

Marker-less Augmented Reality Interactive Furniture Layouting (Mapping and 3D Object Placement Component)

Software Requirement Specification

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Declaration

I hereby declare that the project work entitled “Marker-less Augmented Reality Interactive Furniture Layouting” (Mapping and 3D object placement component) submitted to the Sri Lanka Institute of Information Technology, is a record of original work done by our group under the guidance of Mr. Udara Samaratunge (Supervisor) and Mr. Tharindu Perera (Co- Supervisor), and this project work is submitted in the fulfillment for the award of the Bachelor of Science (Special Honors) in Information technology Specialization in Software Engineering. The results embodied in this report have not been submitted to any other University or Institute for the award of any degree or diploma. The diagrams, research results and all other documented components were developed by myself and I have cited clearly any references I have made.

Name : N. J. De Silva

Signature:

Table of Content

1. Introduction.....	1
1.1 Purpose.....	1
1.2 Scope.....	1
1.3 Definitions, Acronyms, and Abbreviations.....	2
1.4 Overview	2
2. Overall Descriptions	3
2.1 Product perspective	3
2.1.1 System interfaces	4
2.1.2 User interfaces.....	4
2.1.3 Hardware interfaces	6
2.1.4 Software interfaces.....	6
2.1.5 Communication interfaces	7
2.1.6 Memory constraints.....	7
2.1.7 Operations	7
2.1.8 Site adaptation requirements	7
2.2 Product functions	8
2.3 User characteristics.....	13
2.4 Constraints.....	13
2.5 Assumptions and dependencies.....	13
2.6 Apportioning of requirements	14
3. Specific requirements	15
3.1 External interface requirements.....	15
3.1.1 User interfaces.....	15
3.1.2 Hardware interfaces	17
3.1.3 Software interfaces.....	18
3.1.4 Communication interfaces	18
3.2 Classes/Objects.....	19
3.3 Performance requirements.....	20
3.4 Design constraints	20
3.5 Software system attributes	20
3.5.1 Reliability.....	20

3.5.2	Availability	23
3.5.3	Security	23
3.5.4	Maintainability	23
3.6	Other requirements	23
4.	Supporting information.....	24
4.1	References.....	24

List of Figures

Figure 1: Initial scanning window with furniture Library window open	4
Figure 2 : interface of Download 3D furniture with serial number	5
Figure 3 : interface of Furniture Library with one 3D furniture in slot	5
Figure 4 : 3D furniture placement interface.....	6
Figure 5 : High-level Diagram	8
Figure 6 : Use-case Diagram.....	9
Figure 7 : Activity Diagram.....	12
Figure 8 : Class Diagram	19

List of Tables

Table 1: Use-case Scenario 1	10
Table 2: Use-case Scenario 2.....	11
Table 3: Use-case Scenario 3.....	11
Table 4: User interface details for figure 1	15
Table 5: User interface details for figure 2	16
Table 6: User interface details for figure 4	17
Table 7 : Test case 1.....	21
Table 8 : Test case 2.....	21
Table 9 : Test case 3.....	22
Table 10 : Test case 4.....	22
Table 11 : Test case 5.....	22

Software Requirements Specification

1. Introduction

1.1 Purpose

The Purpose of this document is to present a detailed description of requirements for Mapping and 3D object placement Component of “Markless Furniture” Application. The document will explain the purpose and features, the interfaces, what the system will do and the constraints under which it must operate.

1.2 Scope

This document is intended for both stakeholders and the developers of the system. This document covers the requirements for the mapping and 3D object placement component of the “Markless furniture” application. The application will work as a platform for customers to obtain better knowledge on furniture that they wish to purchase by using Augmented Reality. Prior mentioned component consist of two sub-components. A mapping component which identify the real environment using image tracking and marker-less Augmented reality to allow a location for augmentation of 3D furniture. The 3D object placement component retrieve the said mapping information and allows for placement of 3D furniture, this component will also function as a medium for customization of furniture colour, texture and design. The document will focus on both of these components of mapping and 3D object placement.

1.3 Definitions, Acronyms, and Abbreviations

AR	Augmented Reality
3D	3-Dimensional
SLAM	Simultaneous Localization and Mapping
OS	Operating System
SDK	Software Development kit
RAM	Random Access Memory

1.4 Overview

The product is targeted to be used by furniture dealers and customers. The application allows to download 3D models of furniture by inputting an item code which is specific for the respective item. These 3D models can then be projected to the real environment using augmented reality allowing the users to experience the design of the furniture before to purchase of the actual product.

The next chapter, the Overall Description section, will provide an in-depth overview of the functionalities as focusing on users. The section will focus on comparing the software application to the existing systems in the market. Then the chapter moves on in to explaining several interfaces, constraints and operation of users to provide the reader with the better perspective understanding of the product. The chapter then explaining summary of main functions, characteristics of users, Constraints of system, Assumptions and dependencies and conclude with Apportioning of requirements.

The third chapter looks into the specific requirements on the system, and will be written primarily for developers. This section will describe the technical aspects and in-depth detail of the functionalities mentioned in the previous chapter.

Both sections of the document describe the same software product in its entirety but are intended for different audiences and thus use different languages. The document will conclude with providing any supporting information with regard to the content of the document.

2. Overall Descriptions

Marker-less Augmented reality is an method used for augmenting of 3D objects or image on to the real world without having the rely predefined information to augment object. Marker-less Augmented Reality relies on tracking features [1] (distinctly identifiable location such as shapes, edges and point) of the area of the real-world retrieved on run time and data from device sensors to identify the position onto which digital images are augmented.

Mapping and 3D object placement component rely on this knowledge to map (identify the tracking feature) the real environment and provide the information necessary to achieve marker-less AR. The component will consist of several sub-components. These namely,

- Retrieving 3D furniture information
- Mapping of real-environment
- Placement of 3D objects
- Changing the orientation of placed Objects (position and direction)
- Customization of placed objects (colour, texture, furniture add-ons)
- Identify when tracking information is lost

2.1 Product perspective

As marker-less AR is a newly emerging technology in the market, not much applications were create for furniture base marker-less AR. Out of most of the popular product currently in the market “Augment”[2] and “Udecare”[3] are product that have experimented with marker-less AR but in both instances the user has to remain stationary in-order to augment the object and the 3D object does not lock to the location on real-world. This drastically reduces the user’s freedom to view the object from different angles and locations.

SLAM is an approach which was originally used in environment mapping for robotics, which was latter improved for computer-vision based applications such as AR. SLAM is one of the main approaches of achieving marker-less AR.

2.1.1 System interfaces

Mapping and 3D object placement is a component within the Mobile Application “Markless Furniture”. The component functions as the foundation for the augmented reality functionalities and will be utilizing the mobile device’s camera for recognize the environment.

For this component to function the mobile device should work on Android OS (4.3 Jelly Bean or newer).

2.1.2 User interfaces

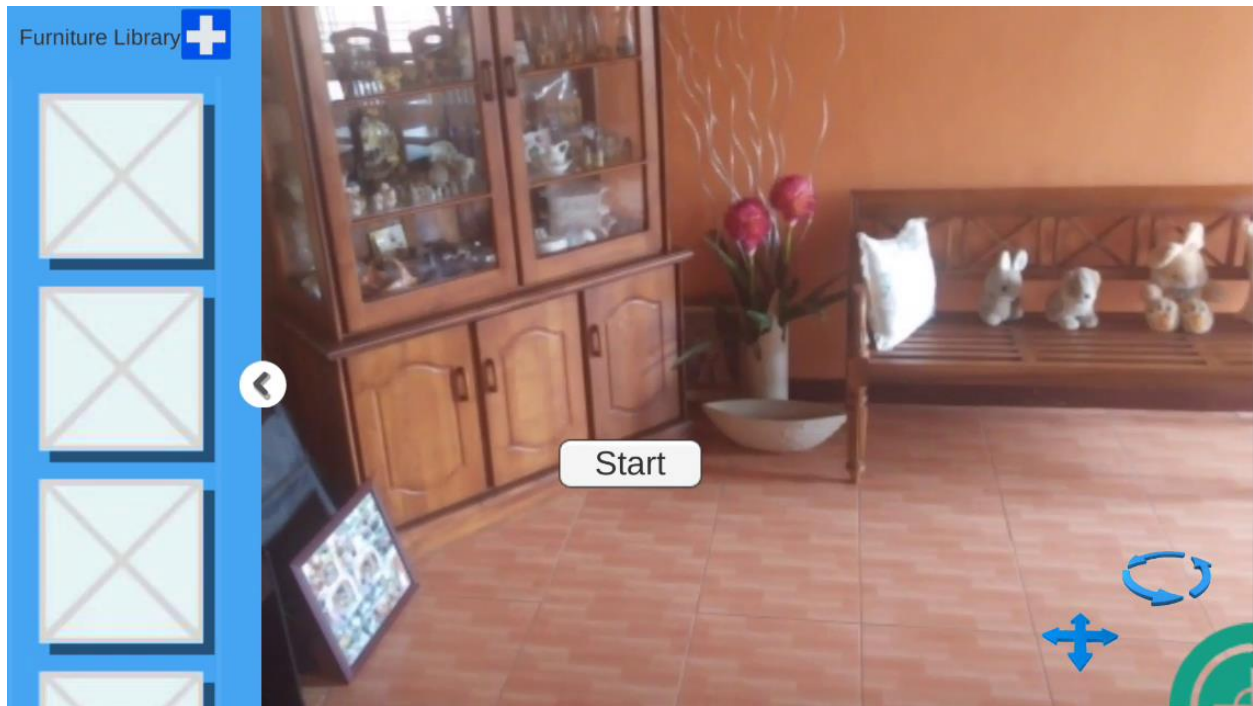


Figure 1: Initial scanning window with furniture Library window open



Figure 2 : interface of Download 3D furniture with serial number

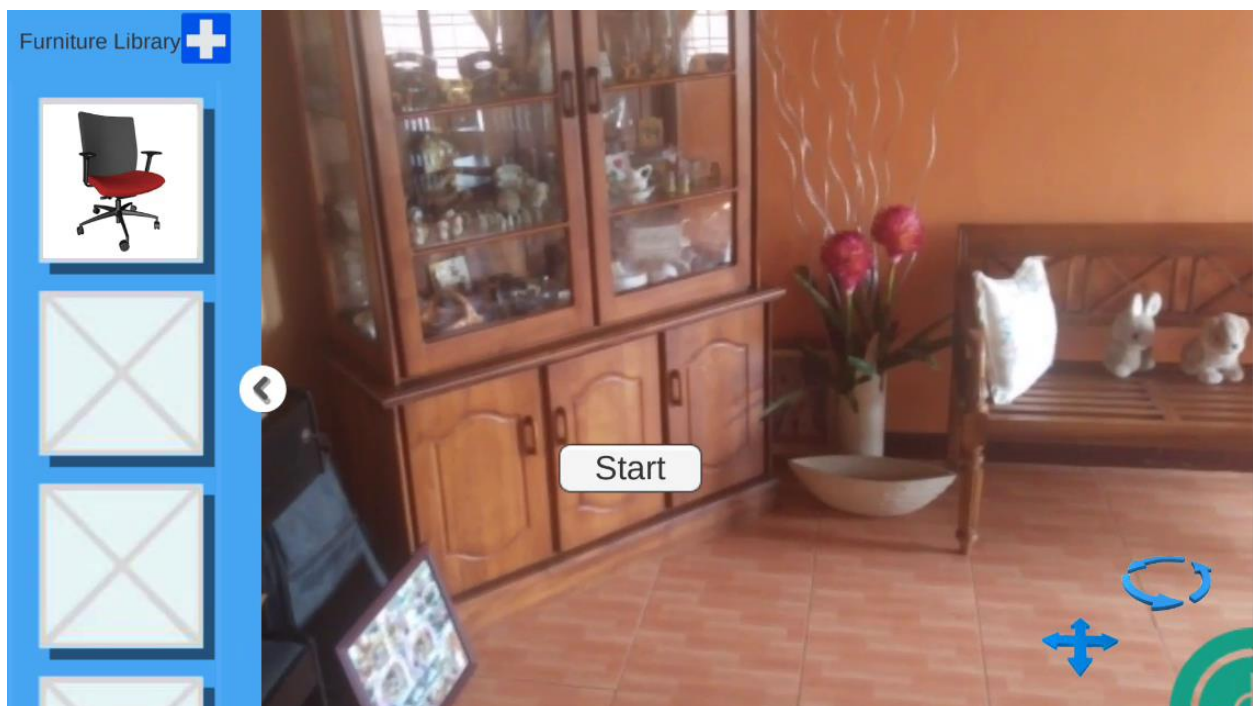


Figure 3 : interface of Furniture Library with one 3D furniture in slot



Figure 4 : 3D furniture placement interface

2.1.3 Hardware interfaces

An android OS running mobile device consisting of,

- Dual-core Processor
- Mobile Device's sensors
 - Accelerometer
 - Magnetometer
 - Gyroscope

2.1.4 Software interfaces

- Unity 3D
- Kudan AR
- Microsoft Azure Cloud Server

2.1.5 Communication interfaces

The user's smart phone should support high speed data communication methods such as 3G (HSPDA), 4G (LTE).

2.1.6 Memory constraints

The mobile device is expected to use a minimum of 1 Gigabyte of RAM and have a minimum of external free storage of 1 Gigabyte.

2.1.7 Operations

- User should enable the internet access of the mobile device.
- Download the furniture they wish to place using the serial No. obtained from the dealer.
- Aim the mobile camera at the location he/she wish to place the 3D furniture.
- Add multiple 3D furniture to the location he wish to place the furniture.
- Change position and direction of each augmented 3D furniture.
- Change colour, texture or hide/show add-on of the 3D furniture.
- Change snapshot of augmented furniture on real environment.
- Remove unwanted item information from library to download new item information.

2.1.8 Site adaptation requirements

Since the user can be of any nationality the user interface must be created for English language.

2.2 Product functions

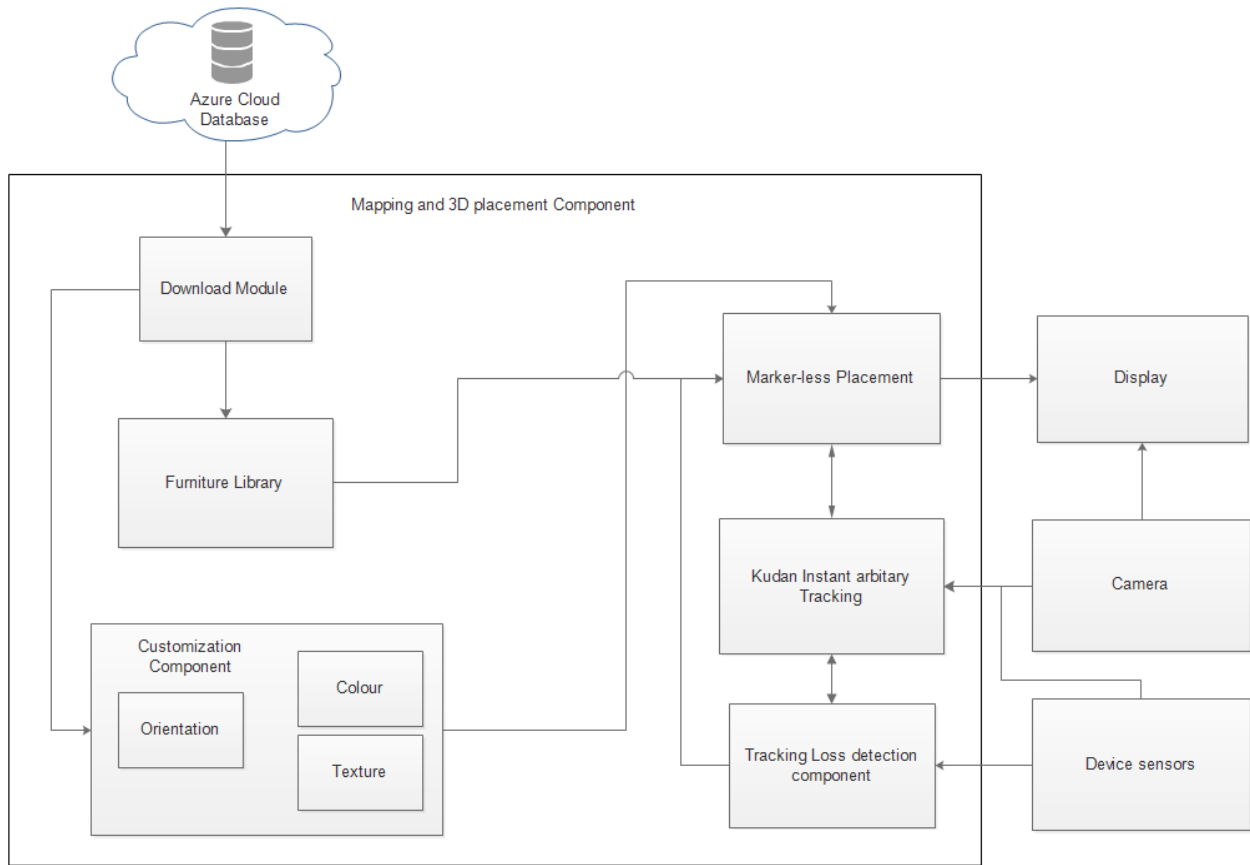


Figure 5 : High-level Diagram

- Download Module : Used in downloading 3D furniture information from the internet.
- Furniture Library : In-built library in application to hold the downloaded information.
- Customization component : Contains all information necessary for customization of furniture.
- Marker-less placement : A component which will hold information of furniture when they are augmented.
- Kudan Instant arbitrary tracking : Methods used for achieving marker-less augmented reality
- Tracking Loss detection component : Used for identify the instances where marker-less tracking is lost and to automatically recover.

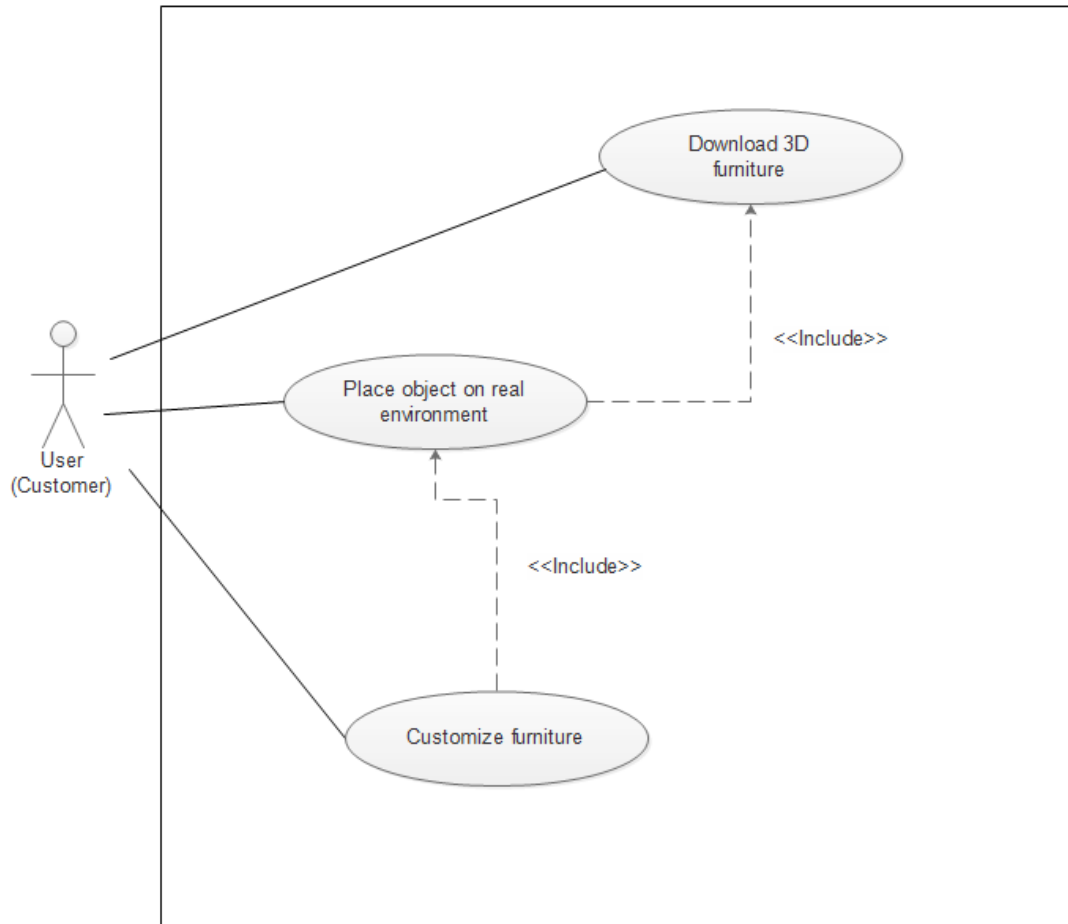


Figure 6 : Use-case Diagram

User case scenarios

Use case 01	Download 3D furniture
Primary Actor(s)	User (Customer)
Pre-Condition	Mobile device is connected to the internet The proper serial No. of the product is known
Post-Condition	3D furniture is download to mobile application in-build library
Main Success Scenario	1. Use case starts with the application opening and connecting to the internet 2. User open the left-hand sliding panel (furniture library)

	3. User click on the add button on the top of opened window and displays a dialog window to enter furniture serial number 4. User enters the serial number 5. System validates the serial number 6. The relevant 3D furniture and it's details are download onto a slot on the furniture library panel 7. The use case ends with successfully close dialog window and displaying successfully downloaded window
Extensions	3.a Disconnected for internet, system displays a message to reconnect. 5.a Invalid serial number, system displays an error. 5.b The dialog window is closed

Table 1: Use-case Scenario 1

Use case 02	Place 3D object on real environment
Primary Actor(s)	User (Customer)
Pre-Condition	3D object is located in the furniture library panel The device camera is aimed at the location to place the 3D furniture
Post-Condition	3D furniture is place on the location the user aims at

Main Success Scenario	1. User selects the object he wish to augment to the environment 2. User aim the device camera at the location to augment 3. User clicks on the “Add the environment Button” 4. The select object is placed on the location
Extensions	

Table 2: Use-case Scenario 2

Use case 03	Customize furniture
Primary Actor(s)	User (Customer)
Pre-Condition	3D object is located in the furniture library panel and is placed in the environment The selected furniture has customizable features (colour, texture, design)
Post-Condition	The furniture is customized
Main Success Scenario	1. User selects the object he wish to customize 2. System displays options of customization as buttons on the bottom right corner of the display 3. Use clicks on the desired customization 4. The selected furniture is customized accordingly
Extensions	

Table 3: Use-case Scenario 3

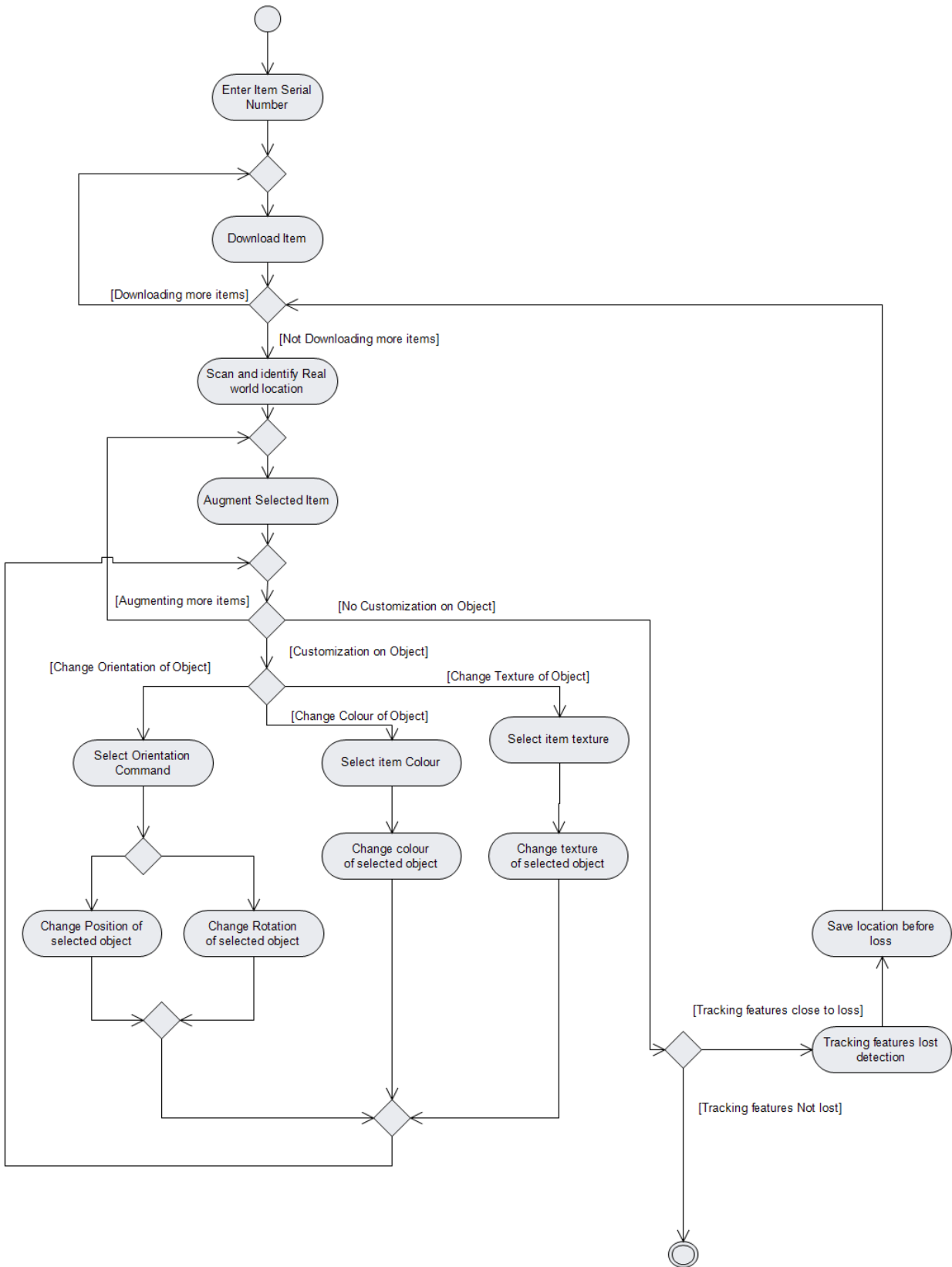


Figure 7 : Activity Diagram

2.3 User characteristics

The system is mainly focus for 2 types of users

- Furniture Dealer, who wish to utilize the application to advertise their products.
- Customers, who wish to examine furniture before purchasing.

This application is mainly developed for any customer with compatible smart phones who wish to purchase furniture and like to examine the products prior to purchasing. The application will retrieve information of 3D furniture which the furniture dealers will upload to the database and provide a serial number for each product in the database. Customers can retrieve this serial number from the furniture dealer and utilize it in the application to download the 3D furniture and augment.

2.4 Constraints

The propose system consist of a mobile application and web application. The constraint for each are considered separately. This document focuses on explaining the mobile application constraints.

- The download of 3D furniture is depended on internet connectivity
- The perform well with the mobile sensors (Gyroscope, accelerometer, magnetometer)
- The mapping and identification of tracking feature in the environment is performed automatically without any user intervention.
- The application will only allow to download a limited amount of furniture to maintain the performance of the application. When limited is reached to 3D furniture the unnecessary furniture which is already in the library can be removed.

2.5 Assumptions and dependencies

- The mobile the minimum requirement of supporting operating system and hardware.
- The internet connectivity can be established with ease on request.
- The mobile device storage is capable of storing and access information related to the application.

2.6 Apportioning of requirements

Essential requirements

1. Allow user to enter the serial number of item and download the 3d object from server.
2. Augment 3D object to environment when item is select from the Furniture Library slot.
3. Allow user to add multiple items.
4. Allow user to add duplicate of any item in Library.
5. Allow to rotate or change position of augmented 3D object.
6. Allow user to change colour of targeted 3D object.
7. Allow user to change texture of 3D object.
8. let the user customize the design of the 3D object with the add-ons given.

Desirable requirements

1. Display the 3D furniture's details on a panel next to the object.
2. Allow users to take snapshot of the augmented furniture in the environment.

Optional requirements

1. Identify the lighting condition in the environment and change the 3D furniture look to match.

3. Specific requirements

3.1 External interface requirements

3.1.1 User interfaces

Figure 1: Initial scanning window with furniture Library window open

Name of the item	Add button	Slot buttons of Library Panel
Description of purpose	Display a dialog window where use will enter furniture serial number	Used to hold image of
Source of input or destination of output	Touch	Touch
Valid range, accuracy and/or tolerance	N/A	N/A
Units of measure	No	No
Timing	No	No
Relationships to other inputs/outputs	No	Placement of 3D object on the real-environment
Screen formats/organization	Top left, within the furniture library panel	Gird arrangement in library panel to display all downloaded 3D objects
Window formats/organization	Left of screen	Left of screen
Data formats	N/A	N/A

Table 4: User interface details for figure 1

Figure 2: Download 3D furniture with serial number interface

Name of the item	Serial number text field	Download button
Description of purpose	Allow user to input the serial number of 3D object to download	Used to hold image of
Source of input or destination of output	Touch , and keypad	Touch

Valid range, accuracy and/or tolerance	N/A	N/A
Units of measure	string	No
Timing	No	No
Relationships to other inputs/outputs	Message Dialog-box with notification of availability and download of 3D object	Message Dialog-box with notification of availability and download of 3D object
Screen formats/organization	Middle of Dialog-box next to label “Serial No:”	Bottom center of Dialog-box
Window formats/organization	Center of the screen	Center of the screen
Data formats	string	N/A

Table 5: User interface details for figure 2

Figure 4: 3D furniture placement interface

Name of the item	Start Button	Move button	Rotate button
Description of purpose	Initial scan and instantaneous place of selected 3d Object onto the location targeted by devices camera	Used to change the position of the augmented 3D object	Used to change the direction the augmented 3D object is facing
Source of input or destination of output	Touch	Touch	Touch
Valid range, accuracy and/or tolerance	N/A	N/A	N/A
Units of measure	No	No	No
Timing	No	No	No
Relationships to other inputs/outputs	Initialization method for obtaining floor level and tracking	To the object which is to be moved	To the object which is to be rotated

	features of the environment		
Screen formats/organization	Center of the screen	Bottom left corner of the screen	Bottom left corner of the screen
Window formats/organization	Center of the screen	Bottom left corner of the screen	Bottom left corner of the screen
Data formats	N/A	N/A	N/A

Table 6: User interface details for figure 4

3.1.2 Hardware interfaces

An android OS running mobile device consisting of,

- Dual-Core Processor
The process multitasking capabilities, in-order to Augmented Camera to function in background while other functions comes into action.
- Accelerometer
To identify the orientation of Camera to the real-world
- Magnetometer
To identify the direction to which the camera is pointed and changes the augmented 3D object direction to match.
- Gyroscope
To identify the orientation of the floor and the 3D objects compared to the camera

3.1.3 Software interfaces

- Unity 3D

The main integrated development environment on which the mobile application and its respective components are developed.

- Kudan AR

Out of all augmented Reality SDK currently available only 2 has proven to of marker-less AR creating solutions. These are Wikitude [4] and Kudan AR [5]. Out of these Kudan AR is the only SDK which offer marker-less AR for android development through Unity 3D. Therefore Kudan AR is used as the development tool for mapping and marker-less augmented reality object placement.

- Microsoft Azure Cloud Server

This is used for Cloud storage of 3D objects and their respective information.

3.1.4 Communication interfaces

The data communication between mobile application and the web service is achieve through internet connections. Therefore data communication between centralized database of cloud and mobile device's local database is handled through the internet. The mobile device's connect can range from minimum of 3G connection to fast 4G (LTE) connection.

3.2 Classes/Objects

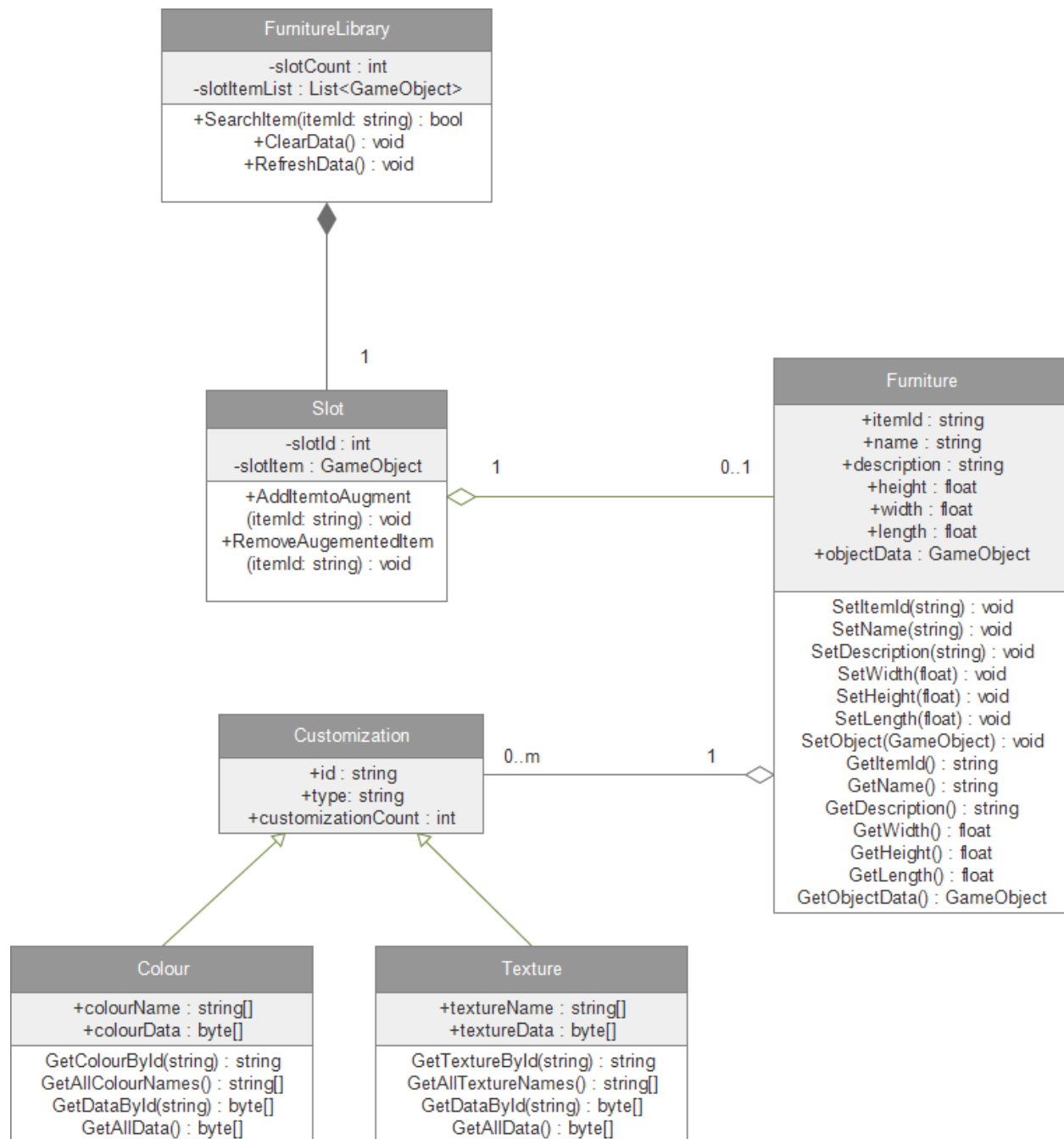


Figure 8 : Class Diagram

3.3 Performance requirements

- 3D object and all its relevant information should be downloaded when requested.
- The download of information should not obstruct/freeze other functionalities.
- The system will handle a maximum of 6 3D furniture in the augmented environment at once.
- The tracking feature information will iteratively increase or decrease to maintain the optimal level necessary maintain the stability of augmented objects.
- The functionality of some feature (moving, rotation and customizations) should only focus on to targeted 3D object to avoid redundancies from occurring.
- The system will operate with minimum RAM of 1GB

3.4 Design constraints

This application is mainly focus for furniture purchasing customers. The colour and theme of application should be simple and attractive while not obstructing/distracting the user from the view of the camera. The user should be able to hide un-necessary interfaces once their tasks are fulfilled

3.5 Software system attributes

3.5.1 Reliability

The system should be able to perform and maintain its function without the continuous use of internet. If the internet connection is lost during the data download, the data in destination shall not be corrupted. In the context of 3D object placement, the location of the object should be fixed when camera moves from one object to another.

Test cases with reference to use-case diagram (figure 6)

- Download furniture

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
01	Download 3D furniture successful	• Device is connect to the internet • Application is open	1. Open the left panel by clicking the arrow sign button on the left of the window 2. Click on the top “plus” sign button 3. Enter the serial number 4. click the download button	Serial No : itm001	• 3D furniture image appear in one of the slots

Table 7 : Test case 1

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
02	Download 3D furniture unsuccessful	• Device is connect to the internet • Application is open	1. Open the left panel by clicking the arrow sign button on the left of the window 2. Click on the top “plus” sign button 3. Enter the serial number 4. click the download button	Serial No : item1	• messagebox is displayed with “Serial number invalid message” message

Table 8 : Test case 2

- Furniture Library

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
03	Selection of furniture for placement	• One slot is filled with an item	1. Open the left panel by clicking the arrow sign button on the left of the window 2. Click on slot with item		• messagebox is displayed with “Item ready to augment” message

Table 9 : Test case 3

- Customization component

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
04	Change of Colour of furniture	• One item is augmented on to the environment • The item has colour customization options	1. switch to colour customization by sliding the bottom right corner button to left once 2. Click on the button 3. click on the red colour button		• The augmented item’s colour changes to red

Table 10 : Test case 4

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
05	Change of texture of furniture	• One item is augmented on to the environment • The item has texture customization options	1. switch to colour customization by sliding the bottom right corner button to left twice 2. Click on the button 3. click on the 1st texture button		• The augmented item’s texture changes to red

Table 11 : Test case 5

3.5.2 Availability

The mobile application should be available for access by any user. The application should not rely completely on internet connection and should only notify the user when it is necessary. The 3D furniture and their respective information which was downloaded should be available with-in the application throughout the runtime for easy access and only be remove once the application is closed.

3.5.3 Security

3D furniture models and their respective information will be maintained with-in the mobile device only while the application is active. When the application is close all downloaded details will be remove to keep confidentiality of information. Encryption methods should be used to store important data.

3.5.4 Maintainability

The system should be implementation should be done in a way to preserve the maintainability. The data-storage should be organized and information of performance issue which might occur should be logged and store with proper encryption for reference. The system be standalone to avoid any interruption from maintained done on the server-side. The mobile application should be able to upgrade with-ease.

3.6 Other requirements

Extensibility and Modifiability: System should be able to accept new features and customizations with ease.

Accessibility: The user interface should be easily accessible and understood by any use.

4. Supporting information

4.1 References

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