Marker-less Augmented Reality Interactive Furniture Layouting

(Estimating dimensions of objects from mobile camera)

Software Requirement Specification

Project ID: 16-105

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Declaration

I hereby declare that the project work entitled "Marker-less Augmented Reality Interactive Furniture Layouting" (Estimating dimensions of objects from mobile camera) 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.

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Software Requirements Specification

1. Introduction

1.1. Purpose

This report will explain the requirements of “Scale identification” component of “Markless Furniture” App in detail. By reading this document reader can comprehend about the features of the app, the motivations of users and their needs, interfaces and rules and regulations under which app must operate.

1.2. Scope

This document will be used as a reference mainly by developers and stakeholders for clarifying the requirements of the “Scale Estimation” component of “Markless Furniture” App. “Scale Estimation” component grant the above app to be more realistic by simulating the real furniture experience through 3-dimensional object. This component must take the mobile camera input and detect the objects present in the feed and estimate the scale which will be sent to the mapping and 3-dimensional object placement component as an input.

This component may need some other inputs like Accelerometer reading, focal length of mobile camera other than the mobile camera feed to perform the estimation. When implementing performance is critical aspect thou this is a mobile app.

1.3. Definitions, Acronyms, and Abbreviations

3D	3-Dimensional
RAM	Random Access Memory
AR	Augmneted Reality

1.4. Overview

The supposed product will mainly useful for the customers who are about to buy furniture and the furniture dealers. Users come with different aspects to make a purchase so the prier product must simulate the experience of the furniture by the 3D model of the furniture which will please the above expectations and make the path to purchase and to find what they really need.

The second chapter overall description give a comprehension about the functionalities of the system in detail explaining interfaces, constrains, assumptions, dependencies and requirements. The third chapter focuses on specific requirements such as, availability, maintainability, reliability and security of the system and the technical aspect of the functionalities mentioned Furthermore this will discuss about performance requirements and internal interface requirements which will be useful for developers.

2. Overall Descriptions

Simulation of the experience getting from furniture must be the goal of this app. When mapping the 3D object it should be projected to the correct scale. What if the mapped 3D object looks larger than the real object or smaller? In that case user is not getting the correct simulation. If not user may not tend to make the purchase. Therefore mapping of the 3D object must be done to the correct scale so that it can effect to both customer and salesman's perspective.

In order to map the 3D object to correct scale system must first identify the scales of the objects present in the environment. Then scale the 3D object and project. If 3D object scale is correct relative to the environment projection is successful. When performing these task developers need to go through following sub tasks.

- Take the camera feed as input, capture clear image.
- Extract the useful information (object's boundaries) from the image using image processing techniques.
- Getting additional inputs like camera focal length, incident angle and pitch angle using Accelerometer meter readings and height of the camera relative to the ground.
- Generate the scales using trigonometry and ratios techniques.

2.1. Product perspective

Among the popular product currently in the market "Augment" [2] and "Udecore" [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 and the both wont estimate the real world scale and project the 3D object in to correct scale. So this will be a new introduction to market.

2.1.1. System interfaces

Estimation of scale of objects using mobile camera is a component within the Mobile Application "Markless Furniture". The component functions as the foundation for the augment 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

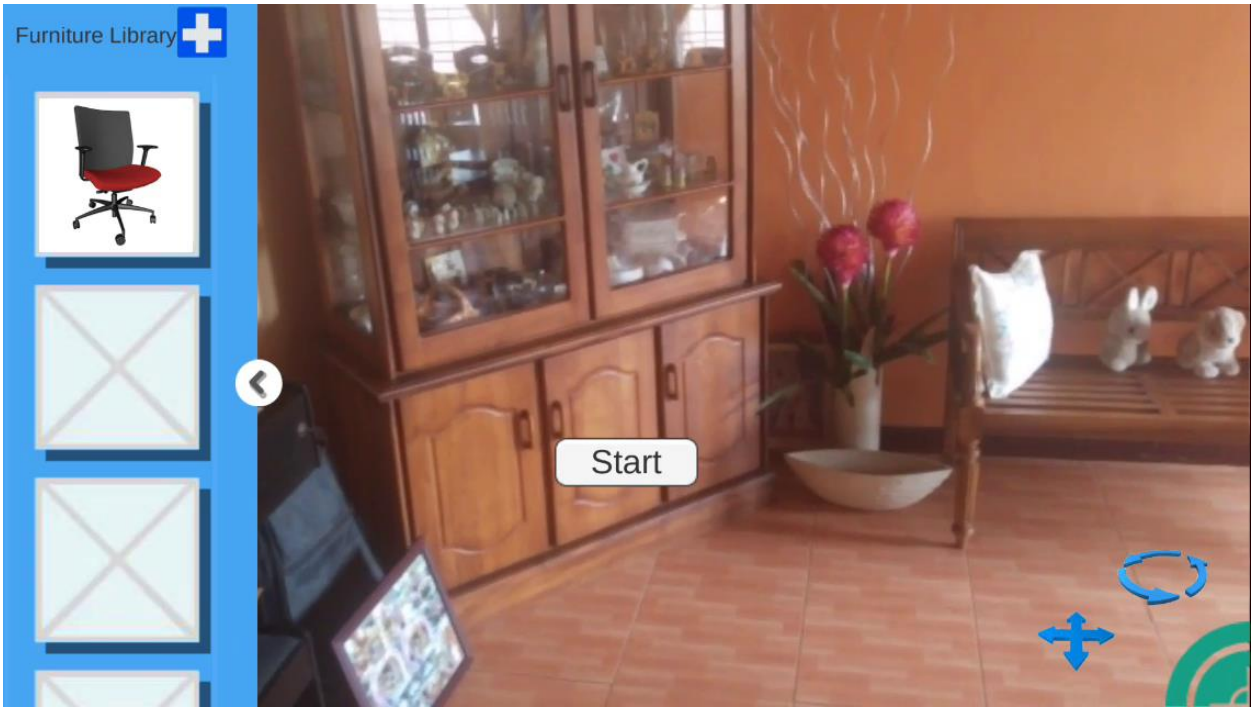

Figure 1 : Getting image of environment.

2.1.3. Hardware interfaces

An android OS running mobile device consisting of,

- Octat-core Processor
- 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 2GB of Ram and external storage of 1GB or more free space.

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.

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

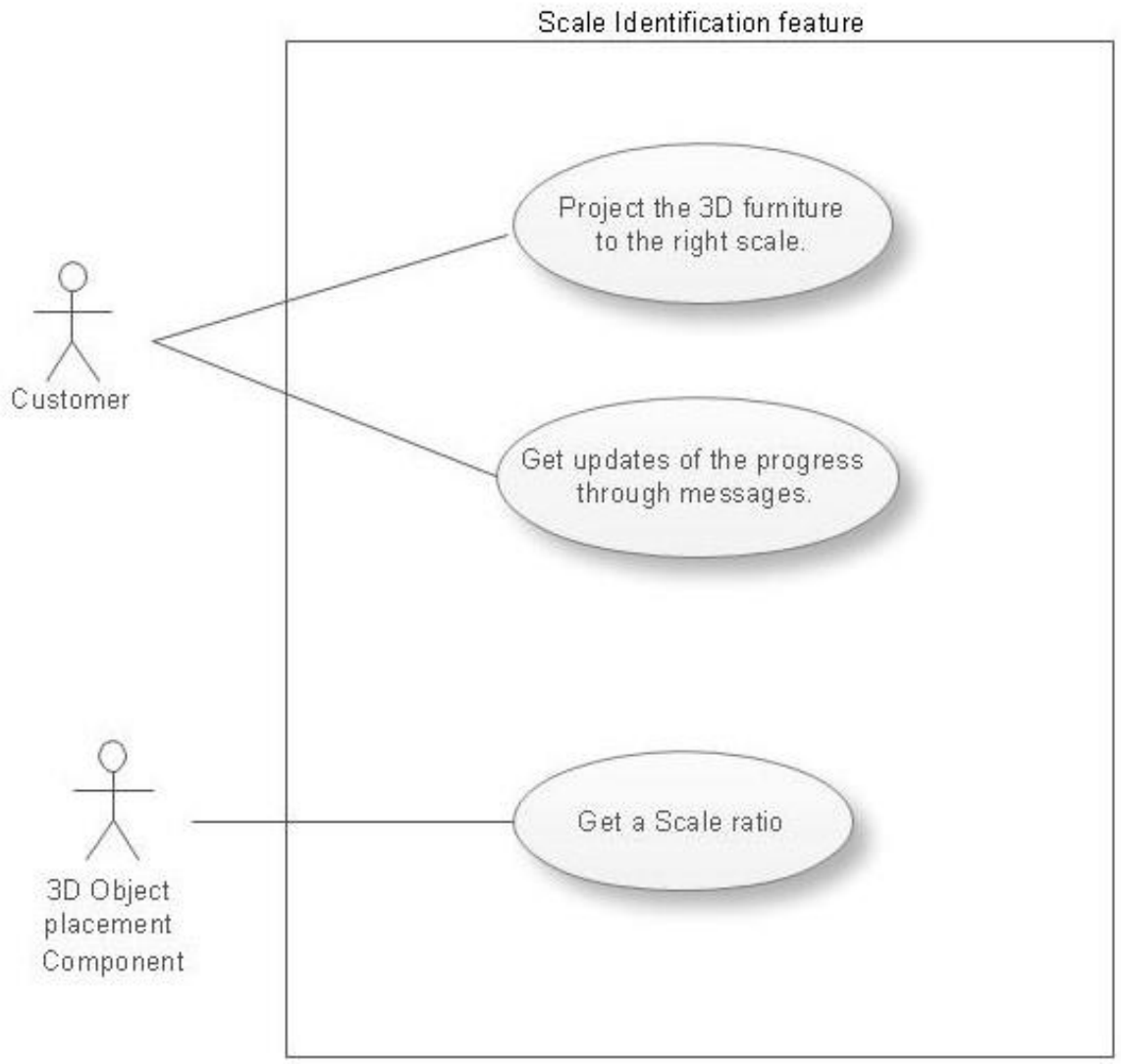

Figure 2 : Use-case diagram

2.2.1 User case scenarios

Use case 01	User need to get the scale of the 3D object correctly.
Primary Actor(s)	User (Customer)
Pre-Condition	Mobile device is connected to the internet

	Accelerometer and camera details need to be accessed.
Post-Condition	Start the 3D object placement
Main Success Scenario	1. Use case starts with the application opening and connecting to the internet. 2. System must give proper instructions to capturing image. 3. User gets warnings and information while processing the scales 4. Give input to the 3D object placement component.
Extensions	1. a System display error if mobile attributes could be accessed. 4.a Give system error if could not success and re start the process.

Table 1 : Use Case 1

Use case 02	Get updates of the process through messages.
Primary Actor(s)	User (Customer)
Pre-Condition	Mobile device is connected to the internet Accelerometer and camera details need to be accessed.
Post-Condition	Start the 3D object placement
Main Success Scenario	1. Use case starts with the application opening and connecting to the internet. 2. Give messages in each phase to the user on top of the screen.

Table 2 : Use Case 2

Use case 03	Get the scale ratio.
Primary Actor(s)	3D object placement component.
Pre-Condition	Mobile device is connected to the internet Accelerometer and camera details need to be accessed.
Post-Condition	Start the 3D object placement
Main Success Scenario	1. Use case starts with the application opening and connecting to the internet. 2. System must give proper instructions to capturing image. 3. User gets warnings and information while processing the scales 4. Give input to the 3D object placement component. 5. Adjust the 3D object according to the ratios given.
Extensions	1. a System display error if mobile attributes could be accessed. 4.a Give system error if could not success and re start the process.

Table 3 : Use Case 3

2.2.2 Activity Diagram

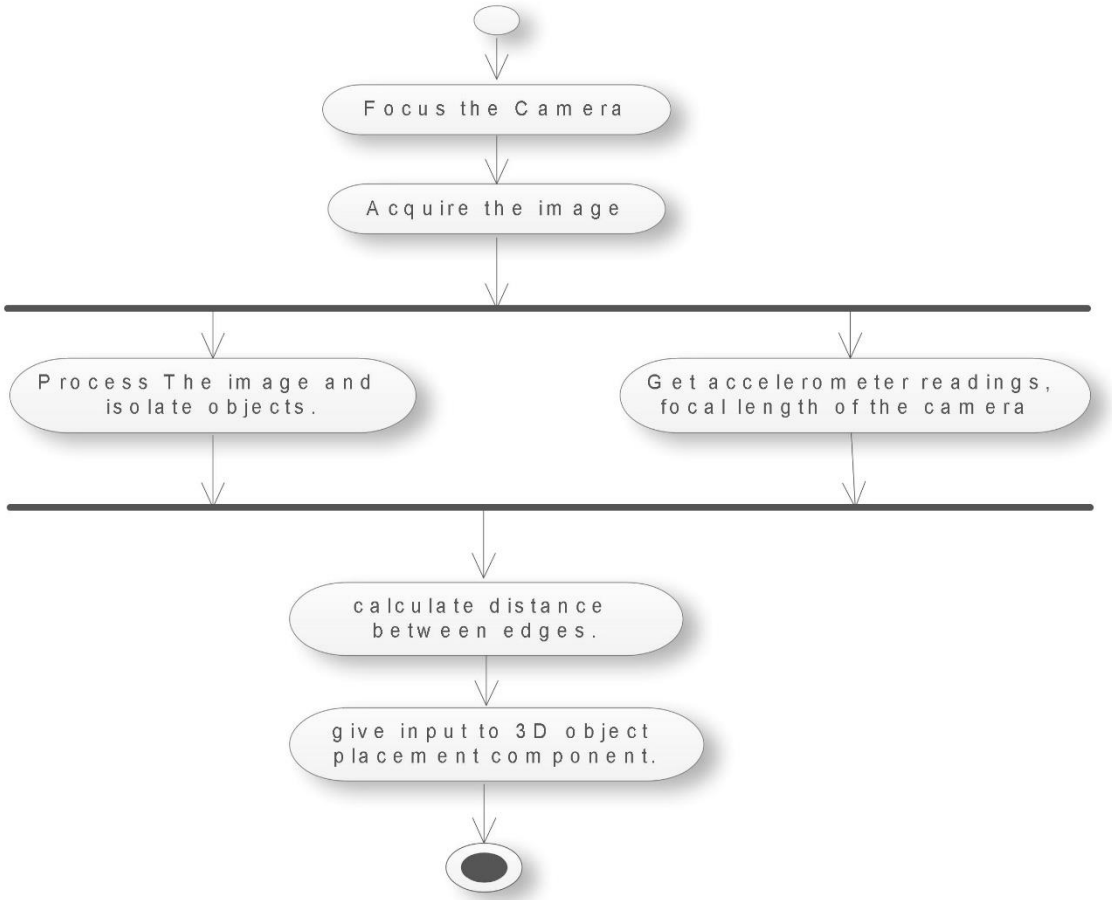

Figure 3 : Activity diagram

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 focusing on experience simulation of real furniture which will be useful for customers who seeking to make a purchase. They mindset is to get the perfect furniture to satisfy their need. Furniture dealers also use this app to convince their customers to make their selection to be perfect which will ease their marketing process.

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 perform well with the mobile sensors (Gyroscope, accelerometer, magnetometer)

- The scale identification feature in the environment is performed automatically without any user intervention.
- Thou this process is estimation the scales that produce doesn't always accurate to the point.
- The final output (Scales) depend on the accuracy of the Accelerometer readings and height of the camera held relative to the ground.

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.

3 Specific requirements

3.1 External interface requirements

3.1.1 User interfaces

Figure 1: Initial scanning window.

Name of the item	Initial camera view.
Description of purpose	Give instruction to user. To hold the phone until scanning is done.
Source of input or destination of output	N/A
Valid range, accuracy and/or tolerance	N/A
Units of measure	No
Timing	No
Relationships to other inputs/outputs	No
Screen formats/organization	Top left, within the furniture library panel
Window formats/organization	Left of screen
Data formats	N/A

Table 4: User interface details for figure 1

3.1.2 Hardware interfaces

An android OS running mobile device consisting of,

- Octat-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

The Augmented Reality software development kit for development of 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 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**

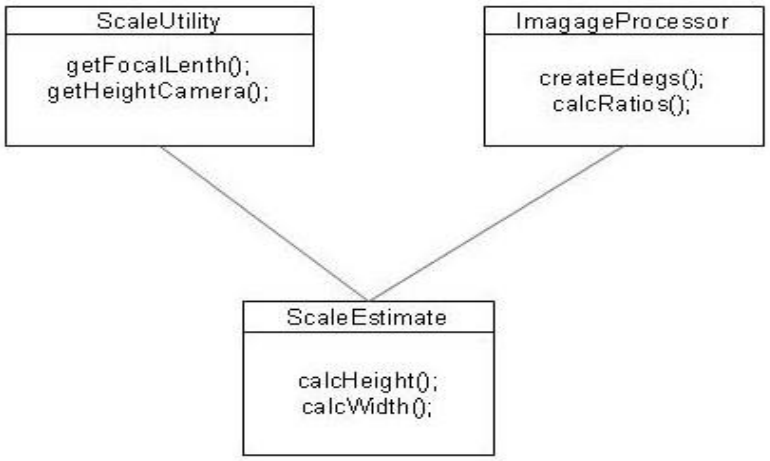

Figure 4 : Class Diagram

3.3 Performance requirements

- The tracking feature information will iteratively increase or decrease to maintain the optimal level necessary maintains the stability of augmented objects.
- The system will operate with minimum RAM of 1GB

3.4 Design constraints

This application is mainly focus for furniture purchasing customers. The color 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 Test Cases

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
01	Scale Identification Success.	• Device is connect to the internet • Application is open	1. App comes to the initial page 2. Direct to the environment 3. Look for warnings and messages	N/A	• Application Gives a message" Scale identified "message on the screen.

Table 5 : Test Case 1

Test case #	Description	Pre-conditions	Test Steps	Input	Expected output
02	Scale Identification Unsucess.	• Device is connect to the internet • Application is open	4. App comes to the initial page 5. Direct to the environment 6. Look for warnings and messages	N/A	• Application gives a message" Scale identification unsuccessful "message on the screen.

Table 6 : Test Case 2

3.6 Software system attributes

3.6.1 Reliability

The system should be able to estimate the scale of the environment on any circumstance and if any action affect with the calculation let the user to know what is happening through messages and warnings and give instruction to keep good interaction with user.

3.6.2 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 Scale estimation part should be always working in the initial stage of the app when starting.

3.6.3 Maintainability

The system should be implementation should be done in a way to preserve the maintainability. 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 like in need of make a update in the calculation method.

3.7 Other requirements

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

4 Supporting information

4.1 References

[1]A. Comport, E. Marchand, M. Pressigout and F. Chaumette, "Real-time markerless tracking for augmented reality: the virtual visual servoing framework", *IEEE Trans. Visual. Comput. Graphics*, vol. 12, no. 4, pp. 615-628, 2006.

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