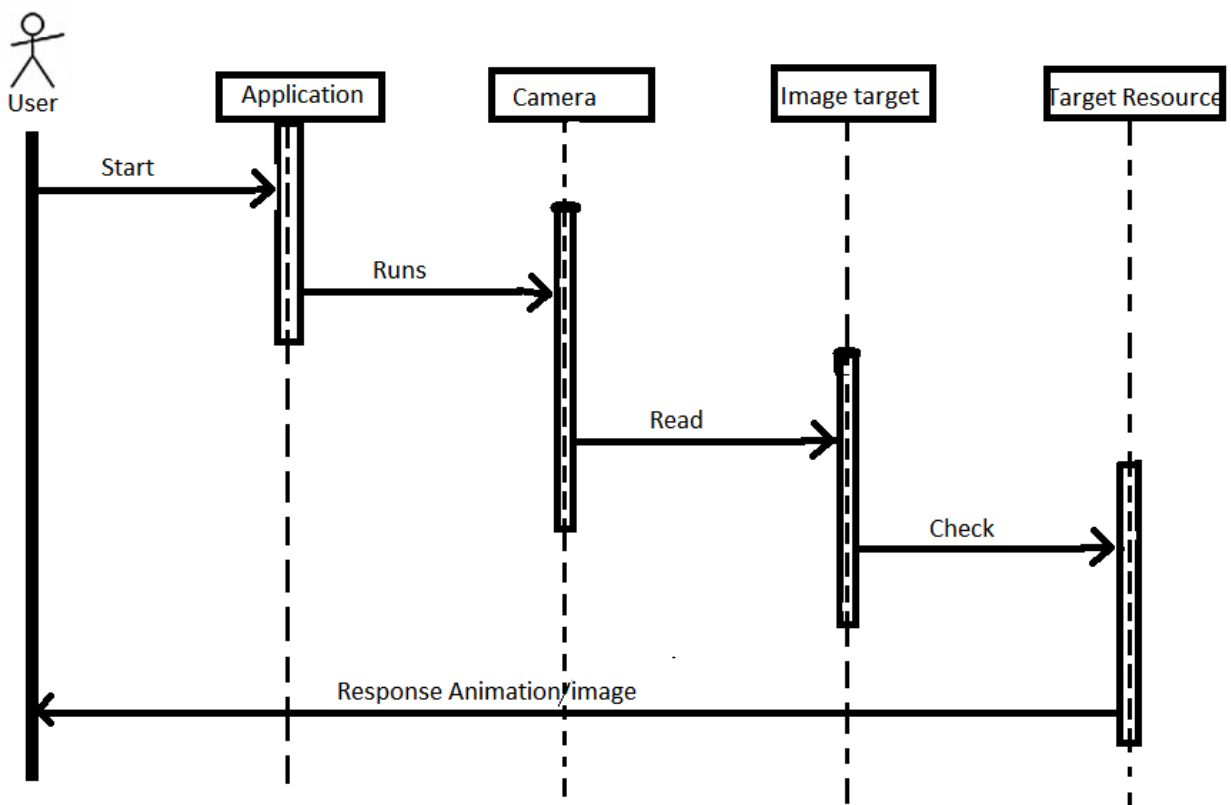


Figure 4.5-2 Sequence Reading target Image

#### 4.5.2.2 Sequence Diagram 2: Task

The animations/Images are shown on the screen as a result of reading Target Image. After the animation a task is given in form of animation/image. The user will give input through touch in the form of virtual buttons. Inputs are analyzed and as a result of the input, result animation/Image is shown on the screen of smart phone of user.

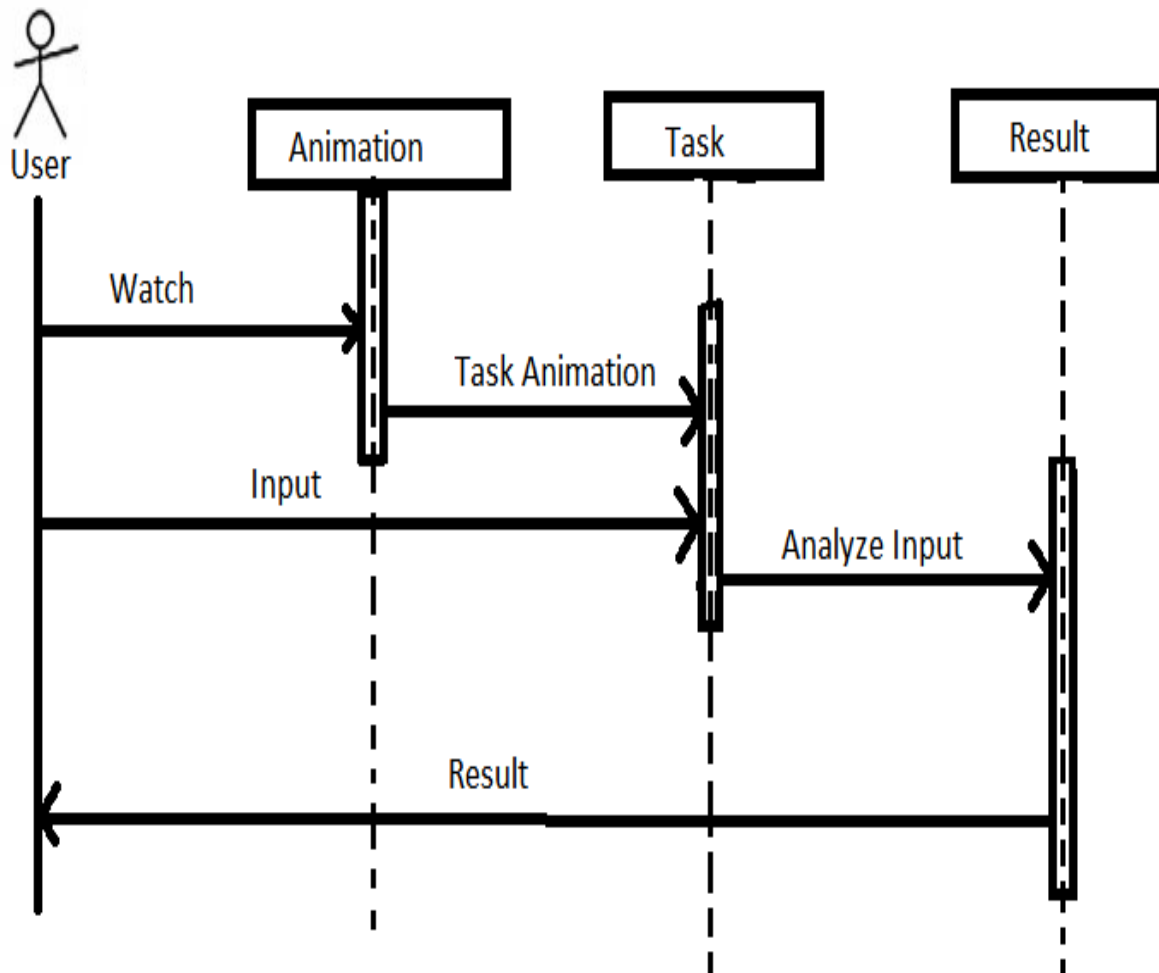


Figure 4.5-3 Sequence diagram task

### 4.5.3 Module View

Input from the surrounding is read through camera which is passed to the target pattern detection and tracking module the module coordinate with the device pattern resource database to identify the animation and images corresponding to that. Virtual world construction module uses the information from the previous module and renders the virtual buttons and animation/images on the real world view of the user. Virtual world construction module also interacts with task creation and result computation logic module and input from this module is used in the construction of virtual world as appropriate (either from task creation/result computation).

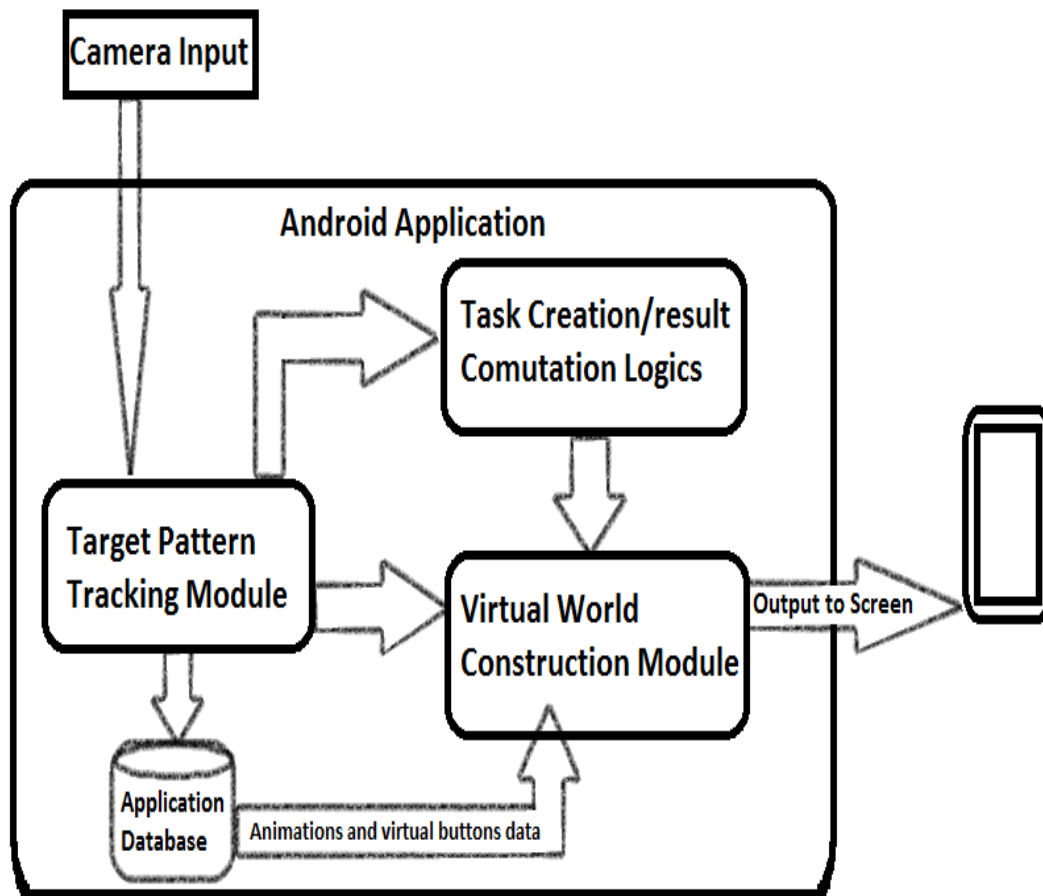


Figure 4.5-4 Module Interaction



#### 4.6. Low Level Design

As shown in the above module diagram that the main modules of the system are the following

##### 4.6.1 Target pattern Tracking Module

Analyze camera input to detect and track target pattern and match it with target resources. The module will read target pattern and scan it for pixel information through camera after getting all the frame information it will match the information in the application target resource.

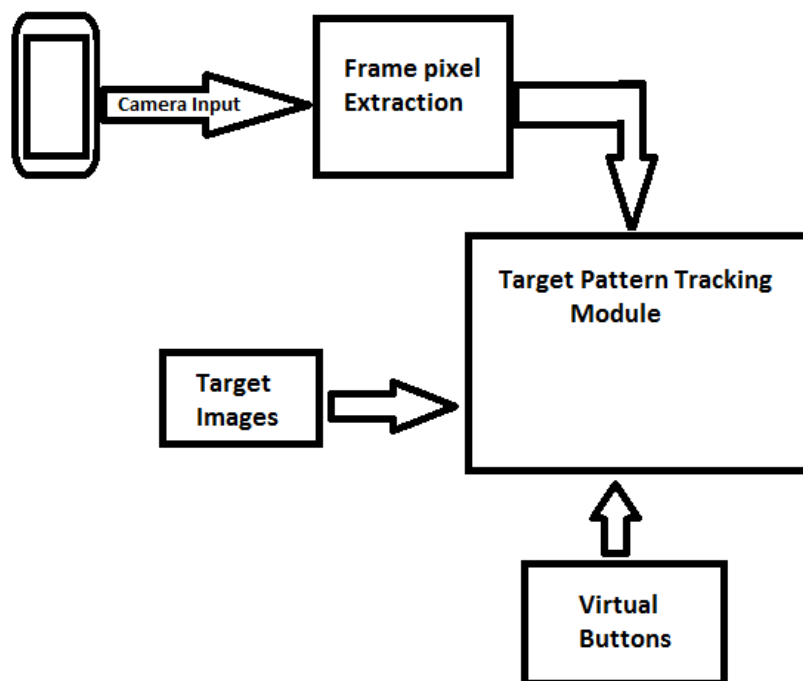


Figure 4.6-1 target pattern tracking module

#### 4.6.2 Virtual World Construction Module

The virtual world Construction module visualizes data i-e the animations and the virtual buttons related to data received from the target pattern tracking module and passes them to the screen to be rendered. It reconstructs the virtual world in case of task completion or change in data from target pattern tracking module.

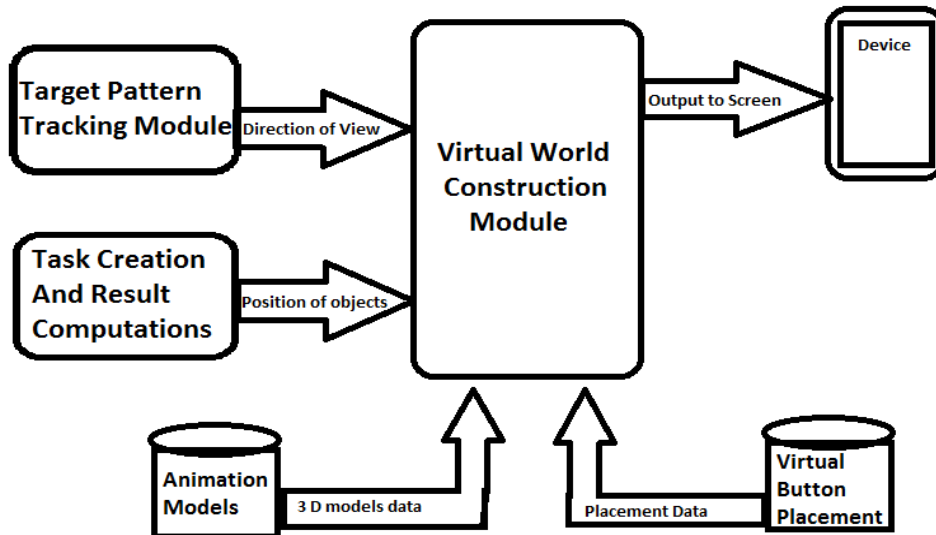


Figure 4.6-2 virtual world creation module

### 4.6.3 Task Creation and Result Computation Module

This module will deal with the creation of task for the user according to the read target pattern furthermore it will cater the result computations and the selecting animation according to the results.

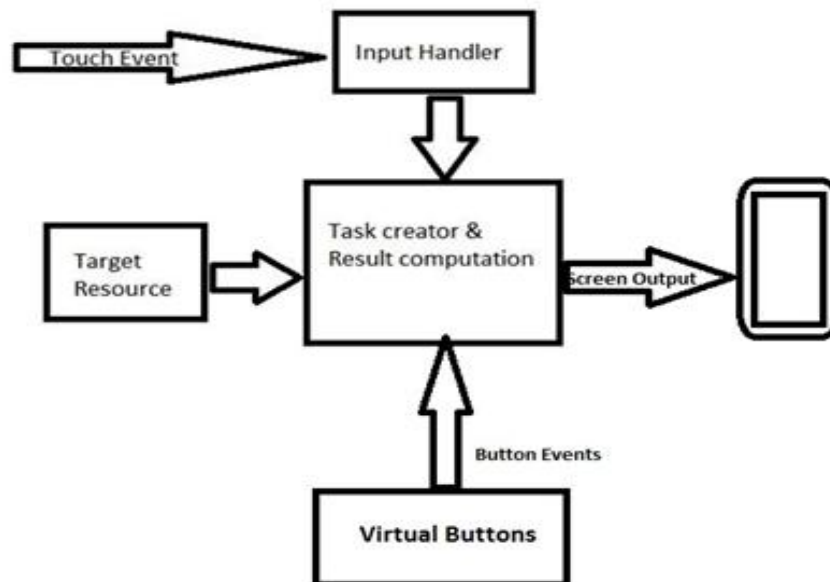


Figure 4.6-3 task creation and result Computation Module

## 4.7. User Interface Design

### 4.7.1 Application Control

- All screen displays are a mixture of real world with the virtual world. The mobile camera is on, and the animation/ images shown as a result of target image are displayed in that scene.
- There is a option menu which include option to turn on/off the sound.
- Another option is also listed in that menu to control the brightness of screen.
- In option menu there is a option of help tips. By selecting help tips user will see some tips to run the application properly.
- When animations are shown on screen, there is button on the screen to pause the animation.

- To do the task user will touch the screen on the correct place for input. The system will confirm the input through pop up displaying the message to submit the input or to retry.

## 4.8. Interface

### 4.8.1 Screen 1: Loading Image/Animation on target image

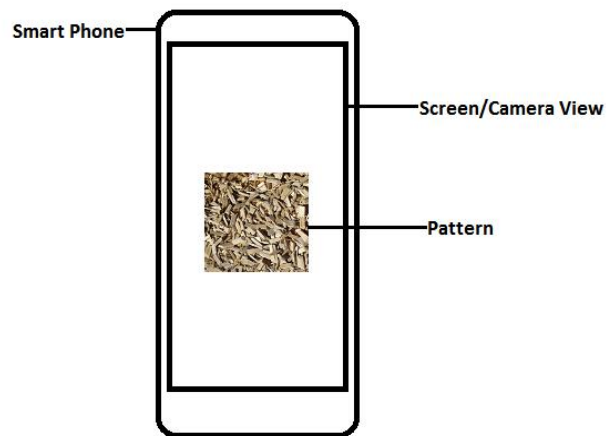


Figure 4.8-1 Screen loading Image/Animation on target Image

### 4.8.2 Screen 2: Learning From Animations

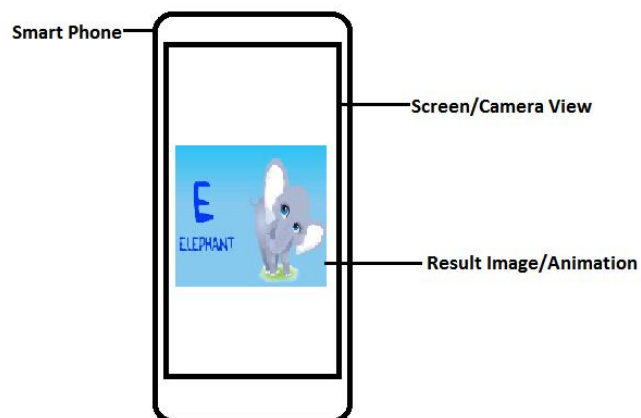


Figure 4.8-2 Screen Learning from Animations

### 4.8.3 Screen 3: Tasks

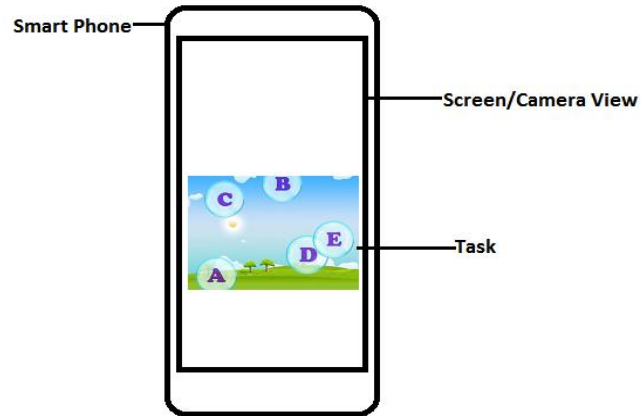


Figure 4.8-3 screen tasks

### 4.8.4 Screen 4: Options

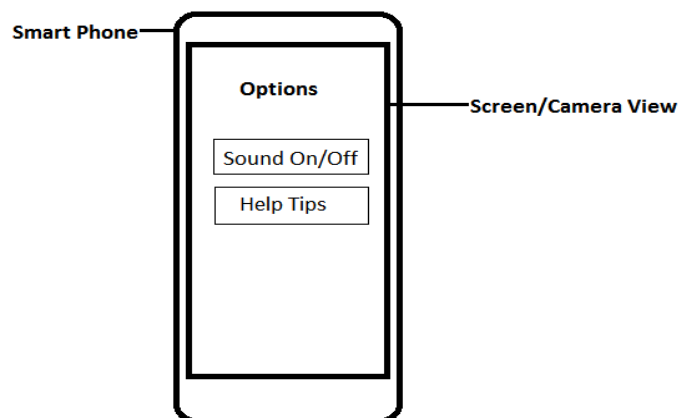


Figure 4.8-4 Options

#### 4.8.5 Screen 5: Main menu

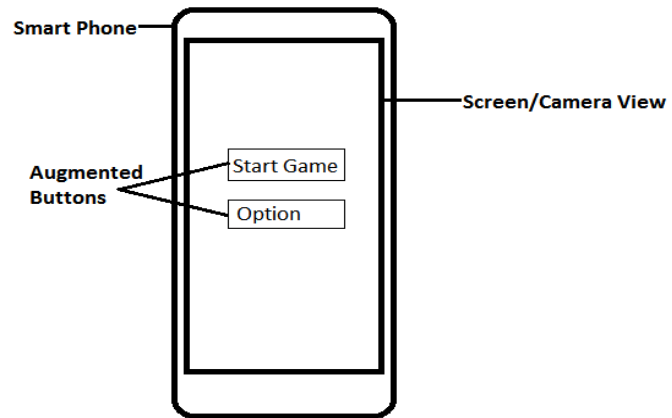


Figure 4.8-5 Screen Options

# **Chapter # 5**

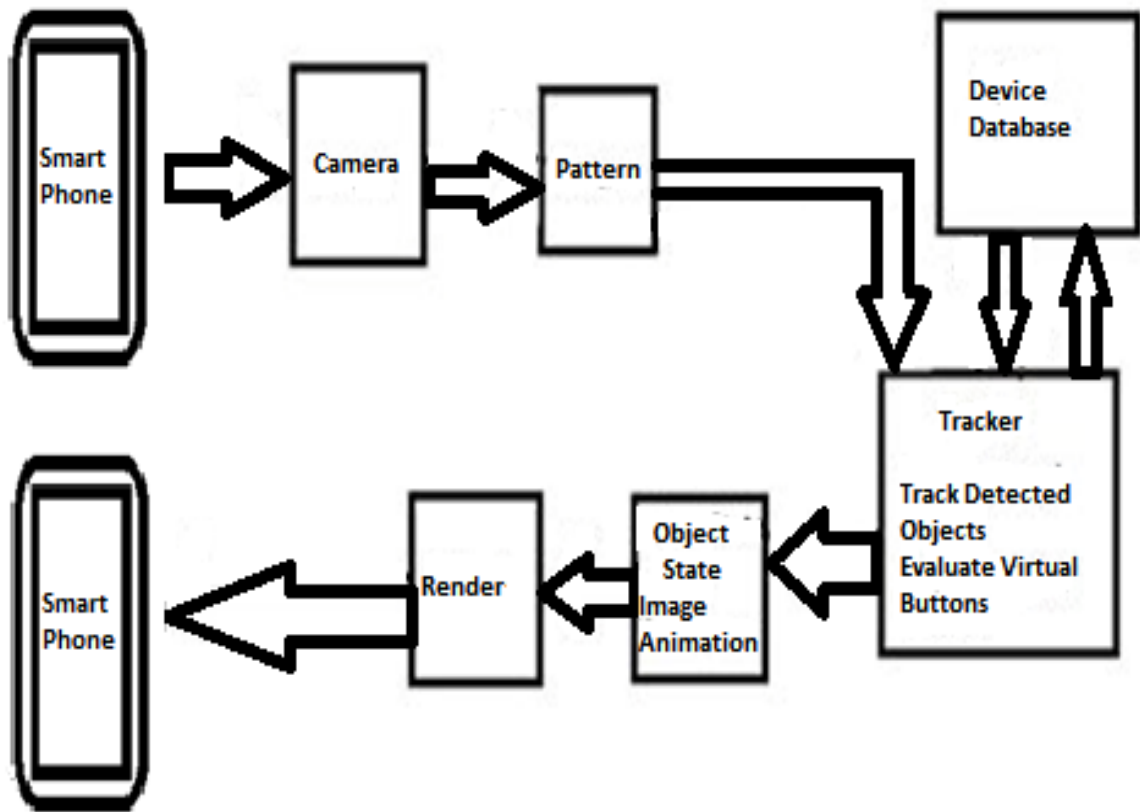
## **System Implementation**



## 5.1. System Architecture

The general architecture of the application follows the general pattern in alignment with the QCAR (vuforia) SDK

- Device camera is used to capture the real world frames.
- Camera frames are converted into pixel format which is passed to the tracker.
- Tracker deals with three main areas of implementation.
  - Tracking image targets, Multi Targets and virtual buttons
  - Detect new target patterns or track already detected patterns.
  - Handling and evaluating virtual buttons.
- The input from tracker is used to develop virtual world state object which uses the converted pixel frame and added virtual objects.
- The virtual world state object is passed to the application and the renderer.
- The renderer displays the augmented virtual world on the device.
- The application uses the virtual world state objects to keep track of user inputs (actions).



## 5.2. Tools and Technology Used

### ➤ **Vuforia Platform**

Vuforia platform served as the base for the augmentation in our application providing libraries to detect ,track image targets and then visualizing the rendering in the camera view.

AR toolkit is used for augmentation on windows application. Partial support is provided by AR toolkit for mobile applications. AR toolkit for mobile is a new tool and is under development. Vuforia provides complete package for mobile augmentation.

### ➤ **Maya 3D**

It was use to create animations of alphabets and 3D objects

Maya provides easy development functionality with easy to use tools. Maya interface is easy to understand for beginner. While 3D Studio Max is not good for beginner it is mainly designed for professional level.

### ➤ **Adobe Photoshop**

Adobe Photoshop was used to create the images. These images are used as a target images. The camera read these target images and show animations.

Adobe Photoshop is a complete tool to draw the images. It provides large number of tools which is used for image editing. Picasa tool doesn't provide so many tools for editing. It just provides basic tools for editing while Adobe Photoshop is a compact tool.

### ➤ **Adobe Illustrator**

Adobe Illustrator is used to create Urdu alphabets.

Maya give option to import Adobe Illustrator files and do editing on those files.

➤ **Cygwin64 Terminal**

Cygwin64 Terminal was used to build the program ndk is a toolset that allowed us to implement parts of our app using native-code languages such as C and C++.

➤ **Dot net perl**

Dot net perl was used to run the script that converts 3d models to vertices array which are then used for rendering.

### **5.3. Development Environment/Languages Used**

Eclipse was used as the development environment for the application as it is widely used for the android application development. Eclipse being an integrated development environment tends to offer a richer code editing experience that includes extras like wizards, debug mode and color coding, just to name a few.

The major portion of the application is written in C++ language with small portion of the application front end is written in java

## 5.4. Processing Logic/Algorithms

The images used as targets on which to render virtual content forms a database of target. The xml file of the database is read into a dataset which is used for image detection using vuforia functions in the C++ code and virtual button declaration. Each image is given a name. In the rendering function dataset returns the read image and the virtual buttons are added to the list of trackables and new virtual button created on runtime. Control flags are used as the means to control the direction of execution and changing animation for a single image target. Task flags are used to relate task to their corresponding image target and replace the leaning animation with the task animation.

```
TaskFlag=0
Load trackerdata()
    Detect image tracker
    Create dataset
    Select dataset
Rendering()
    Dataset.gettrackable

    If(trackable.getname==(alphabets,numbers)&&taskflag<=4)
        State= trackable.getname;
        If(state!= trackable.getname)
            Reset all flags

        If Strcmp(trackable,(alphabets,numbers))
            Set vertices
            Set normals
            Set texcoord
            Set texture
            Set sound
```

if (buttonpressed)

    deletbuttonpressed

    create button

    Set taskflag

If (taskflag==1)

Alphabets and models rendering

If (taskflag==2)

Task rendering

If (taskflag==3)

retry rendering

If (taskflag==4)

Finish rendering

# **Chapter # 6**

## **System Testing and Evaluation**

## **6.1. Testing**

Software testing is any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results.

Testing is done in order to ensure that the system is meeting all its functional and non functional requirements. It is also done to determine the correct behavior of the system.

Some of our test cases are given below.



## 6.2. Test Cases

### 6.2.1 Reading the pattern from the camera

<b>Test Case ID</b>	TC_FUNCT_01	
<b>Description</b>	Testing the reading/scanning of pattern through Smartphone camera.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 1	
<b>Initial Conditions</b>	Application is installed.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Start the application.	
2	Point camera towards pattern.	
3	Verify that camera is reading pattern correctly.	<b>Pass</b>
4	Verify that correct dataset is created and activated.	<b>Pass</b>

Table 6.2-1 Test Case Reading the Pattern From the camera

## 6.2.2 Images and animation against patterns

<b>Test Case ID</b>	TC_FUNCT_02	
<b>Description</b>	Testing that the animation/image is shown.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 2	
<b>Initial Conditions</b>	Dataset is created and activated.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Verify that the animation/image is shown.	<b>pass</b>
2	Verify that the virtual buttons is displayed.	<b>pass</b>

Table 6.2-2 Test Case Images and Animation Against Patterns

### 6.2.3 Correct Image and Animation

<b>Test Case ID</b>	TC_FUNCT_03	
<b>Description</b>	Testing that the correct animation/image is shown.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 3	
<b>Initial Conditions</b>	Image/Animation shown on pattern.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Verify that the correct animation/image is shown.	<b>pass</b>
2	Verify that the correct virtual buttons is displayed.	<b>pass</b>

Table 6.2-3 Test Case Correct Image And Animation

#### 6.2.4 Multiple animations on one pattern

<b>Test Case ID</b>	TC_FUNCT_04	
<b>Description</b>	Testing that the multiple animation/image is shown.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 4	
<b>Initial Conditions</b>	Image/Animation with virtual buttons is shown on pattern.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Animation is shown with virtual button.	
2	Virtual button is pressed for next animation.	
3	Verify that the next animation is shown.	<b>pass</b>
4	Verify that animations are shown in correct sequence on pressing of virtual buttons.	<b>pass</b>

Table 6.2-4 Multiple Animations on one Pattern

## 6.2.5 User Input

<b>Test Case ID</b>	TC_FUNCT_05	
<b>Description</b>	Testing that the proper input method is provided.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 5	
<b>Initial Conditions</b>	Image/Animation with virtual buttons is shown on pattern.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Virtual buttons is provided with animation/image.	
2	Users have pressed the virtual button.	
3	Verify that the input from user is correctly read.	<b>pass</b>

Table 6.2-5 Test Case User Input

## 6.2.6 Analyzing User input and Showing Result Animations

<b>Test Case ID</b>	TC_FUNCT_06	
<b>Description</b>	Testing that the user input is analyzed correctly and correct animation/image is displayed.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 6	
<b>Initial Conditions</b>	User has pressed the virtual button.	
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	The input from user is correctly read.	
2	Verify that input from user is analyzed correctly.	<b>pass</b>
3	Verify that correct result animation/image is shown.	<b>pass</b>

Table 6.2-6 Test Case Analyzing User Input and Showing Result Animations

### 6.2.7 Flow of Story

<b>Test Case ID</b>	TC_FUNCT_07	
<b>Description</b>	Testing that the correct user input is analyzed and correct animation/image is displayed.	
<b>Applicable for</b>	Smartphone having android platform with a camera.	
<b>Requirements</b>	Functional requirement 7	
<b>Initial Conditions</b>		
<b>Step</b>	<b>Task &amp; Expected Result</b>	
1	Animation/image is shown	
2	Verify that the task animation/image is associated with the previous animation/image.	<b>pass</b>
3	Verify that the result animation is correctly displayed according to the user input.	<b>pass</b>

Table 6.2-7 Test Case Flow of Story

# **Chapter # 7**

## **Conclusion**



Augmented Reality is an interesting and exciting field to develop which served as the motivation behind developing this project. It was a new experience implementing this technology on android and develop it for the purpose of education for children.

The project was able to meet its goals. The project was successful in developing an application which gives children a more innovative and interactive learning experience.

It also came with its own sets of difficulties, we were new to android application development, lot of research was needed to understand the working of vuforia platform and concepts related to AR and multiple tools were needed for the complete development of the project. Solving them turned out to be a rich learning experience for us. By the end of our project we were able to link our academic knowledge to industrial knowledge. The project helped us enhance our skills in C++ language and use it in android application development. We were able to learn lot of new tools alongside

Our project can mainly be divided into the Marker Tracking Module, Virtual world construction module and java GUI interface

### **Further Work**

In future the project would be extended to implement the application for iOS and explore the use and implementation of AR in the other domains like marketing and higher education.

Furthermore the project is extended to multi player level and implementing a user's database where stats and results of user will be saved.

Dynamic animation loading will also be implemented in future.



# References

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