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# **3D Model House**

## **Bachelor of Science in Information Technology**

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# Certificate

We accept the work contained in the report titled “3D model house”, written by Mr. Tahir Mustafa and Awais Tariq as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Information and Technology.

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# Abstract

This project consider the skills of the field of augmented reality, it is a technology through which the view of real world environment is augmented by computer generated Elements/objects. This project describe the characteristics Of Augmented Reality systems, including a detailed discussion of different approaches of representation. The proposed idea for the system is to develop an application which will involve visualization of exterior and interior 3D houses and the conceptual manipulation of the respective models. The goal is to improve presentations and make changes on run-time. This is planned to be achieved by using black and white markers along with other software, and Hardware support. The aspects explored are the skills and techniques required to achieve the desired goal.



# Acknowledgments

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Lastly we would like to thank our parents, who have been there for us throughout this journey; all their effort will help us gain something great in the near future, hopefully!! Their encouragement when it got rough is much appreciated and duly noted.

It brings us great comfort and relief to know that you are willing to take great measures to provide for us.

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*“We think someone else, someone smarter than us,  
someone more capable, someone with more resources will solve that problem.  
But there isn’t anyone else.”*

Regina Dugan



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# Chapter 1

## Introduction

In this age of information technology computers are playing their role in every field of life and their involvement is increasing day by day. They have proven to be faster, efficient and reliable than man in every comparable way. All the processes that were done manually are now being automated. There were times when minor changes needs a redone of project because of no automation, for any successful project change is crucial factor. Now with the passage of time it is convenient to achieve automation by using advanced techniques and tools. Augmented reality which is a domain of the field of computer science is explored and the application developed in projects aims to introduce a new way of depicting the stakeholder's idea such that the gap between the idea and its implementation itself is minimized as much as possible. Over the past decade, a solution has come to light in the shape of a new technology which is known as augmented reality.

### 1.1 Augmented Reality

“Augmented reality (AR) is a technology through which the view of real world environment is augmented by computer generated elements/objects. AR is related to a mediated reality, in which a view of reality is modified using a computer system”[1]. Augmented reality is a mixture of reality and virtual reality. Computer generated information in the form of images, videos or text is merged with the real view. The main objective of this technology is to add information and representation to a real object view and the basic idea behind this is merging the details which are computed by a computer with the details of which are viewed by a person.

## **1.2 Virtual Reality**

Virtual reality (VR) can be defined as computer generated environment. By computer Generated environment it is meant that a person viewing the virtual environment can completely interact with the environment in terms of sight, hearing, and touch and in some cases smell and taste too. The most recent up to date virtual reality environments are displayed either on a computer screen or with special stereoscopic display device.

## **1.3 Marker Based Augmented Reality**

In this project the techniques of marked based augmented reality is used. A marker based augmented will visualize the design through a camera phone. With AR markers when triggered device searches for a specific pattern or an image in the real view and merges the computer generated information against that specific pattern in the real view. Moreover, markers are printed and place on the specific points in the real view.

## **1.4 Project background**

Currently augmented reality technology is not well known in the market of Pakistan. But AR technologies would potentially benefit design modifications and refinements due to the support for viewing the design. In domain of architectural designs blue prints are use which are very complex and difficult to understand. Nowadays, AR technology has been brought into the field of education, entertainment, e-commerce etc. This application is an Illustration of (3D) models for planning and designing phases by using augmented reality which will result in displaying model house and their respective interior.

## **1.5 Project Objectives**

The main objective of this project is to create an android based application using augmented reality which will benefit users and the real estate market. This allow users to visualize 3D model houses to enhance and improve user experience and conformance

## **1.6 Project scope**

User can view different dimension of the 3D virtual object such as the front view, side view and back view of the model by rotating the model (markers).The application includes the functionality of zooming, rotation, dragging of 3D models. The device on which the application will be deployed must support Android. The application will visualize exterior and interior of 3D model (houses and their households) of specific markers. The

Architectural companies can Implement this augmented reality application for virtual 3D representation of their model houses or interior planning for customers.

## **1.7 Problem Description**

Augmented reality is still not carried out as a real output in the field of architectural design although it actually matured from certain practical industrial applications. This showed that Augmented Reality has had a relatively slow transition into the architecture design sector.

Nowadays, people usually take out their time and look for the model house situated far from city, On the other hand, in the industrial design field, some of the designers have used sketches with pen on paper to explore and evaluate early concepts. This is usually drawn in 2D hand sketch. In this case, if the exterior and interior architectural design is present in hand sketch, designer often encounter situations in which client can't view a better graphics of visualization, Hence there should have a way to let people use their mobile to view a 3D architectural design anyway and any time before it populate with the real items.

## **1.8 Project Benefit**

The intended application will benefit the real estate companies by showing their 3D architectural designs to their respective customers which will result in enhanced experience and better understanding. To summarize, these will be most benefited by this project:

- Constructor
- Architects
- Interior designers
- Graphic Designers
- Customers

## **1.9 Outline**

The rest of this report is organized as follows.



## Chapter 2

# Literature Review

In this chapter, we will identify, evaluate and interpret any work or research that has been done related to our project. It will provide help and a layout for achieving our goals. As this project involves a lot of research work so, this chapter holds a lot of significance. This chapter identify the different features extraction techniques and algorithms that can help with our project.

### 2.1 Existing Applications

#### 2.1.1 Maintenance and Repair (ARMAR)

Henderson Feiner proposed the utilization of augmented reality to help in the execution of procedural and repair area. The main goal of this research is to decide how constant system illustrations, overlaid on and enlisted with the real repaired hardware, can enhance the profitability, precision of maintenance work. Current support frameworks require even the most experienced client to see reference prints, manuals, or systems that determine strategies, segment information, and wellbeing data. This makes the maintainer continually switch their concentration from the repair region to the references and back once more. With any new innovation, there exists an inclination to apply to an extensive variety of issues and settings. The association method utilizes a progression of followed markers. A client cooperates with the framework by specifically pivoting or flipping over different followed markers in the interface territory. The framework decides the coveted communication in light of the deceivability, position, introduction, and relationship of these markers. This communication procedure acquires the upsides of marker-based following i.e. low enlistment blunder and powerful vision the creator reasoned that with these a client can figure out how to arrange the adjacent expanded controls while keeping their eyes concentrated on the repair region. As of now, such an approach could undermine the

achievement of AR applications in the support field. Rather, outline endeavors must concentrate on generally straightforward and focused on applications that give high usefulness and substantial outcomes[2].

### **2.1.2 Invisible Marker**

Hanhoon Park proposes an approach for executing marker-based augmented reality (AR). In particular, to determine the prominence of visual markers, utilization of infrared (IR) markers that are not visible to the human eye is considered. The primary thought is to utilize an extra outer camera with IR usefulness to track IR markers that are not recognizable in phone camera. Moreover is to put a visual fiducial object at where the fields of perspective of the outside camera and the phone camera are covering, which empowers the outer camera to track the geometric change between the fiducial object and the IR markers. Therefore, since the fiducial object is trackable with the phone camera, the posture in respect to the IR markers can be registered by utilizing the change. IR markers were compared with those of visual markers. The results of visual and IR markers under an ordinary lighting environment were very evident that the working conditions of the IR markers were stricter than those of visual markers as for the user it is easy and convenient to trigger the marker which is visible[3].

### **2.1.3 The Lego Connect**

The Lego Connect, an application that scans the image of product from the product manual and display the complete model of the product after attaching all the parts together the application provides maximum customer satisfaction as the customer can view the 3D model of the complete structure without having to attach the parts of the structure together. The manual can be viewed online, thus the customers can view and scan the markers from their homes and get a proper view of the product because of this they do not have to visit the store every time. Some limitations we have figured out in this application are all the features of the application cannot be accessed on desktop platform. Especially the guidance for product construction feature, as the user will have to keep on changing the positions of the web-cam. The application does not produce fair result on mobile platform. For better results a tablet or a big screen mobile is preferred for clear and accurate visualization of the model parts and the complete structure. [4].

### **2.1.4 Augmented Reality as a tool in Architectural and Urban design**

Soren S. Sorensen proposed that architectural representations through 2D blueprints or sketches is pretty old technique, also it has many limitations. To overcome these barriers and for good communication, Sorensen proposed a research on the new emerging



technologies for the interactive and attractive architectural design. Augmented reality a system that can blend virtual objects into real life, this helps us to have an experience at full scale by viewing architectural design. As the project works on location based AR. Once your camera is facing the particular area. The app would look into the database for the model of that particular location and project the model. The hectic procedure was the orientation of the model from different angels, in which the user needs to walk around the model to see it from different views[5].

## **2.2 Proposed Solution**

An android based mobile application for architectural purposes for designing and implementing an augmented reality based on town planning structure for the conceptual manipulation of models which will provide a better visualization and orientation of models. Our application will be compatible with every android smart phone. The application will not consist of using old technology (web cams) which do not provide the user with portability and accessibility of the application anywhere and anytime. The designing and training markers, marker detection, displaying models against the detected markers as well as scaling, rotation and movement of the generated markers/models, with all these functionality the application will provide a unique way of visualizing the 3D models.



## **Chapter 3**

# **System Requirement Specifications**

### **3.1 Proposed System**

The system we have proposed is going to be an android based application that will maximize customer conformance and maximize visualization by enabling the user to view the visualization of 3D model for better understanding of the ideas implementation. With AR markers when triggered it will show both exterior and interior of 3D model house, one can interact with it for interactive architectural design. The application will cover the aspects for architectural design. This will likewise put a conclusion to the contentions that occur between the developer and the user through representation of the item before buying it. The initial version of the application is expected to be on android platform and detect multiple markers at a time. The makers for this initial version will be a combination of black and white, as it is the best practice and helpful for the camera to identify, however for later versions colored and more complex markers may also be introduced as technology is getting improved day by day.

### **3.2 Existing System**

A blue print is a light-sensitive sheet, on which an architecture design is imprinted, based on the technical and design requirements of the stakeholder. Blueprints have a lot of contribution in architectural designing as they have been used from ages, constructors uses these blue print to construct buildings. The procedure permitted quick and exact reproduction of drafts utilized as a part of development and industry. The blue-print process was portrayed by light-hued lines on a blue foundation. In Blueprints everything needs to be done from scratch, even a most common model need to be redrawn again and again. Hand drawing models need extra time to be drawn as compared to the computer

generated Models. In blueprints, if at a later stages user changes the requirements, then all the working needs to be redone in order to meet the requirements.

### **3.3 Requirement Specifications**

The requirement specification refers to functional and non-functional requirements of a project. The requirements for our project are described below.

#### **3.3.1 Functional Requirements**

The following are the basic functional requirements of the application:

- 1 As soon as the application is launched the custom camera of the application should automatically be launched.
- 2 When the marker image is scanned from device's camera, the application should start scanning the image.
- 3 When a marker is detected the application should process the marker and scan for a match.
- 4 When marker match is found the application should display the respective Model against it.
- 5 In case no marker match is found the application should not display any content.
- 6 When the model is displayed the user should be able to rotate the model to properly view it from all sides.
- 7 When the model is displayed the user should be able to scale the model in order to magnify or minimize the size of the model.
- 8 When the model is displayed the user should be able to move the respective marker in order to show run-time changes

### 3.3.2 Non-Functional Requirements

The following are the basic non-functional requirements of the application:

1. *Reliability*

The application should operate reliably. Model corresponding to the respective marker should only be displayed.

2. *Timing*

The application should respond in seconds.

3. *Environment*

The application needs an environment to run for example it need proper light it cannot project right if there is low light.

4. *Performance*

The android phone should have a good processor in order to execute this application instantly

5. *Availability*

The application will be available all the time whenever the user needs it regardless of the fact that your device is connected with internet or not.

### 3.4 Use Cases

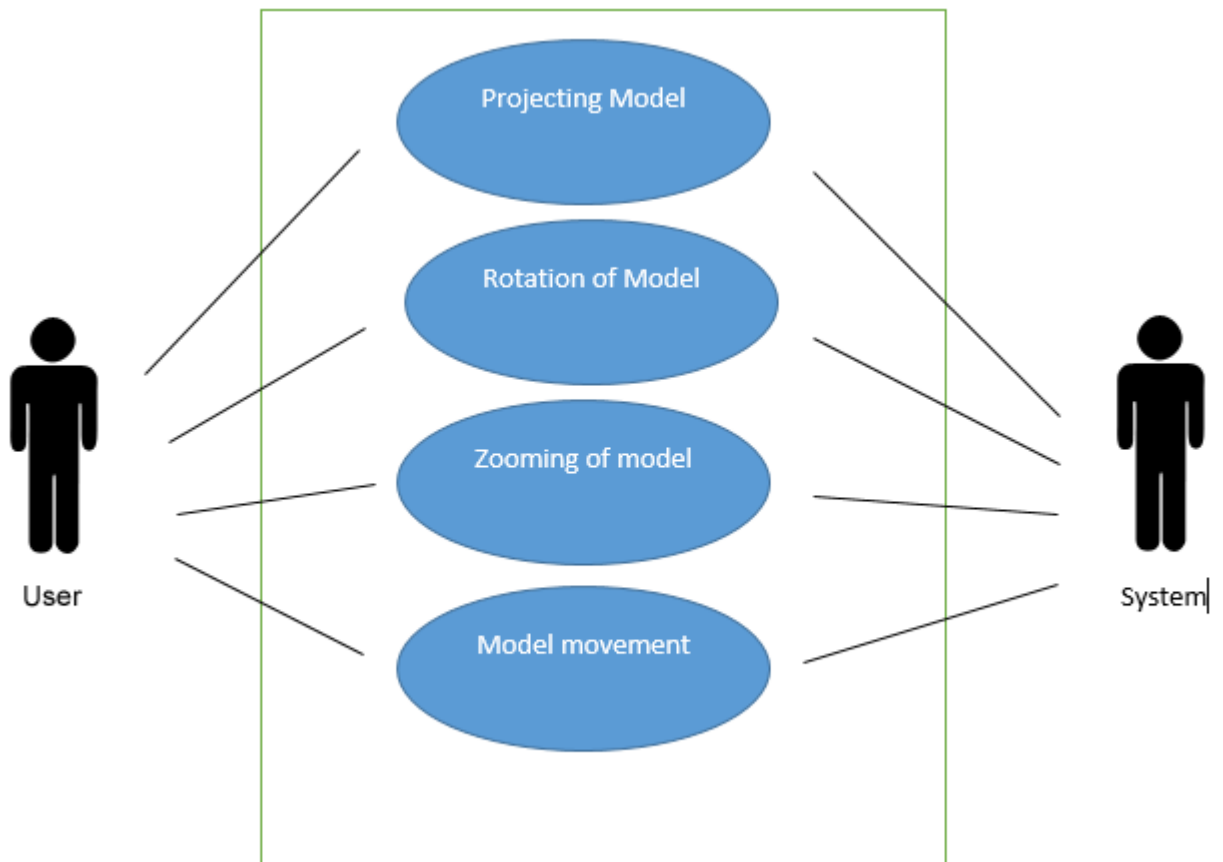


Figure 3.1: Mian Use case

The use cases of the project shows how the user interacts with the application. Given below are some use cases.

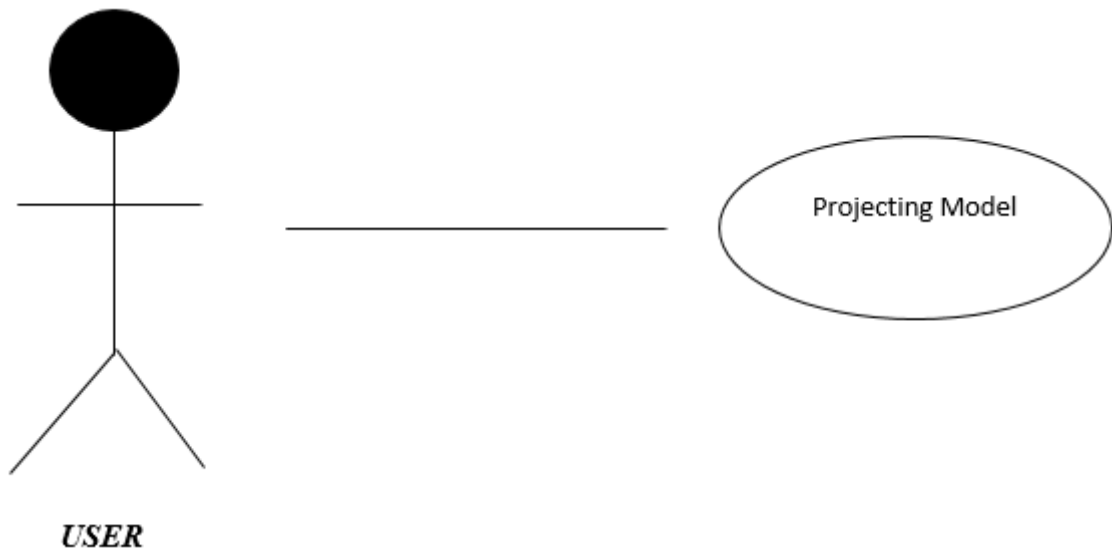


Figure 3.2: Projecting model

- The user opens the app.
- Look for a particular marker.
- Application scans the marker.
- The model is then augmented or projected on the screen.

Detail is in the Table below:

<b>Use Case ID</b>	UC 1
<b>Title</b>	Projecting of model
<b>Description</b>	Projecting of Model after scanning of marker
<b>Primary Actor</b>	User
<b>Pre-Condition</b>	Open Application named 3D model house
<b>Post-Condition</b>	Projection of the model on respective marker

Table 3.1: Use Case 1

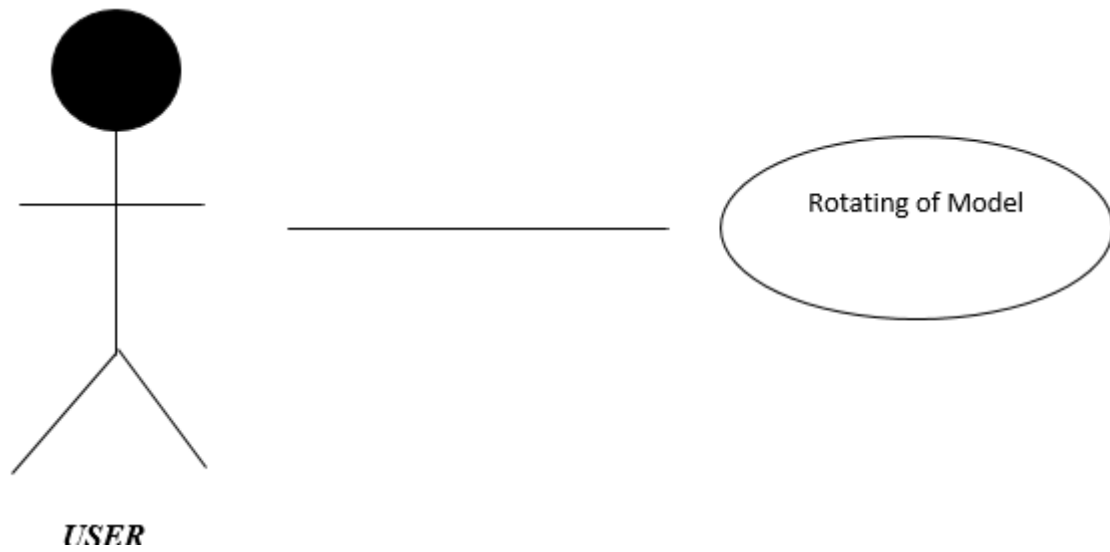


Figure 3.3: Rotation of model

- The user scans the marker.
- The model is then augmented or projected on the screen.
- The user then presses the button for the rotation of the model in circular manner.

Detail is in the Table below:

<b>Use Case ID</b>	UC 2
<b>Title</b>	Rotating Model
<b>Description</b>	Model can be rotate on different angles or can be view from different angles
<b>Primary Actor</b>	User
<b>Pre-Condition</b>	Projection of the model on respective marker
<b>Post-Condition</b>	Model can be viewed from different angles

Table 3.2: Use Case 2



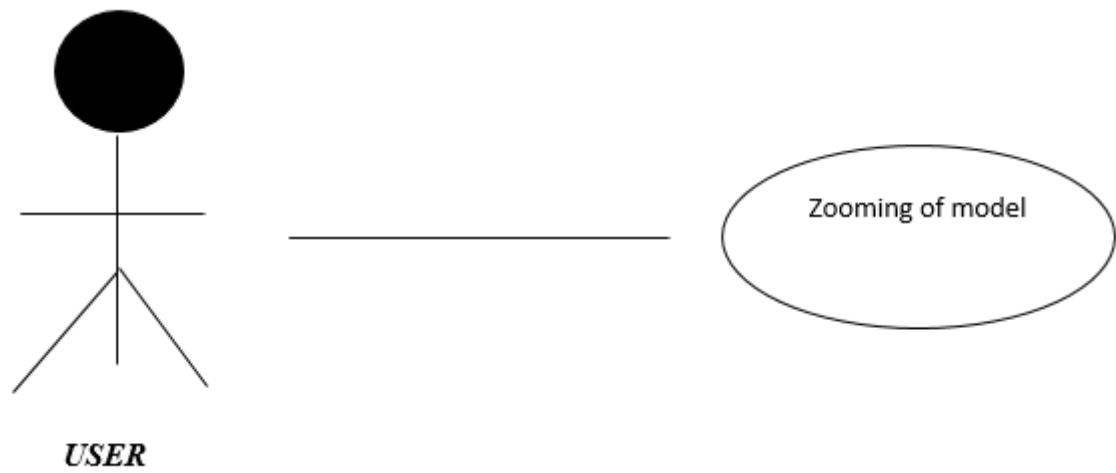


Figure 3.4: Zooming of Model

- The user scans the marker.
- The model is then augmented or projected on the screen.
- User then zoom in and out the model by pinching fingers in and out.

Detail is in the Table below:

<b>Use Case ID</b>	UC 3
<b>Title</b>	Zooming of model
<b>Description</b>	3D Model can be zoomed in or out
<b>Primary Actor</b>	User
<b>Pre-Condition</b>	Projection of the model on respective marker
<b>Post-Condition</b>	3D model will be zoomed in or out

Table 3.3: Use Case 3



Figure 3.5: Model Movement

- The user scans the marker.
- The model is then augmented or projected on the screen.
- The user then changes the position of model (or marker) according to the requirement by dragging the model or dragging the marker.

Detail is in the Table below:

<b>Use Case ID</b>	UC 4
<b>Title</b>	Movement Model
<b>Description</b>	The 3D model will be moved according to the requirement.
<b>Primary Actor</b>	User
<b>Pre-Condition</b>	Projection of the model on respective marker
<b>Post-Condition</b>	The model will be moved as required.

Table 3.4: Use Case 4

## 3.5 System Sequence Diagram

The following sequence diagrams shows how the process interact with each other and in what order:

### 3.5.1 Projecting of Model

This diagram is referring the use case UC1 in which a user starts the application and scan the marker.

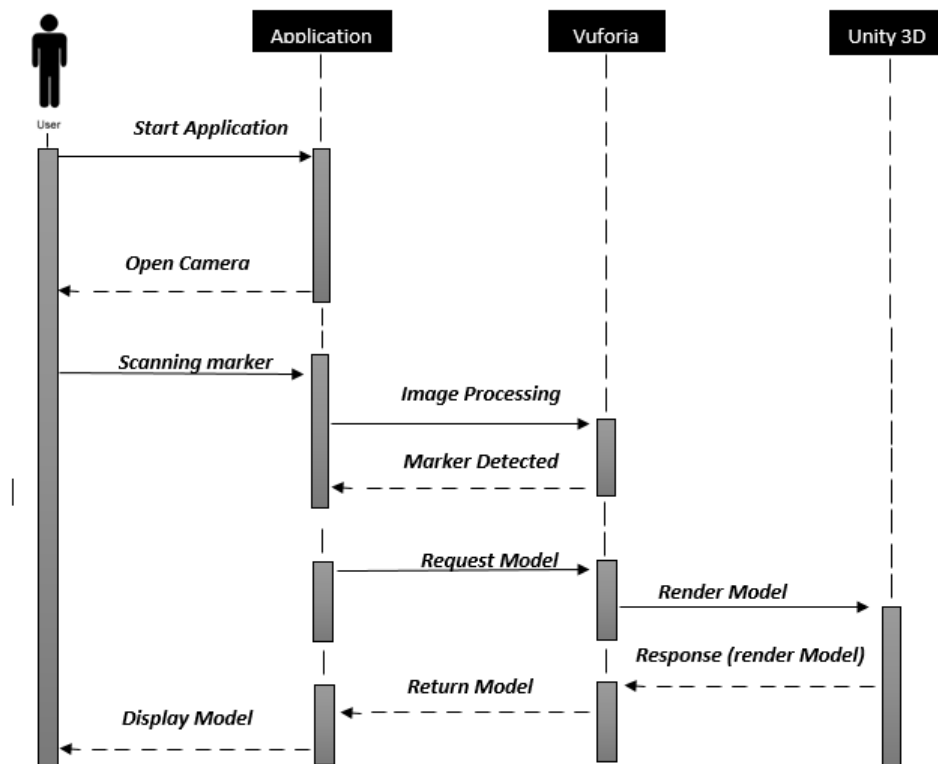


Figure 3.6: Projecting Sequence diagram

### 3.5.2 Rotating of Model

This diagram is referring the use case UC 2 in which the user presses the button for the rotation of the model.

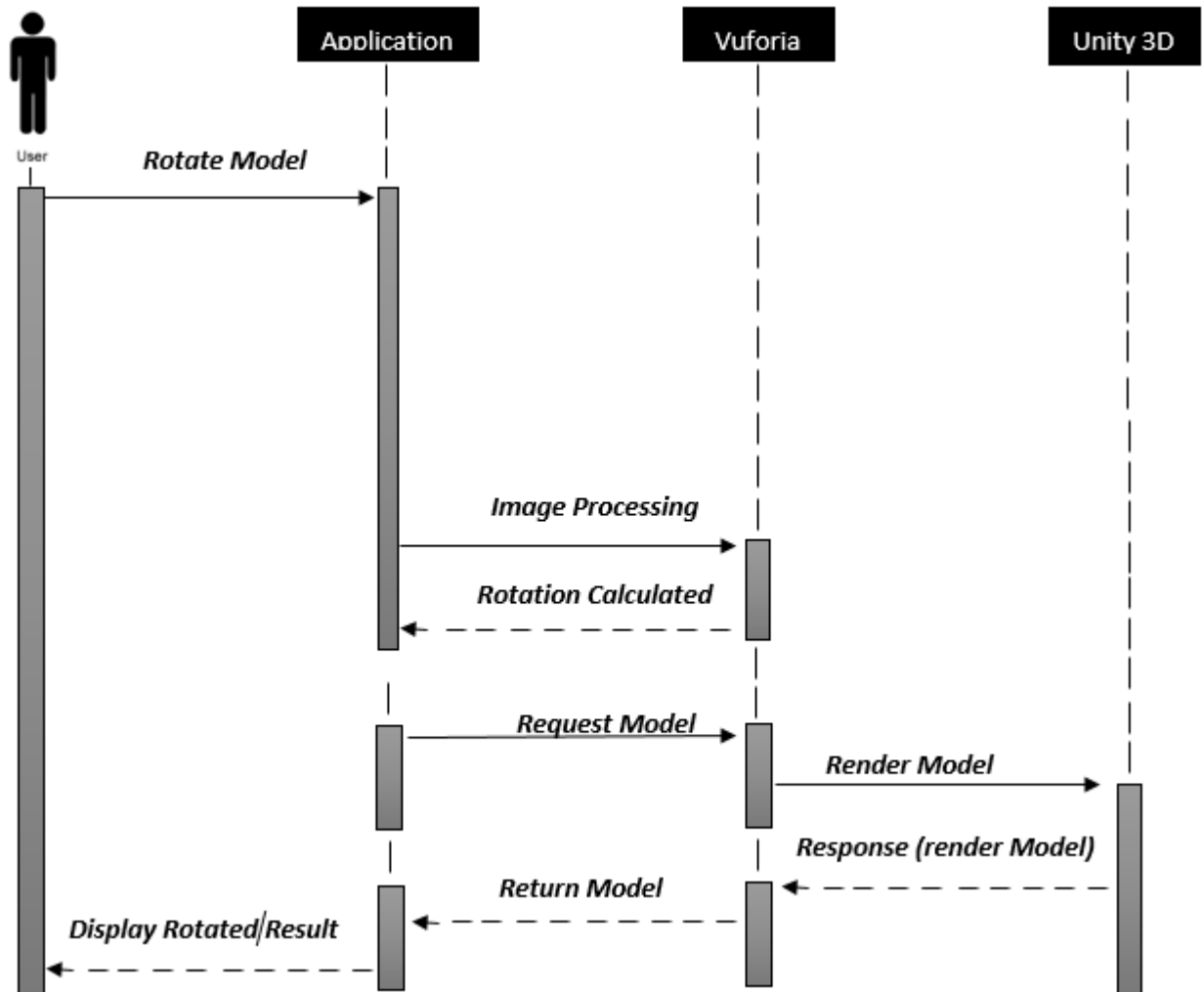


Figure 3.7: Rotating Sequence diagram

### 3.5.3 Zooming of Model

This diagram is referring to use case UC 3 in which user zoom the model by touching the model.

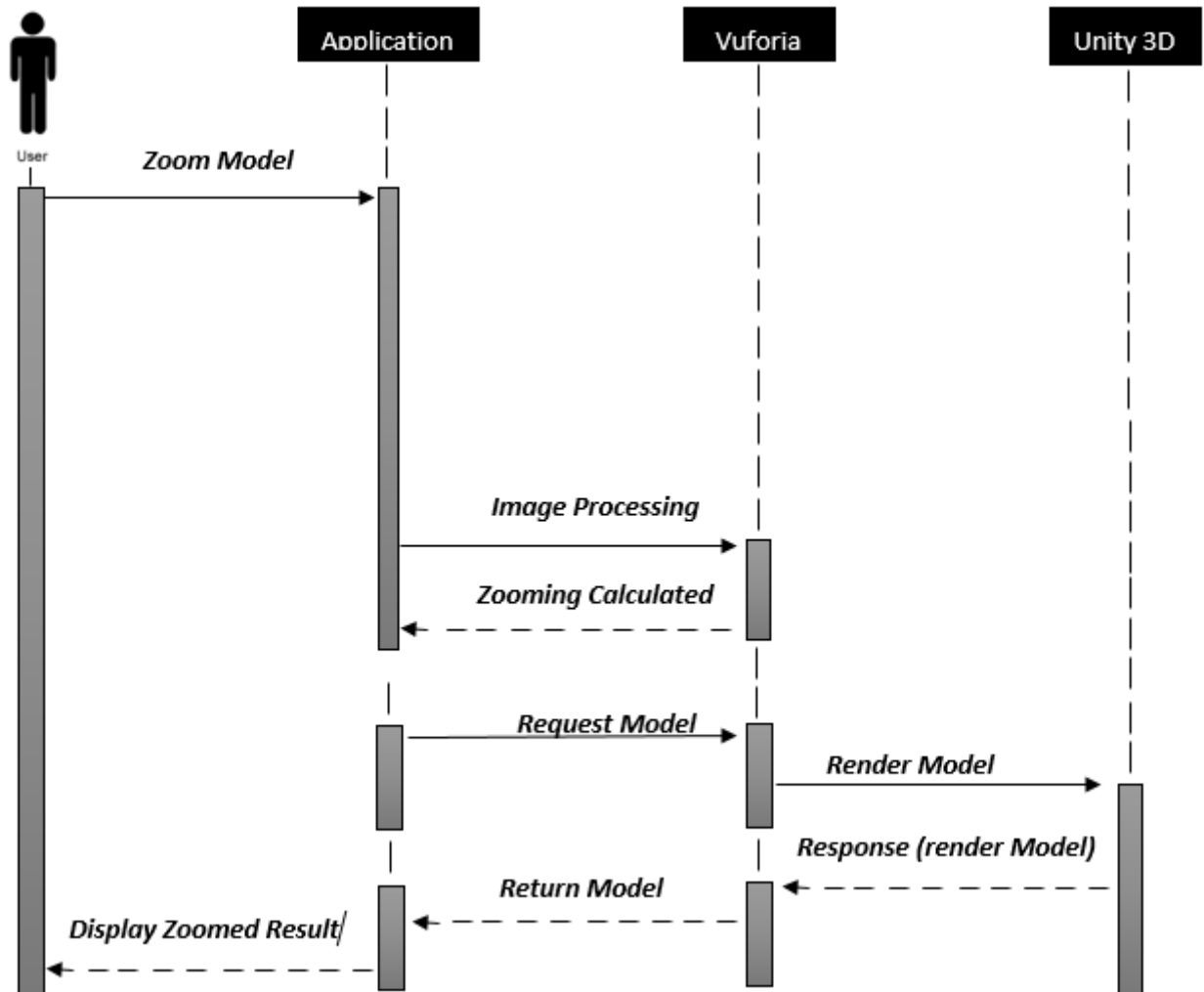


Figure 3.8: Zooming Sequence diagram

### 3.5.4 Model Movement

This diagram is referring to use case UC 4 in which the user can drag his house.

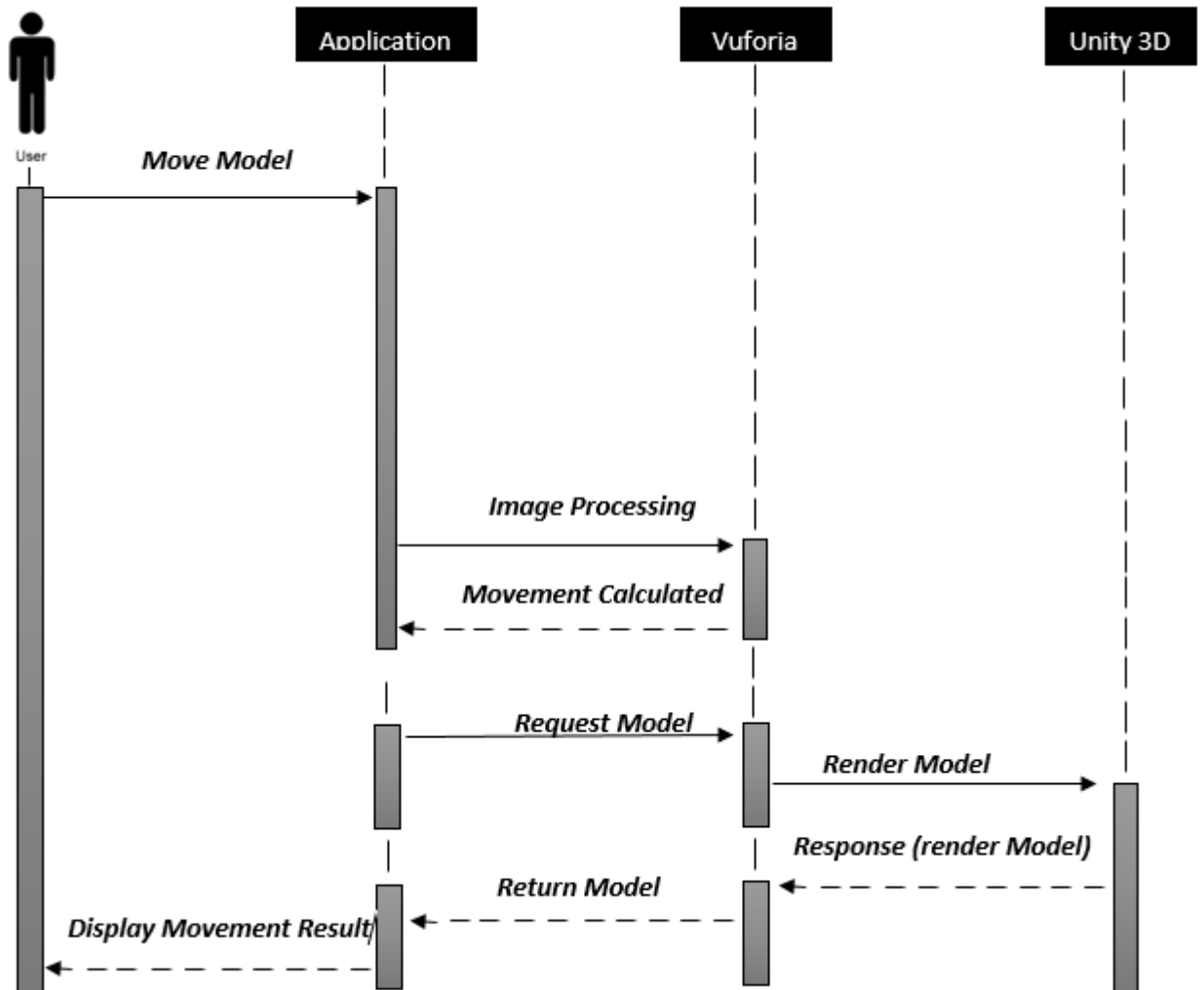


Figure 3.9: Model movement Sequence diagram

# Chapter 4

## Design

In this chapter the design and architecture of the application intended to be developed is discussed. This chapter also presents an overview of how different processes will carry out and interact with each other to achieve the final result.

### 4.1 System Architecture

The application consists of a very simple architecture design. Following steps describe how the processes defined for the application development operate on the hardware, interact with each other and achieve the final output. Architecture, components, modules and interface will be discussed in this chapter.

- Device camera provides real time viewing.
- Temporary memory for temporarily storing the video frames.
- Application of algorithms for processing the video frames and rendering Graphics.

The interaction starts with the user in which marker plays the role of input. Through the device camera we can scan the marker on real time. The libraries being used in different processes to interact with each other consist of Vuforia which provides the functionality of detecting and calculating coordinates of the markers from the live video frames provided by the android mobile camera and for creating augmented reality scene (AR scene), Unity 3D for rendering models and objects in the Augmented reality scene (AR scene). Figure 4.1 describes the complete system architecture.

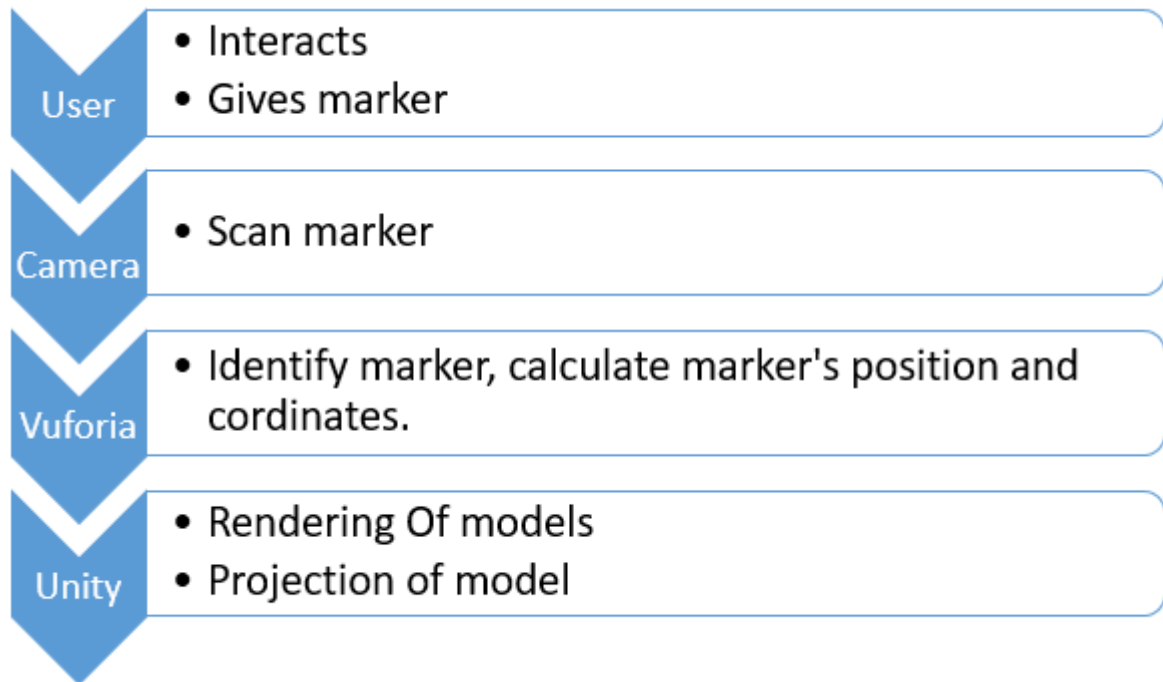


Figure 4.1: Describes the complete application architecture



## 4.2 Application Working Environment

As soon as the user launches the application he will directly interact with the custom camera of the application. He will be able to scan markers through the camera. At the point when the user will point the camera towards the marker, the application will check for any markers with in the picture showed through the camera, detect marker and show the particular substance against it, the application will also allow us to move the markers on run-time with the additional functionality of rotation and scaling. The design constraints of this project is when no marker is detected the application will display nothing, the camera will remain open, proper light is needed by the camera to detect the marker efficiently and to visualize the model. Figure 4.2 shows the working environment



Figure 4.2: System Environment

### 4.3 Design methodology

The following design methodology diagram figure 4.3 shows how the application will be deployed on hardware on android hand held device [8]:

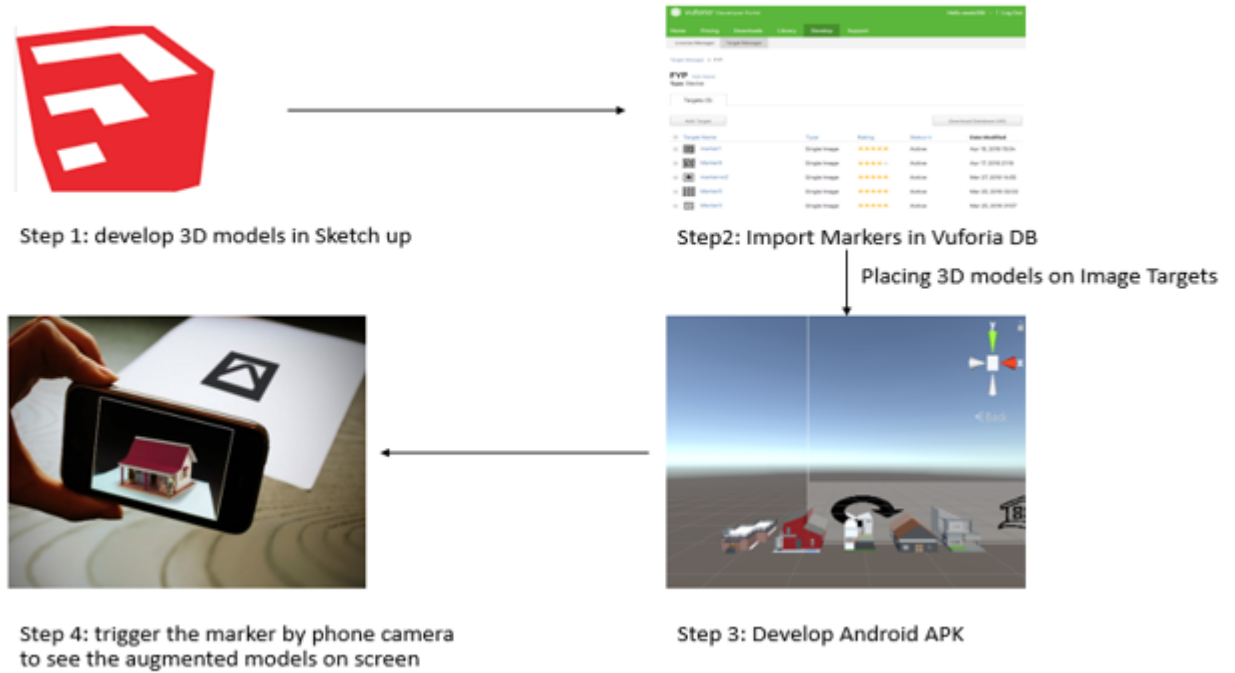


Figure 4.3: Design Methodology

### 4.4 UML Activity Diagram

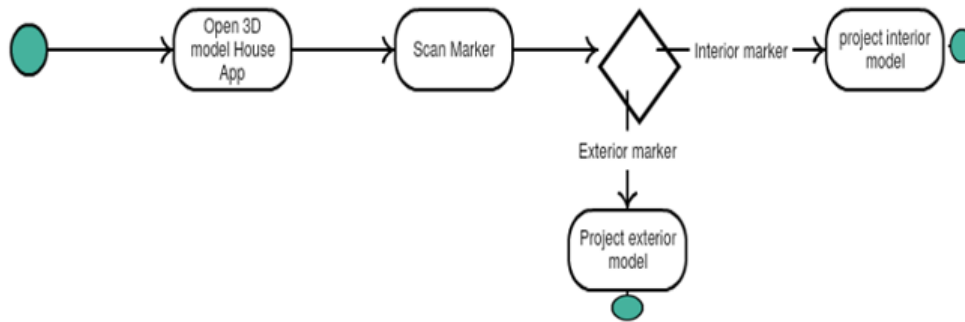


Figure 4.4: UML Activity Diagram

### 4.5 Entity Relation Diagram

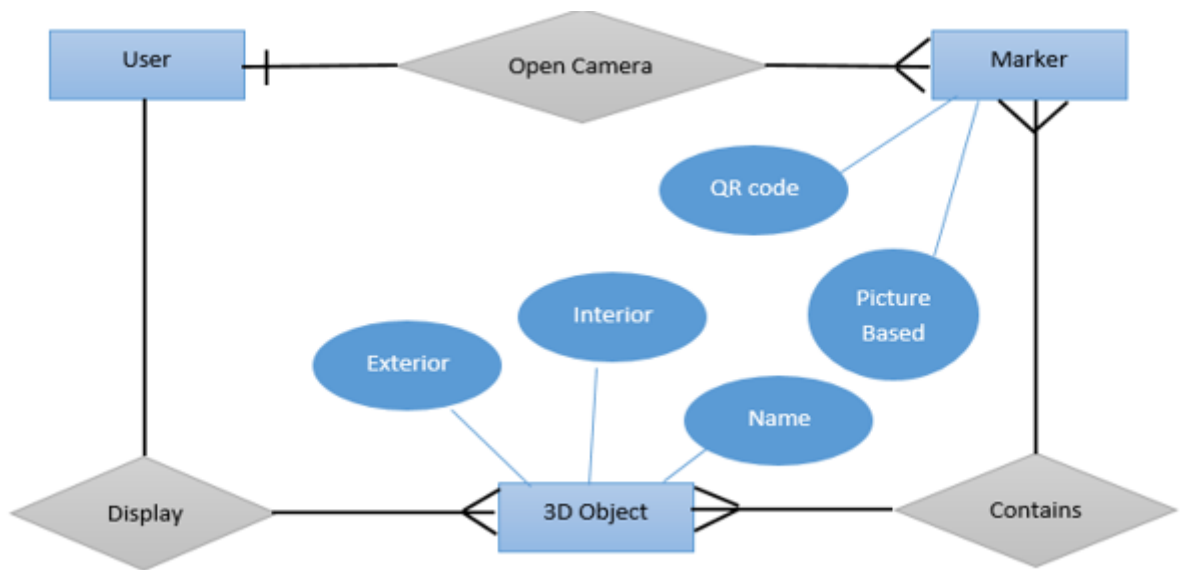


Figure 4.5: Entity Relation Diagram

### 4.6 Graphical User Interface

The following diagram figure 4.6 shows a basic prototype of the application:



Figure 4.6: GUI

## **Chapter 5**

# **System Implementation**

In computer science, system implementation is a process of defining how the system should be built, its physical and system design. It is the process of realization of an application, execution of a plan, ideas, algorithm, design, and model etc. This android based application covering all the aspects of project discussed in previous chapters are implemented and executed on an android smart phone.

### **5.1 System Architecture**

The high-level logical representation of the application is shown in System Architecture. In System Architecture, the components of the system and how they are related to each other are described. How the user interacts with the system and how the system responds. The development environment of the application is also discussed in System Architecture. This system is an application for android based users, it can be used for visualizing 3D model houses with exterior as well as interior in augmented reality. As discussed earlier our application is developed for the architectural designs in 3D with real time interaction of specified 3D models. Once it is installed on your android phone it provides the user with an interactive interface while tracking markers on a live camera stream.

The four major components of our system are projecting model, rotation of model, zooming of model and model movement. As soon as the 3D model is augmented on screen, we can interact with it with different gestures on the screen. For interior we can enter into the second scene (interior scene) of the 3D model. In the second scene, interior of the 3D model is augmented along with interior components.

## 5.2 Tools and Technologies

The following are the tools and technologies which have been used for the development of this application.

### 5.2.1 Unity 3D

Unity is used to create 2D or 3D games and different applications. Unity is used to make application for different platforms. Unity is also used in model the characters or model which are used in the game or application. Unity speeds up the development process of applications. For different customization in the application it provides different plug-ins. Unity is mainly used to develop games, many big gaming industries uses unity like Ubisoft and it is also used to develop other applications like AR application using plug-ins and scripts [6].

### 5.2.2 Vuforia

Vuforia is an online platform or a plugin for unity which helps in developing marker based augmented reality applications. It helps in creating a database of markers used in a project. It allows the developer to place a virtual objects on a marker which is a physical image, this can be viewed through the camera of a smart phone. The camera then scan that the image or marker in real time and places the respective model on the image target or marker or image, so it appears that the 3D model which is virtually constructed on an image target is a part of the real world [7].

### 5.2.3 Sketch Up

Sketch up is a tool that provides the service of making 3D models mainly architectural, interior designs, mechanical machines, films and video game designs. In this project the models have been made in sketch up, while some interior components have been taken from Unity's assets-store. The software generates models in a wide range of formats, including FBX, DEA and OBJ formats[8].

### 5.2.4 Visual Studio

Visual Studio supports different programming languages and Permits the debugger and compiler to effectively execute and diagnose any bugs Visual Studio provides tools that make application development much faster, easier, and more reliable. C sharp Scripts have been used for development of this application. C sharp is a widely used object oriented language and visual oriented language which supports a wide range of libraries. These scripts are highly used in unity based development.

### 5.2.5 Marker Creation

“Different types of Augmented Reality (AR) markers are images that can be detected by a camera and used with software as the location for virtual assets placed in a scene. Most are black and white, though colors can be used as long as the contrast between them can be properly recognized by a camera” [9]. Visual markers are widely used in the AR systems. These markers have some specific properties that make them easy to identify their position in the real world [9]. The markers used in this project are simple bitmap images made in CorelDraw.

The following figure 5.1 shows some sample markers.



Figure 5.1: Markers

#### 5.2.5.1 Marker Constraints

The following are some of the markers constraints and properties which have been consider for the creating markers in this project.

- They must be black and white.
- They must have a square boundary.
- The image inside the marker boundary which is known as the marker image must not be rotational symmetry.

#### 5.2.5.2 Marker Detection

For the marker detection process we use feature extraction technique. A pattern file of each marker, which is generated in the marker training process is stored in the memory, whenever a maker is scanned form the device’s camera, firstly, the image is converted into binary form. The first thing the application scans for in the binary image is the black square boundary of the marker. Once the square is identified the application knows that this part of the image can be a potential marker. A pattern file is generated similar to the

one generated in the marker training process of the marker image portion, which is located in the square boundary. By using the feature matching technique, the pattern file of the input image is matched with the pattern file of the marker stored in the memory. If both the files are the same, thus the marker is detected.

### 5.2.5.3 Marker Training

Once the markers have been designed you have to let Vuforia (which is used for marker detection purposes in this project) know how the marker file looks like. To fulfil this purpose, a marker data-set is generated that contains the marker image. Once this is accessed, the developer is asked for permission to use camera and then asked to set camera settings. Once the camera is turned on the marker is scanned from the camera once this process is complete, unity in-stills the respective model onto the specific marker. The following figures 5.2 and 5.3 shows some models on their respective markers.



Figure 5.2: Exterior



Figure 5.3: Interior



### 5.2.6 Virtual Objects/ 3D Model Rendering

Once the marker has been trained and then detected by the application the next challenge is to render 2D or 3D objects on the real video stream provided by the device's camera. This can be done by directly importing the models onto the scene. 3D or 2D objects can be rendered into the video frame by first creating them in software's like sketch up etc., then importing them. Such models should be made transparent to produce fine details. In this method unity plays its rendering part. The following figure 5.4 shows an example of a 3d model which can be imported onto the scene.

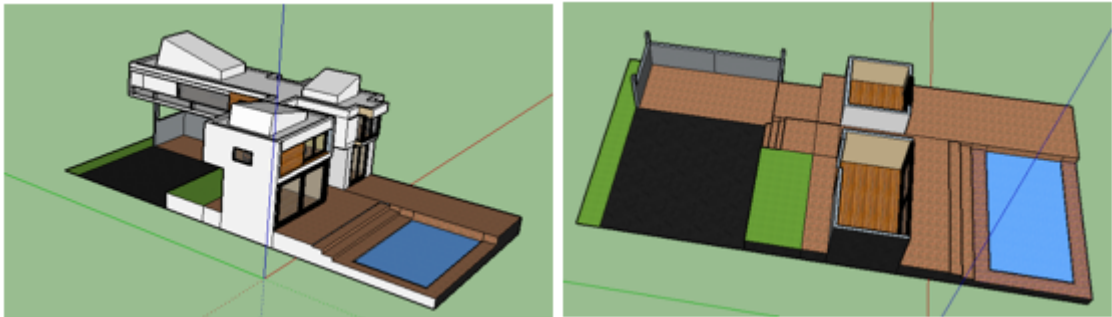


Figure 5.4: Exterior and interior 3D Model

There are five models that are being manipulated in this project, these Models have been made in sketch up whereas some of interior components have been made in Unity 3D by combining various components from unity's asset store as required and using them in form of prefabs.



## **Chapter 6**

# **System Testing and Evaluation**

In this chapter various software testing techniques which have been used to evaluate the application have been described followed by the test results, ending with a conclusion about the final product.

### **6.1 Software Testing Techniques**

The testing Techniques used to test the system were divided in the following.

- Function Testing
- Performance Testing
- Acceptance Testing

### **6.2 Function Testing**

In function testing we performed the following tests:

#### **6.2.1 Unit Testing**

Testing each and every files individually to ensure that they working fine. All the models, packages, android sdk, Jdk files have been tested and they are working fine.

#### **6.2.2 Integration Testing**

Testing the programs, files and the procedure of the system to confirm in the event that they have been incorporated with each other legitimately. The integration of all assets, the

models and the mobile application android activity files have been checked, the test has created reasonable outcomes however there is space for enhancements.

### **6.2.3 System Testing**

Conduct testing of the entire system. A decent method to do system testing is to confirm the system against non-Functional requirements. The framework satisfy all the required non-Functional requirements.

### **6.2.4 Usability Testing**

The application was installed on the phone and was given to a random user for testing. After testing the user was quiet satisfied by the application performance.

## **6.3 Performance Testing**

Software performance testing can be defined as the process of testing the performance of a system. This process involves checking how reliable, effective and accurate the system is. It can determine whether the system is achieving the performance criteria. In general terms we check all the aspects regarding the performance of the system. It has the following types:

### **6.3.1 Stress Testing**

Testing the limits of the system. Mostly done by overloading the system. The application was tested by scanning the marker from a distance but the marker can only be scanned from a distance of 25 inches.

### **6.3.2 Configuration Testing**

Testing the system against various software and hardware configuration with the exact and similar system requirements. The application was tested for configuration testing on android versions 6.0 (Marshmallow), 7.0 (Nougat). Acceptable results were produced.

### **6.3.3 Security Testing**

Testing the security requirements of the system. The system does not require a lot of strict security measures as no confidential information is required to use the application.

## 6.4 Acceptance Testing

Acceptance testing can be termed as testing the system to verify if it is ready for implementation or use. Acceptance testing reveals errors and omissions in the system requirements. There are three type of acceptance testing but for this project only one has been checked which is the following:

### 6.4.1 Compatibility Testing

Testing that whether the system can be installed on user devices or not. The focus of such testing is on two things which are as follows:

- To verify the installation of the complete system on device.
- To verify the functional and non-functional requirements of the system after installation on device.

The application was tested for installation testing on android versions 6.0 (Marshmallow), 7.0 (Nougat) acceptable results were produced.

## 6.5 Test Cases

### 6.5.1 Test Case # 1: Installation of Application

**Note:** The application is to be installed on a device with android operating system. Ideally with android version greater then android version (4.0.3) (Ice-cream Sandwich). The device should have a camera preferably greater than 5.0 mega pixels.

<b>Case ID</b>	01
<b>Function to be tested</b>	Installing the app in android device.
<b>Initial state</b>	No application in the device.
<b>Input</b>	Run the apk file
<b>Expected Result</b>	Installation of full app
<b>Actual Result</b>	Installation of full app
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.1: Test Case 01

### 6.5.2 Test Case # 2: Running the Application

<b>Case ID</b>	02
<b>Function to be tested</b>	While opening the app the camera should run.
<b>Initial state</b>	The application is installed.
<b>Input</b>	Start the application
<b>Expected Result</b>	The app should run without any error, camera should be enabled.
<b>Actual Result</b>	The app runs smoothly, camera is enabled.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.2: Test Case 02

### 6.5.3 Test Case # 3: Scanning the Markers

**Note:** The device camera should not be too far from the marker to be scanned. Preferably within the range of 20 Inches.

<b>Case ID</b>	03
<b>Function To be Tested</b>	Scanning of marker through device camera
<b>Initial State</b>	Application is in running state.
<b>Input</b>	Scanning marker through camera.
<b>Expected Result</b>	Markers should be successfully scanned from the device.
<b>Actual Result</b>	Markers are scanned by camera.
<b>Status</b>	Success
<b>Remarks</b>	There was no feedback when markers were being scanned.

Table 6.3: Test Case 03

### 6.5.4 Test Case # 4: Projection of Models on Screen

**Note:** Respective models against the respective markers should be displayed.

<b>Case ID</b>	04
<b>Function to be Tested</b>	Models should be projected on screen.
<b>Initial State</b>	Application has scanned the marker
<b>Input</b>	Scan the marker from the camera's device.
<b>Expected Result</b>	Projection of model on screen.
<b>Actual Result</b>	Projection of model on screen.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.4: Test Case 04

**6.5.5 Test Case # 5: Model Rotation**

<b>Case ID</b>	05
<b>Function to be Tested</b>	Models Rotating in circular manner.
<b>Initial State</b>	The Model is projected.
<b>Input</b>	Pressing the rotate button.
<b>Expected Result</b>	Model is rotating in circular manner.
<b>Actual Result</b>	Model is rotating in circular manner.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.5: Test Case 05

**6.5.6 Test Case # 6: Model Scaling**

<b>Case ID</b>	06
<b>Function to be tested</b>	Models Zooming in and out.
<b>Initial State</b>	The Model is projected.
<b>Input</b>	Grabbing the model by touching the screen and moving fingers.
<b>Expected Result</b>	Model is Zooming in and out.
<b>Actual Result</b>	Model is Zooming in and out.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.6: Test Case 06

**6.5.7 Test Case # 7: Next Scene**

<b>Case ID</b>	07
<b>Function To be Tested</b>	Checking the projecting of the interior of the same Model.
<b>Initial State</b>	The model is projected.
<b>Input</b>	Touch the next scene button.
<b>Expected Result</b>	Projecting of the interior on the same marker.
<b>Actual Result</b>	TProjecting of the interior on the same marker.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.7: Test Case 07

### 6.5.8 Test Case # 8: Model Movement

<b>Case ID</b>	08
<b>Function to be Tested</b>	Checking the exterior and interior furniture Model dragging from one place to another on runtime.
<b>Initial State</b>	The model is projected.
<b>Input</b>	Touch the model or furniture and drag from one place to another.
<b>Expected Result</b>	Model is moved from one place to another.
<b>Actual Result</b>	Model is moved from one place to another.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.8: Test Case 08

### 6.5.9 Test Case # 9: Previous Scene

<b>Case ID</b>	09
<b>Function to be Tested</b>	Checking the projecting of the exterior of the same Model.
<b>Initial State</b>	The interior model is projected.
<b>Input</b>	Touch the previous scene button.
<b>Expected Result</b>	Projecting of the exterior on the same marker.
<b>Actual Result</b>	Projecting of the exterior on the same marker.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.9: Test Case 09

### 6.5.10 Test Case # 10: Exiting Application

<b>Case ID</b>	10
<b>Function to be Tested</b>	Exiting the application
<b>Initial State</b>	The application is running.
<b>Input</b>	Touch the exit button.
<b>Expected Result</b>	Application is stopped.
<b>Actual Result</b>	Application is stopped.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.10: Test Case 10



**6.5.11 Test Case # 11: Uninstalling the Application****Special Instructions:** N/A

<b>Case ID</b>	11
<b>Function to be Tested</b>	Uninstalling the application from the device.
<b>Initial Stage</b>	The application is installed in the device.
<b>Input</b>	Uninstalling the application from application manager in devices or holding the icon of app in menu and dragging it to uninstall application icon.
<b>Expected Result</b>	Application is uninstalled.
<b>Actual Result</b>	Application is uninstalled.
<b>Status</b>	Success
<b>Remarks</b>	N/A

Table 6.11: Test Case 11



## **Chapter 7**

# **Conclusions**

This project was intended to build up an android based application for architectural design. Implementing an augmented reality visualization of exterior and interior conceptual models and manipulating them were successfully executed .The major functionality of the created application was to scan markers and show the 3D models of the structures that are to be developed on a specific site at the coveted area. The fundamental functions that should have been implemented were, designing and training markers, marker detection, displaying models against the detected markers as well as scaling, rotation and movement of the generated markers/models. All of the functions that were required to complete this project were successfully implemented in the application developed. The project presented a challenge of learning a new technology, a new tool and a new language. One of the major difficulty was to apply the house hold components in the interior model but with continues self-study, tutorials and researches we managed to apply it successfully. Interior modelling in our project is unique implementation in augmented reality which will aid interior designers to represent their model houses along with exterior and interior effectively The present version can be improved by improvising or using a better model integration technique with Vuforia and Unity 3D. Detection of multiple and colored markers can be introduced.

### **7.1 Future Enhancement**

The initial version of the application is on android platform. However, later forms of this application can be developed for IOS which will target a huge market. The future versions of the application can be refined for commercial use and deployed in the Pakistani market. This study generated base line that will help future researchers to design constructive 3D model display in the field of augmented reality.



# Appendix A

## User Manual

### A.1 Introduction

This chapter is for users which will help them in how to use 3D Model House application.

**Instruction:**

1. Start the application.
2. Scan a marker.
3. Scan the markers from a range of 20 inches to get better result.

### A.2 Scanning a Marker

Select the 3D model House icon from the main menu to start the application. When the application starts, the camera of the device will auto automatically start. Now point towards the marker so that the application can scan it. Make sure that you have enough light for the application to detect and scan the marker. The following figure A.1 shows a sample marker.



Figure A.1: Shows a sample marker

### A.3 Projection of Model

The application should display the following result as illustrated in figure A.2:

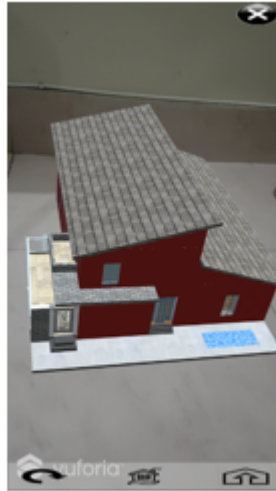


Figure A.2: Projected model

### A.4 Rotation

The user will be able to rotate the model by pressing the button on the bottom left corner, shown in figure A.3:

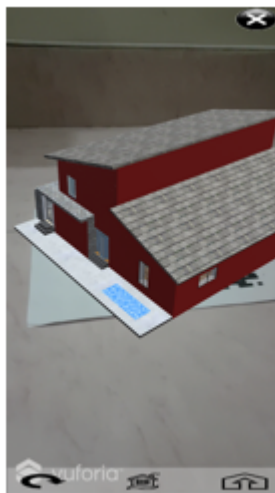


Figure A.3: Rotating model

## A.5 Scaling

The user can zoom in or zoom out the model with the help of pinching in or pinching out the fingers, as shown in figure A.4:



Figure A.4: Scaling the model

## A.6 Next Scene

The user can see the interior of the same house by pressing the interior button in the right bottom corner, interior is shown in figure A.5:



Figure A.5: Interior view

## A.7 Interior Components Movement

The user can drag the components of interior by touching the furniture and dragging it, movement of furniture is shown in figure A.6:



Figure A.6: Interior drag

## A.8 Model Movement

Exterior model can be moved or dragged by two methods, in first method by moving the marker and in second by dragging the house by touching the model and then dragging it, as shown in figure A.7:



Figure A.7: Dragging model and Marker Movement



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