



“ROBOT CHEF”
VIRTUAL REALITY FOOD SERVING
GAME

**A dissertation submitted for the Degree of Master of
Information Technology**

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DECLARATION

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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ABSTRACT

This report presents the overview of a Virtual Reality enabled food serving game which is giving the explanation of game logics and game mechanics to play further by using VR. The main game story explains that the player needs to participate as a Robot chef in a sci-fi restaurant. The main goal for this game is to prepare and serve food dishes within certain time period. VR is the main tool for this project which handles the virtual exploration of this game environments and also capable to interact with game objects. Considering VR interaction, this project has used leap motion device to detect hand gestures to perform seamlessly. VR technology utilizes computer graphics with real time process to create realistic world which responds to user's input.

Additionally, this report covers the VR integration, gameplay logics, game mechanics and game design structure by explaining suitable diagram to understand the game flow. It assumes that the devices which are used here will be measured the user's motions accurately.

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LIST OF ACRONYMS

3D – Three Dimension

API – Application Programming Interface

CPU – Central Processing Unit

FPS – Frame per Seconds

GPU – Graphics Processing Unit

HMD – Head mounted display

HUD – Heads Up Display

IDE - Integrated Development Environment

RAM – Random Access Memory

SCI-FI – Science Fiction

SDK – Software Development Kit

URL – Uniform Resource Locator

UI- User Interface

VR – Virtual Reality

CHAPTER 1

1. Introduction

“ROBOT CHEF” is a Virtual reality enabled food serving game for PC. The main game concept is the player will be played as a Chef at a sci-fi restaurant who has to prepare and serve food dishes by using the food orders within a certain time period. This project covers the integration of Virtual Reality (VR) technology and identifying the VR interaction problems through a game. This game covers the VR integration, gameplay logics, game mechanics and VR object interaction. VR is the computer-generated simulation of a 3D environment using user’s input indirectly which is utilizing computer graphics with real time process to create realistic world which responds to user’s input. Therefore, this project uses the VR device to explore the virtual environment and also using hand detection device to detect the player’s hand movements.

1.1 Identified Problems

As a VR game this project mainly focus on the game logics and game mechanics to perform effective output. From a developer point of view this project identified some technical constraints that are faced while developing this project. As per the game mechanics this game should perform effectively without any interaction challenges with the devices. The devices should provide the proper game interaction without any delays therefore,

1.2 Solutions

VR is a technological tool which allows user to experience which can’t experience in the real world. And most VR games are based on simulation type where user can interact with objects which is not possible in the real world. Therefore, this project mainly focuses on solving the above problems by creating a VR game to get the player’s feedback for ensuring the correct solution.

This is a food serving game which enables to interact with 3D food objects to experience the VR interaction. Additionally, the game logics give more challenges to the player while they are playing to achieve for additional upgrades. This game project is to give a solution to the VR interaction problems by using VR headset and leap motion sensor to achieve the VR interaction solution. Integration of Oculus rift and Leap motion gives full experience of virtual environment to the users and gives flexible controls with easy accessibility without carrying additional controllers. Connecting both VR headset and hand detection sensor (Leap motion) which gives the solution for VR interaction problems.

1.3 Motivation

Currently, people are getting the idea of Virtual reality concept from games and movies which gives more expectations of future technology developments. Most technologies stepping with a solution to the current problems by using the proper technology tool in the right place. There are rare number of games that are available in the market in Sri Lanka which indicates the VR technology needs to be developed in Sri Lanka. This project will give players to explore the virtual world and able to interact with objects without any additional controllers or remote. VR technology is out of reach for normal users with high-end requirements. Therefore, this project convinces the achievable requirements to prove the advantages of VR tool. There are already plenty of investors in the VR market, but it could be some time to achieve this technology to be monetized. These kind of future technology projects should be encouraged to the future development to achieve certain solutions.

1.4 Goals and Objectives

This project has a goal to provide solutions for virtual reality interaction problems which can be achieved by giving a VR simulation game with a proper game design and development.

The main objective for this game is the player should prepare food and serve with in the given time period by using both VR headset and leap motion sensor. And this game not only for entertainment but also expects to improve player's gameplay decision making ability in each level and ability to interact with objects by using given devices too [7]. The player can explore the immersive virtual environment by using VR headsets and also able to interact with objects using Leap motion device.

The following objectives should be achieved by the player while playing the game to reach the goal. The objectives are,

- The player has to register and login to the game server which gives the unique player identification and also to store player score and details.
- Player has to use the devices to play the game by using hand gestures like pick, drag and drop.
- In the gameplay, the player has to prepare and serve the specific food dishes with the appropriate food orders.
- Each food dish has separate score points to collect therefore, player should finish each orders to obtain the score points.
- Need to reach the minimum score limit for unlocking each level by maintaining the score level to the minimum score points.
- The global leaderboard will store the player's score points and will be showed the top scored players on the leaderboard.

1.5 Scope

- The login system maintains the player details and player activities by monitoring the level score points and upgrades.
- Each game level having separate individual score points to unlock which indicates player should maintain the minimum score points of each level.
- Player can able get time upgrades by using gained score points which enables to increase the game time period.
- Device usage guidance will be displayed separately before starting to play the game which gives usability guidance for the player.
- Player profile will be maintainable for long term and database stores player details and score points and completed level numbers.
- This game has a global leaderboard to maintain the player's score and skill points where players can challenge each other players. Database stores the player's score, skill points and completed level history.

1.6 Chapter Breakdown

This sub-topic will explain the overall project's chapters separately with related overview descriptions of all five chapters.

Chapter 01: Introduction -

This introduction chapter has given an overview of this project by explaining the identified problems, solutions and the scope.

Chapter 02: Background -

This chapter mainly focus about the similar project's review and technical feature comparisons. Additionally, this chapter briefly explaining the implemented tools and technologies by selecting the important tools for explanation.

Chapter 03: Methodology -

Methodology chapter explains about the logical structure design by giving the appropriate diagrams with proper explanations. This chapter includes the design document as well which provides the explanation of game logical design and UI design.

Chapter 04: Game Design -

This is the design chapter to elaborate the game logics and game mechanics with suitable diagrams. Game story and game levels flow structure gives the brief of game flow.

Chapter 05: Evaluation -

This chapter explains the testing method for this game project and also it gives a summary of test cases which were used for testing purposes. Additionally, this chapter includes the user feedback with statistical approach of this project.

Chapter 05: Conclusion -

This final chapter concludes the whole project report including the topics like future development and user aspects.

CHAPTER 2

2. BACKGROUND STUDY

2.1 Introduction

Virtual reality researches have been developing in the world over the last thirty years. Eventually It opens a new perspective for our society. But it creates many scientific challenges for researchers to research about the future technologies. Let's see the breakdown details of the used devices of this project.

2.2 Devices Breakdown

2.2.1 Virtual Reality Headset (Oculus Rift)

Inside virtual reality headsets or head-mounted display (HMD) is a series of sensors, pair of eye displays, lenses, display screen(s) and a control circuit board. Software turns the contents into two warped side views. Sensors, lenses, display screens, processing unit are the key components inside of a VR device. Magnetometers, accelerometers and gyroscopes are three common sensors in a VR headset. These sensors work together to get user's motion and direction in space [4].

These devices are to achieve six degrees of freedom of a user's motion. Move forward / backward, left/ right, up/ down, roll, yaw, pitch are the six degrees of freedom which gives users to maneuvers in space.

VR headsets made with 110° field of view (FOV) which is sufficient to view the image widely. And 60 fps frame rate is needed to avoid lagging frames where oculus rift runs at 90fps to give real time experience. Most headsets prefer low latency which is the amount of time takes to display image simultaneously with the user head position [4]. Considering that VR input devices like VR controllers, gamepad or joystick to create interaction between the real world and the virtual world. Hand tracking enables track the user's hands in the virtual environment without any additional controllers to carry on.

2.2.2 Leap Motion sensor

Companies such as Leap Motion have been working on hand tracking extensively, both inside and outside of VR, for years. Leap motion sensor supports to track hand and finger motions as input. Two IR cameras and three infrared LEDs create hemispherical area which is 2 feet deep on each side to capture user's hand motions [8].

2.3 Problem Identification

Most VR headsets rely on traditional controllers like keyboard, mouse and gamepad. QWERTY keyboard is the easiest medium to enter texts or interact digital contents for past decades. But the VR users have to carry additional VR controllers to interact objects which make users to always rely on controllers. The expectations of VR cannot be given by these devices and need to implement a natural user interface using hand gestures to enable users to control and interact with objects in the virtual world.

This project illustrates about the hand tracking device leap motion with Virtual Reality headsets to play online. Hand tracking device enables to track the user's hands in the virtual environment without any additional controllers to carry on.

2.4 Similar VR Games

The Cooking Game VR – It is a fast food preparing game with VR technology which has the same game concept as this project. The main game concept is player must prepare the fast food dishes to completing the task with satisfying the customers in the game. This game supports Oculus Rift and Oculus Touch device for the VR interaction where the player must carry additional controllers [3]. Additionally, this game has two external features to engage with other players which are,

- Oculus leaderboard integration – Separate leaderboard for oculus users.
- Player vs player gameplay - Two players challenge [3].



Figure 2.2: The cooking game VR gameplay visual

Positives – Simple gameplay with simple level design which makes the game flow smoothly.

Oculus leaderboard and two player challenges allow to challenge with other players by cooking and scoring [3].

Negatives – Basic graphics and static game environment makes the game quality and level complexity to low.

Comparisons

The Cooking Game VR	Robot Chef
Oculus Rift and Oculus Touch support for interaction	Oculus supported but not support Oculus Touch for interaction
Hand detection not support	Hand detection support by using Leap Motion
Oculus leader board only for oculus users	Global leaderboard for all users
Player vs player support	Not support

Table 2.1 – The comparison table between Cooking Game VR and Robot chef.

2.5 Similar Research

“A Development of Virtual Reality Game utilizing Kinect, Oculus Rift and Smartphone”

This research based on the user convenience and cost efficiency in order to using Kinect, Oculus Rift and smartphone. They have use smart phone as a controller to interact with objects and Kinect is for tracking user’s body movements [2].

They have used three components to implement this research, which are client to execute the VR game , smartphone to work as a input device and server to communication between client and the smartphone.

Implemented processes

- User can give touch, swipe, drag inputs from the smartphone and the input data go to the server and server gives the response to the game.
- Oculus Rift to visualize the VR contents and tracks the player’s head movements.
- Kinect track the player’s body movement using skeleton and joints which will directly go to the game and real time synchronize the player’s position in the gameplay [2].

Finally, this research concludes with the players would have diverse to operate various input devices in a game. The following Figure 2.3 shows connectivity flow diagram by using VR headset, Kinect and a smartphone.

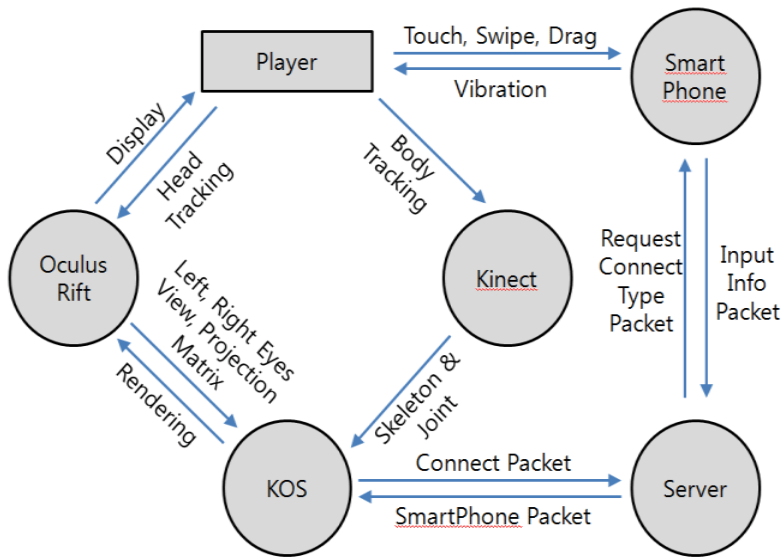


Figure 2.3: VR, Kinect and smartphone connectivity diagram [2]

(taken from the journal “A Development of Virtual Reality Game utilizing Kinect, Oculus Rift and Smartphone”)

The following Table 2.2 shows the comparisons between

Comparisons

Research work	Robot Chef
Kinect and smartphones use for interaction	Oculus supported but not support Oculus Touch
Body tracking support from Kinect	Not support for body tracking.
Does not have any leaderboard	Has global leaderboard
Player vs player support	Not support

Table 2.2 – The comparison table between the research work and robot chef game

2.6 Implemented tools and Technologies

Nowadays game design and development processes done by game engines which includes the animation, UI design, networking, rendering and scripting as well. The following factors describe how the tools and technologies were used in this project.

Game Engine - Game engine is the heart of this project which carries this whole game from beginning stage to the final stage. Game engine itself has the physics, scripting, networking, graphics rendering components which works with cross-platform compiler and runtime components. The device compatibility, graphics rendering process, scripting language support and reusability are the main considerable requirements while choosing a proper game engine tool. This project used Unity3D as the game engine to handle this whole project.

Designing Tools – Designing tools provides the suitable game UI and 3d models to implement gameplay elements.

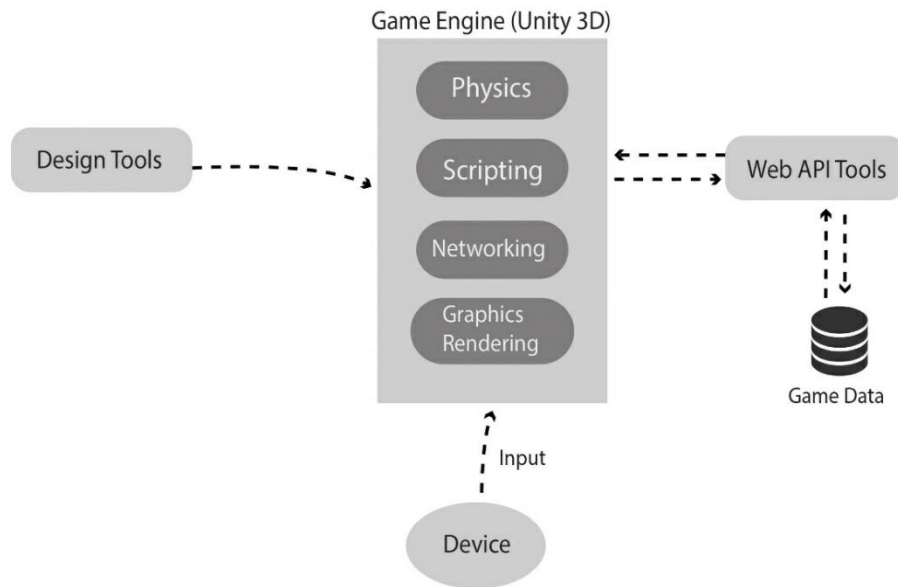


Figure 2.4 – Game engine components

The above Figure 2.4 describes the game engine components and its workflows when in game runtime. device input manages by the game engine build-in component which directs all input from external devices into the game engine and up to the game. This project used Maya and Adobe illustrator as designing tools and Unity 3D and Sublime Text as development tools.

Unity 3D - Unity is a cross-platform game engine which can be mostly used to create games, virtual reality and augmented reality applications. Unity supports the graphical APIs like Direct3D, OpenGL, WebGL and Vulkan. And it provides reflection mapping, parallax mapping, texture compression,

shadow maps and ambient occlusion as well. Moreover, Unity offers the primary scripting API in C# and additionally offers real-time Global illumination and Nvidia PhysX engine for more realistic output.

Maya - Maya is 3D computer graphics application which is mostly used to create 3D design and 3D models for games, movies and interactive applications. Therefore, this project mainly used as 3D design tool for creating game environments and game props with textures.

The following technologies have used to develop this game which are,

C# - Unity mainly support as primarily scripting API in C# which is based on .Net framework. C# is a functional, generic and object-oriented language therefore it's easy to use as game programming language.

Php – Php is famous for server scripting therefore this project used as Web API scripting language and it was mainly used for API creation and database connectivity.

Oculus SDK – This is the SDK for Oculus rift which is the core kit for connecting PC and the device for the real-time visual responses.

Leap Motion SDK – This is the main SDK for the leap motion device to get the real-time hand gestures to the PC.

2.7 Requirements

2.6.1 Functional Requirements

Player should know these functional requirements which makes the early preparation before playing the game. The following list gives the functional requirements of this game project to the player. This is a VR technology enabled project therefore, player should have the VR device to play this game which is the main hardware capability for this project. For the quality experience user should select the proper VR headsets to utilize the hardware and software technology with generated content. As a PC game, this project works only on Windows which means there will be a restriction for other platforms.

2.6.2 Non-functional Requirements

Player should have high performance GPU to run this game with using VR technology because of the graphics rendering process. High GPU helps to render quality graphics without any delays.

The primary function of this game is to showing the best of reality to the player to feel everything they see.

2.8 Limitations

The following factors are describing the restrictions to perform this game effectively which are,

- Player needs high-end PC to play this game – The real time VR rendering process needs high performance GPU system to achieve the effective output.
- Need enough space – Player needs enough space to setup this device which explains be more aware of the around environment while wearing the VR device.
- Quite expensive devices – The VR device is quite expensive than a normal mobile VR device.
- Dizziness – One of the main problems in VR devices which is having dizziness when using the device for long time.

2.9 Challenges

There are some technical challenges were faced to implement this project which are,

Quality content – The 3D contents should render smoothly without any delays therefore; the contents followed a certain pipeline to create. The 3D contents should have limited polygons to render through VR headset.

Freedom of movement – The movement and orientation are the challenges with the wired VR devices which explains the player should have limited area of access for interact.

CHAPTER 3

3. METHODOLOGY

3.1 Introduction

This methodology chapter is mainly focusing on the design of game logics and mechanics of this game. The main UI design, level design, character design will be shown in Game Design Document which is in the design chapter. This chapter displaying the game flow design, web API flow structure, game database design and game logical design to showcase the project pipeline.

3.2 Game Flow Structure

Figure 3.1 shows the game flow structure to show the

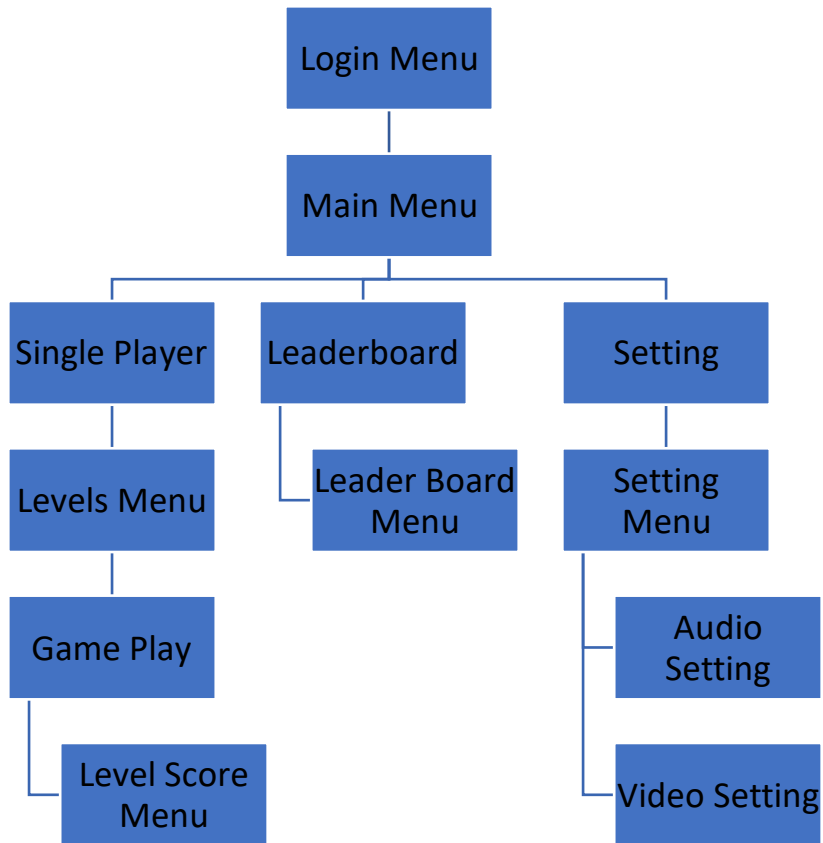


Figure 3.1- Game flow structure diagram

- The player must be registered first and login through the game server to start the game.
- After login success player can able move to the main menu of the game.
- Player will be instructed to the level menu by choosing play button where the player should choose the appropriate level to play the game.
- Player will be guided to wear the VR headsets before starting the game.
- Player has to use the leap motion device to interact objects by using pick, drag and drop gestures.

- Game level leads to the gameplay by selecting unlocked levels which can be displayed in the level menu.
- Game starts with the tutorial level to demonstrate the game controls and mechanics by giving step by step game logic process.
- Player can able to choose the level in the level selection menu and this would show the overview of the levels.
- Leaderboard option gives the best scored players details of top 5 players to showcase the best scores.

3.3 Game Play

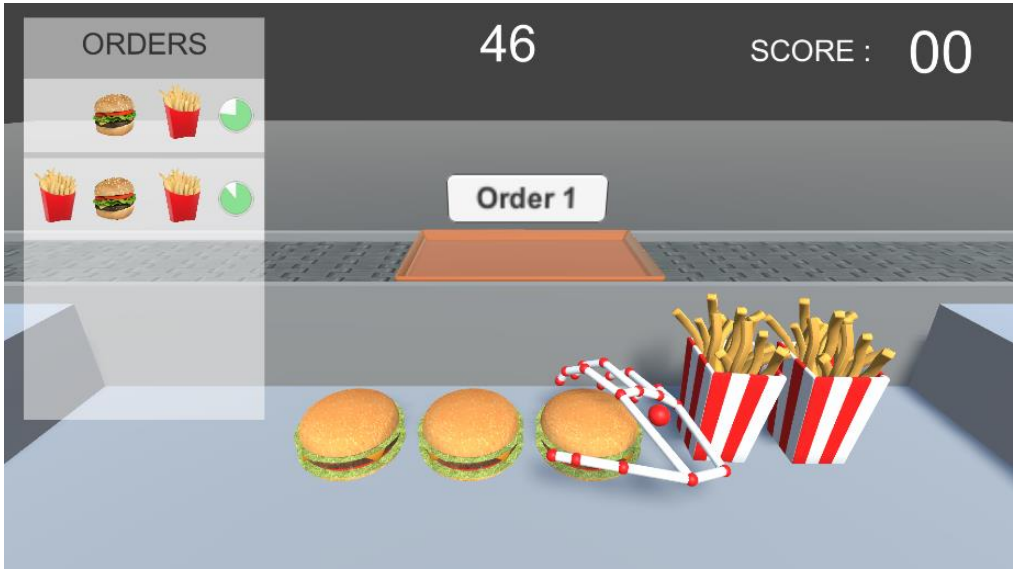


Figure 3.2– Game play visual

The above Figure 3.2 shows the main gameplay of level 1 which includes the orders menu, game time and game level score. Player has to prepare and serve food with the given time by using food orders menu. Each order has its own individual time to finish the order by using the leap motion controller to picking the appropriate food and dropping on the correct order place. Each food has individual score point which adds with the player score after serving the food order. The orders tray automatically moving to the player’s accessible area to deliver the suitable food dish.

3.4 Gameplay Analysis

Gameplay analysis covers the gameplay structures, gameplay elements, level flow and level complexity which is measuring the level finishes time and player score. The following Figure 3.2 shows the gameplay elements which have been using while the gameplay.

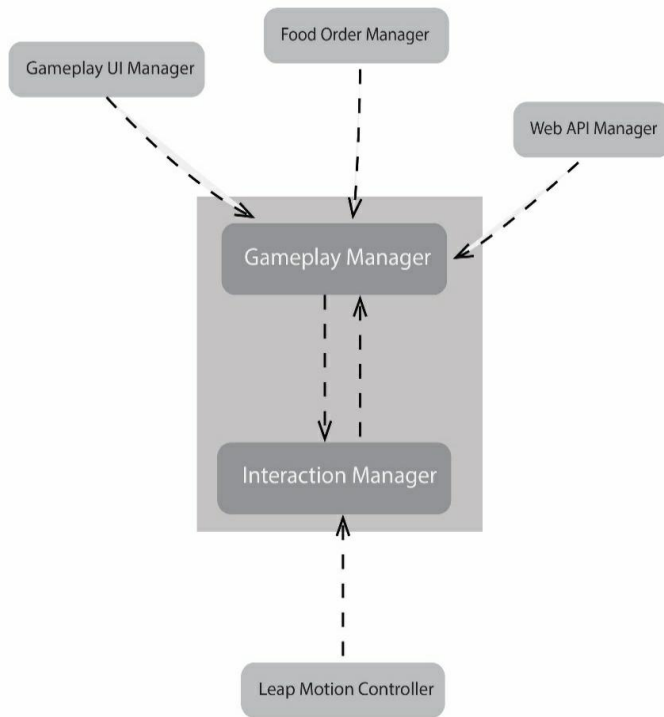


Figure 3.3 – Gameplay Elements Structure

- **Gameplay Manager** – This is the element which controls the entire game. This main code controller has three sub elements to provide appropriate data in real time.
- **Interaction Manager** – Interaction manager is to retrieve data from leap motion controller. The hand type, hand position and orientation are the parameters which will be transferred between gameplay manager and interaction manager.
- **OVR Manager** – This the element to retrieve actual data of Oculus Rift (VR device) in real time. Device orientation and position are the parameters which will be retrieved from the device.
- **Gameplay UI Manager** - This element handles the gameplay UI to update real-time to the head up display (HUD). Game time, food orders and player score are the UI elements will be showed up in the game play.
- **Food Order Manager** – Food orders will be organized and properly managed by this element for each game level. This element handles the current order, pending orders and calculates the player score by comparing the orders and player’s delivered food items in the given time.
- **Web API Manager** – This element handles the web request and response processes and pass the appropriate data to the Gameplay manager. Player login session, player score updates and player level completion are the functions will be conducted by this element.

3.5 API Request Flow

This project has separate API to save player scores and details which can be useful to fetch the data separately for each use. The following diagrams explain the Web API flow to get the appropriate responses through API URL.

3.5.1 Login API request and response flow

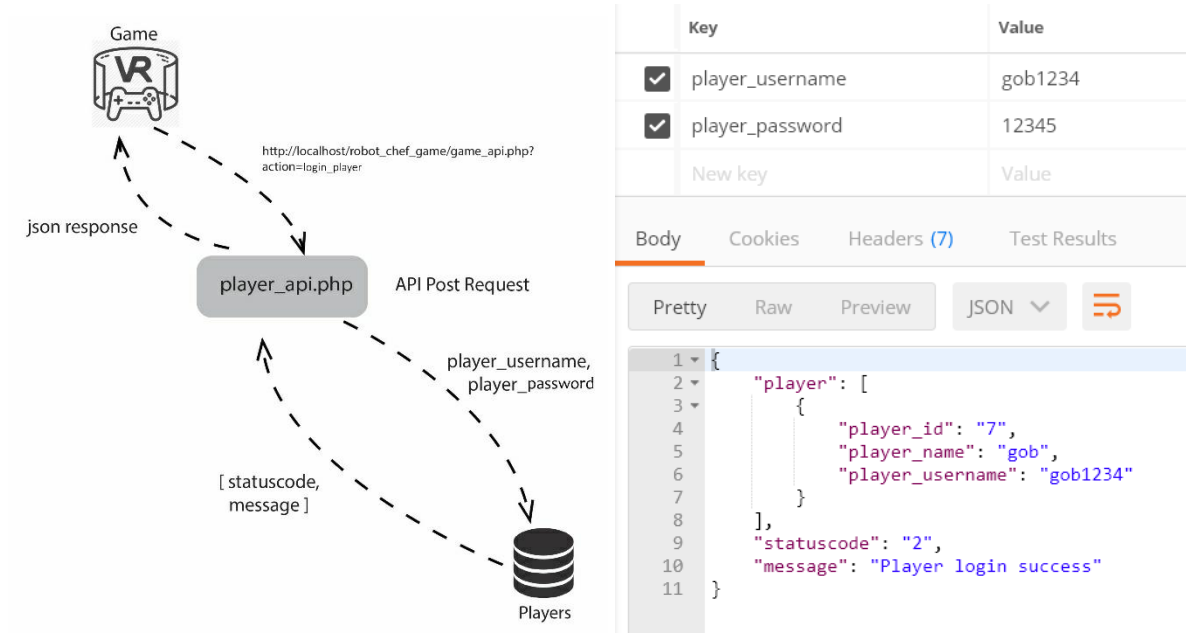


Figure 3.4 – Login API flow diagram and API response

The Figure 3.3 explains the login API request flow and the response flow with three parts which are, game application, API file and database. The game application directly connects with the API through appropriate URL. The post request includes the player username and password which will return the player details, status code and message as json responses. By checking the database with the appropriate username which will return the status code as success if the username doesn't exist in the database which will return an error.

3.5.2 Leaderboard API request and response flow

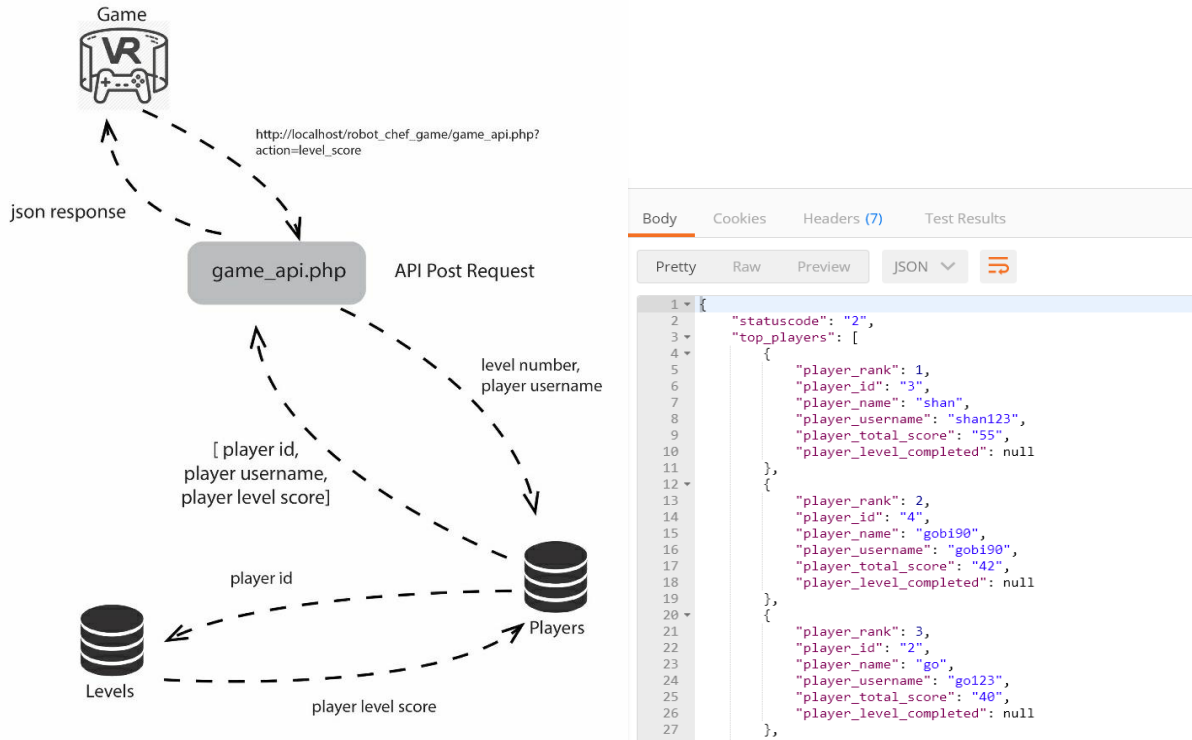


Figure 3.5 – Leaderboard API request and response flow

This above Figure 3.4 shows the leaderboard API request and the response flow with three parts including database. The game requests the API to get the leaderboard top player's score details through the appropriate API URL. There is no POST data to send before requesting and the response will be showed as JSON array with player details and player score.

3.6 Level Structure

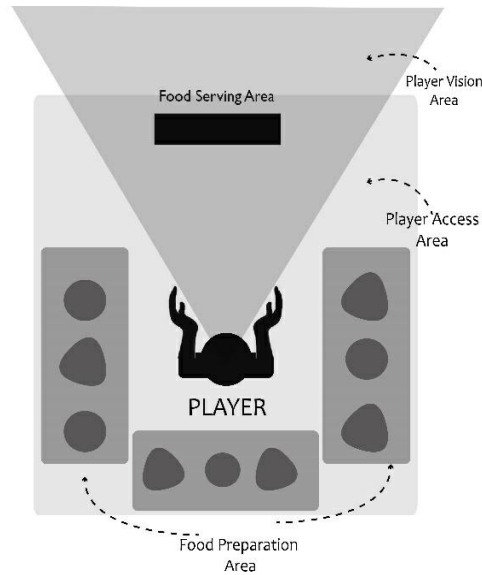
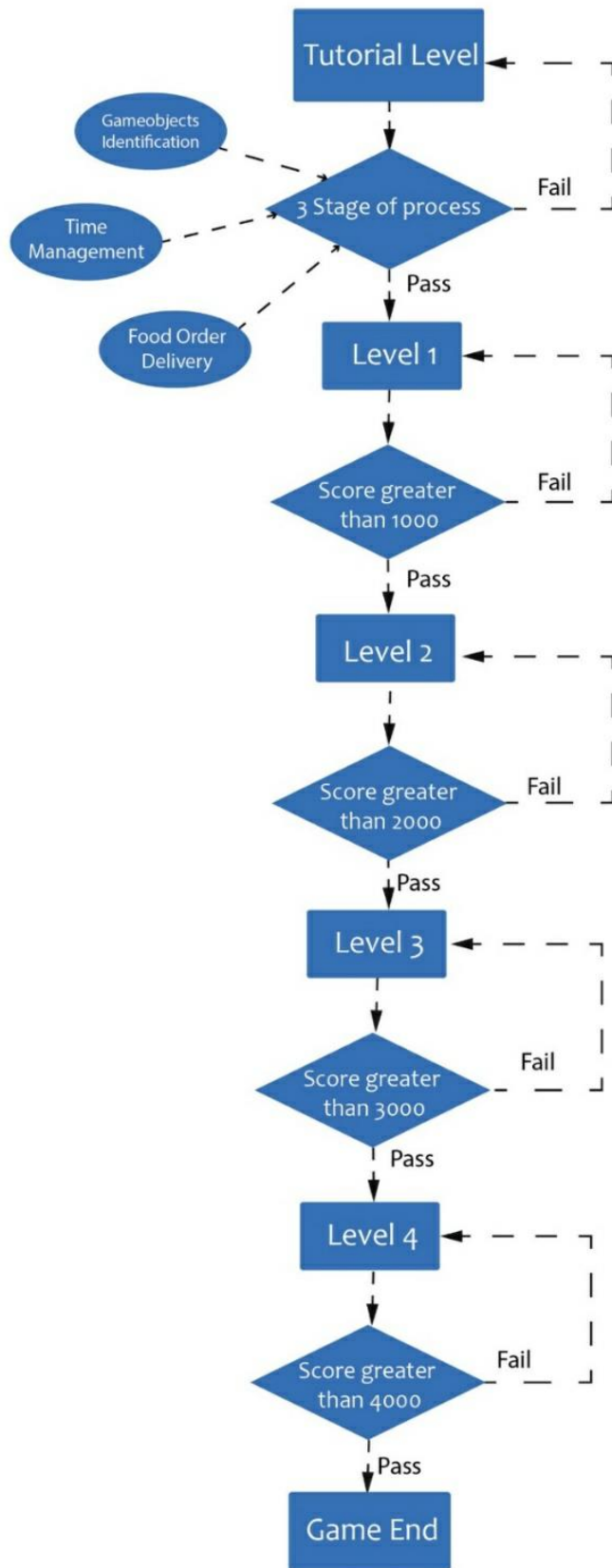


Figure 3.6 – Level structure diagram

The above Figure explains the level structure of this game where there is a limited game area where the player can able to access when using the virtual reality technology. Player vision will be reduced for limited orientation by using VR headset. Player access area , food preparation area , food serving area and player vision area are 4 areas which are visible in the gameplay.

- Player access area is the player centric area where the player can able to interact the game objects.
- Food preparation area is for to identifying suitable food products where player has to prepare food product to serve.
- Food serving area is the area to serving food product by picking product in the food preparation area.
- Player vision area is the limited vision area in the VR headset and player gets 360 degrees of vision area.



3.7 Level Flow Structure

The following Figure 3.7 shows the overall game level's flow chart by showing the 4 levels and a tutorial level. Game begins with the tutorial level to identifying the game logics and the game mechanics. Then player directed to the level series of gameplay. Each level has its own score points where the player has to gain by playing following levels.

Tutorial level has 3 stages to complete which are game object identification, time management and food order serving.

Figure 3.7 – Game level flow chart

CHAPTER 4

GAME DESIGN

This chapter explains the game design structure by including the game mechanics, level design, UI design and character design topics.

4.1 Game Concept

“ROBOT CHEF” is a 3D virtual reality based food serving game for PC. The main concept is the player has to prepare food and serve given food orders within the given time period. Player score will be stored separately for the

4.1.1 Game Story

Player will be played as food serving robot in a sci-fi restaurant which helps customers to prepare food dishes and serve it by the food orders system. Food orders will be displayed to the player where the player should consistently prepare the dishes and serving it within a given time period.

4.1.2 Goals/Objective

This game motivates players to complete all levels by scoring points required by each level. Player will be asked to score certain score points to unlock the next levels which indicates the player needs to maintain the minimum score points to unlock each level.

Single player – This game mode allows one player to play this game. The player has to achieve each level score points to unlock next level. Every player has their own data which includes the score points, completed levels and upgrade details separately.

4.2 Game Mechanics

4.2.1 Game Controls

The player has to wear the virtual reality headset to explore the immersive experience of the game world. And the player can control with their hands by using the Leap motion sensor. The game camera is parent with VR headset so, the game camera orientation depends on the VR headset’s orientation. Player can able to use grab/pick, drag, drop and move gestures to interact with objects using the Leap motion sensor.

Player has to use grab gesture to pick objects and drop gesture to drop/snap object to the correct position.

4.2.2 Game Logics

Player has to prepare the suitable food and deliver it to the correct order within the time period according to the food orders. The food orders will be displayed to the player separately during the gameplay. The game score depends on the time of delivery, speed, food product preparation and food order management. Player has to manage the time with the proper delivery order which makes the player

4.3 Game Levels

This has 5 levels including the tutorial level which will start at the beginning. Each level has score points to score which will unlock the next level and also player gets upgrades by scoring separately upgrade points also. Tutorial level is the first level to begin the game to understanding game logics and mechanics. The following Figure 1 shows the flow of each game level with each level's tasks.

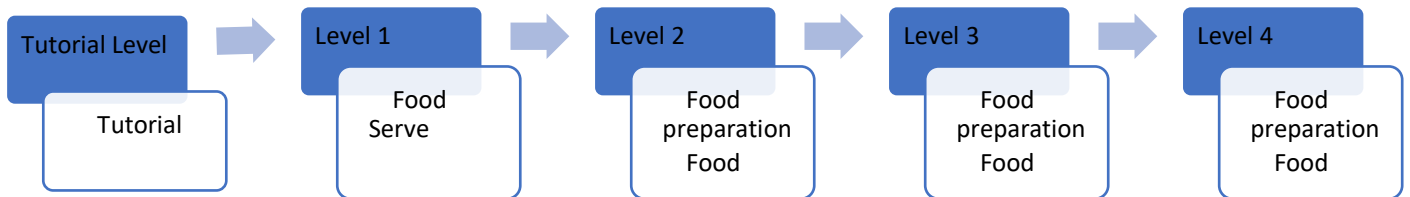


Figure 4.1 – Game level flow design

4.3.1 Game Challenges

- Player has to identify the suitable food products by seeing the food orders and serve the orders within the given time period.
- The player needs hand sensor device with the Virtual Reality Headset to interact the food objects.
- Each level unlocks with the specific score points which the player has to achieve it.
- Each food order has its own serving time where the player has to serve the food with in that time.

4.4 Level Design

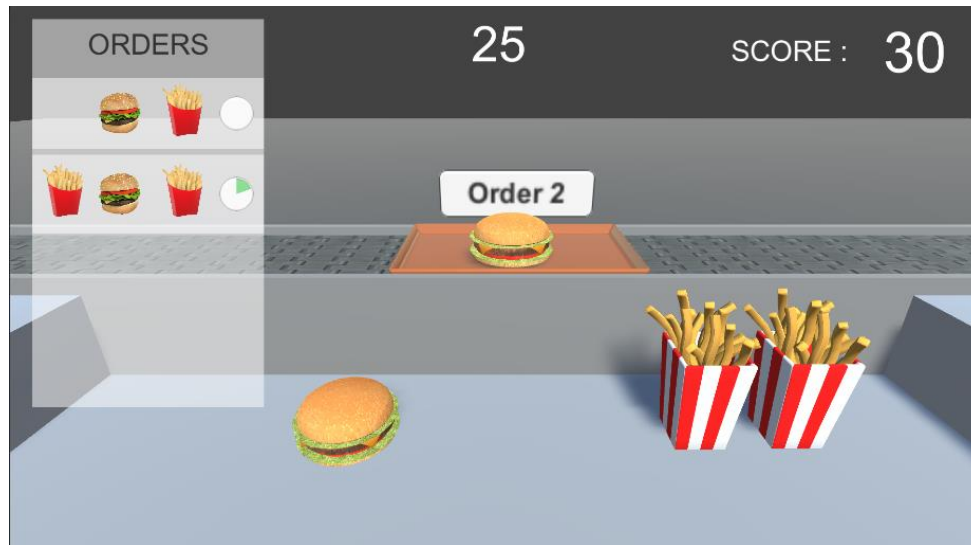


Figure 4.2 – Level gameplay HUD

There is a limited game area to access where using the Virtual Reality technology. Player vision will be reduced for limited orientation by using VR headset. Player access area, food preparation area, food serving area and player vision area are 4 areas where player focus in the gameplay.

- Player access area is the player centric area where the player can able to interact the game objects.
- Food preparation area is for to identifying suitable food products where player has to prepare food product to serve.
- Food serving area is the area to serving food product by picking product in the food preparation area.
- Player vision area is the limited vision area in the VR headset and player gets 360 degrees of vision area.

4.5 Player

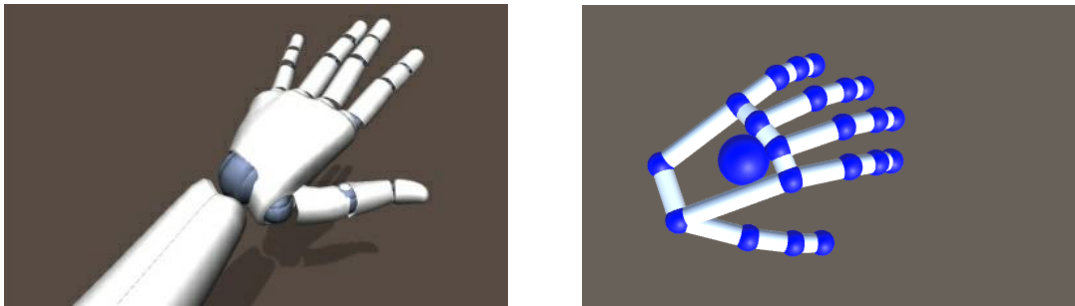


Figure 4.3 – Player representation

There is a partial visualization where player's hand will be displayed in the gameplay. Player can control the 3d hand with the leap motion device. Player can able to interact with the object using the device. Object picking, moving and dropping can be done using a hand gesture to the device. Additionally, player can able to interact with the game UI which gives the full freedom of controls to the player.

4.5.1 Player Tasks

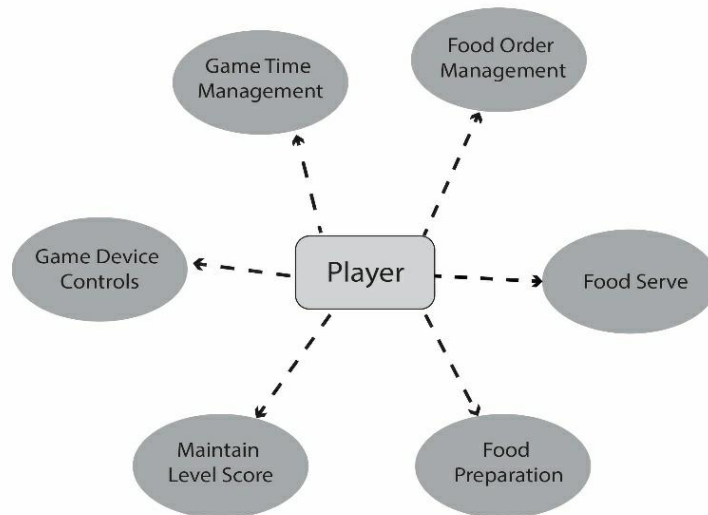


Figure 4.4 – Player's game play tasks

The above Figure 4 shows the player tasks in the gameplay and player should focus on these tasks to complete the game levels.

- **Game Device Controls** – Player has to control the game with the help of the VR device and hand gesture controllers.
- **Time Management** – Player has to be focus on the game time and food order individual time as well. Each food order has separate individual time for to complete the food order.
- **Food Order Management** – Food orders will display to the player to focus the food products. Each order has its individual time of delivery.
- **Food Serve** – Player should focus on the food orders menu and the game time to perform the food serving tasks.
- **Food Preparation** – Some level player will be asked to prepare the food dishes on time by the food order menu.
- **Maintain Level Score** – Each level has level score points to reach which unlocks the next level, otherwise the player has to play again the current level.

4.5.2 Obstacles

Time is the main obstacle for this game which affects the player’s score directly. Game level time and food order time are the two types of time constraints which indicates with the gameplay UI to alert the player to complete the tasks . Game level time indicates the main level time to give limitations to the level. Each level has separate game level time periods. Food order time indicates the time which holds each order. Food order will be terminated after end of order time.

4.6 Game UI Design

Game UI design mainly focus on the UI design of game menus, gameplay UI, buttons, and icons design. The following Figure 6.5 explains the each game menu’s connectivity where all game menu mainly connects with the main menu screen to perform each functionality.

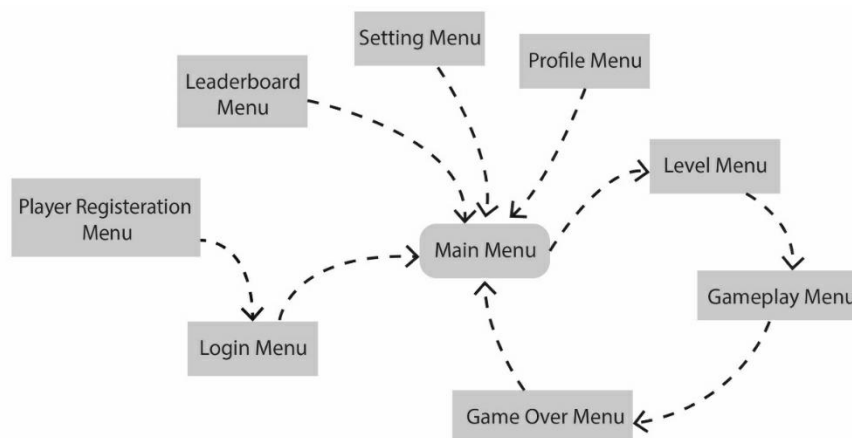


Figure 4.5 – Game menus connectivity

4.10.1 Login menu and Register menu



Figure 4.6 – Login menu and Registration menu

The above Figure 6 shows the both login and register menu screen design which will be displayed at the beginning of the game. The player should register and login to game to enter the game.

4.10.2 Game Main Menu



Figure 4.7 – Main menu

The above Figure 7 shows the main menu of this game which contains five main buttons including play, setting, leaderboard, profile and log out buttons. Top left corner occupied for player's username which comes along with whole game. Play button leads to the levels menu where the player can able to select the level and the leader board menu gives the global leaderboard screen.

4.10.3 Leaderboard Menu



Figure 4.8– Leader board Menu UI

Above Figure shows the game leaderboard menu design which includes the player's username and the scores to visually showcase the top 5 players.

4.10.4 Level Selection Menu

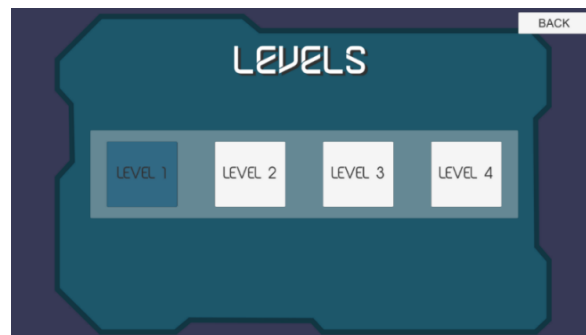


Figure 4.9– Level selection menu UI

The above Figure 4.9 shows the level selection menu to select the specific level to play the game. Each level has a certain score points to unlock the next level therefore, the player should achieve the level unlock points.

4.10.5 Gameplay HUD

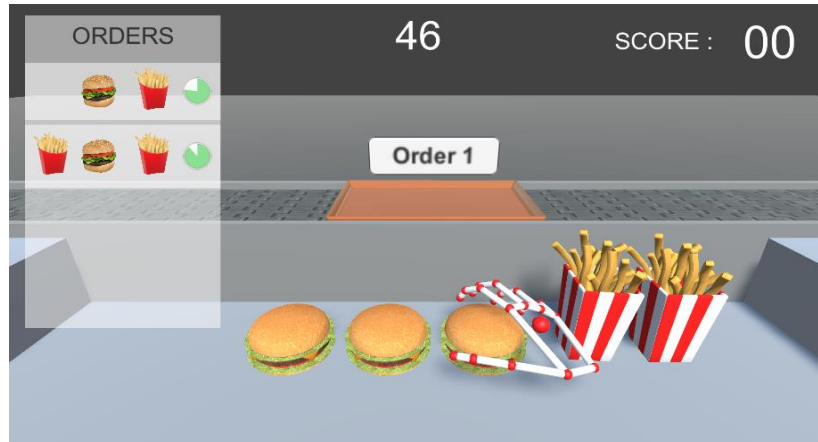


Figure 4.10 – Gameplay HUD

The above Figure 4.10 shows the heads-up display while in the gameplay which includes the food orders menu, game time and player score. Each food order has separate UI panel to handle the orders and individual time where represents food dishes images and time indication.

CHAPTER 5

TESTING AND EVALUATION

5.1 Introduction

This evaluation chapter provides the summary of the results of game testing as outlined document. Game testing is the process for quality control of a game which produces bug free game application to reduce the technical glitches. These are the categories to focus when it's on testing.

- Functionality Testing
- Compatibility Testing
- User Interface Testing
- Gameplay Testing
- Network and Server Testing

5.2 Functionality Testing

This testing is to identify bugs and errors in the game that may affect the user experience and determines the game is working according to the specifications. Game stability, game assets integrity and game play functions are the factors to look at in this testing.

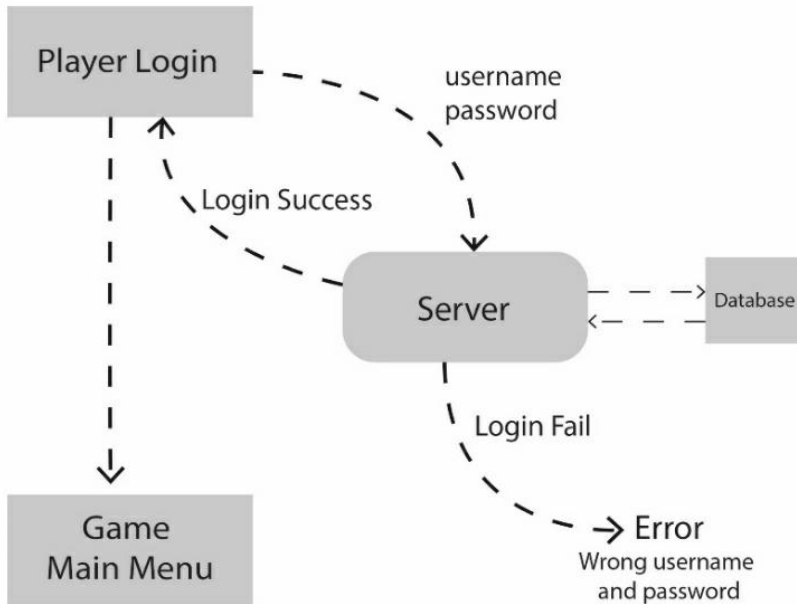


Figure 5.1 – Game login flow

5.2.1 Registration Menu Test Case

Test Case Name	Test Case Description	Inputs	Input Data	Expected Output	Actual Output	Result
Player registration – Positive	Player should register before playing the game.	1.Entering name 2.Entering valid username 3.Entering more than 6 characters of password.	Name - Test Username – Test123 Password – 1234567	Player registered successfully.	Text appear and indicate of success.	Passed
Player registration – Negative	Entering wrong and invalid inputs for to negative output.	1.Entering wrong password	Name - Test Username – Test1234 Password – 12345	Player registration failed.	Text appear and says to	Failed

Table 5.1 – Registration menu test case

5.2.2 Login Menu Test Case

Test Case Name	Test Case Description	Inputs	Input Data	Expected Output	Actual Output	Result
Player Login- Positive	Entering valid input of username and password.	Entering valid username and password	Username – Test123 Password – 1234567	Player login successfully and move to main menu.	Main menu appears	Passed
Player Login– Negative	Entering wrong username and password	Entering invalid username	Username – Test Password – 1234567	Player Login failed.	Text appear and indicate of incorrect username and password.	Failed

Table 5.2 – Login menu test case

Compatibility Testing

Compatibility is normally depending on the application’s hardware and software requirements when the final of the game. Additionally, this game holds the usage of external devices like VR headset and leap motion sensor which are need to be tested before using it. External device drivers and firmware updates should not interfere while using the final build of this game.

5.3 User Interface Testing

This is a testing ensures the usability of the game and includes the players user experience with the user interfaces of this game. User interface is giving the direct feedback from target audience to focus on. The UI response should guide the player to understand the scenario without complexing it. Should check the grammatical errors, spelling mistakes and language mistakes for reducing misleading meaning.

- **Menu functionality** – This is to make sure the game menus are properly working according to the user input with real-time response. And also, the usage of game data which are retrieve from the server should be properly shown in the game menu templates.
- **Game play UI functionality** – Heads up display UI includes the score, game time and other game data which are should properly organized in the UI layout. Scores and game time should be performing the real time response according to the player input. Game over menu UI should leads to the final score and level position of the player.

5.3.1 Game Menu Test Case

Test Case Name	Test Case Description	Inputs	Input Data	Expected Output	Actual Output	Result
Main menu - Check	Checking main menu after logged in	Checking the main menu buttons	Clicking 4 buttons and checking	1.Leaderboard Button to leaderboard 2.Play button leads to level selection menu		Passed

Table 5.3 – Game Menu test case

5.4 Gameplay Testing

This is the main functionality testing to prove the game play is bugs free and utilize distinctive requirements. Gameplay testing divided into 4 categories to focus while testing.

- **Game logics and mechanics testing** - Game mechanics that have to be tested in isolation, actual work in different level implementations. The complexity of the game should be in a balance of game design to get player's attention. Therefore, should check the difficulty of each level to passable to next level of the game.
- **Gameplay UI testing** – Should check the game time UI and score UI to updating with real-time responses.
- **Game progress saving testing** – Game level score and player's current level position should update to the server whenever game level ends.
- **Game graphics testing** - Game graphics performance should be modified according to the player's graphics specifications. Should check the game animations are in realistic and to make sure the visible area of gameplay should be playable without any interference.

5.5 Network and Server Testing

This is for the network and server testing to check server request and response while playing this game. The request API URL has to be properly indicate the request methods which is for to get the proper responses with retrievable data.

5.5.1 Game Score API Test Case

Test Case Name	Test Case Description	Inputs	Input Data	Expected Output	Actual Output	Result
Game Score API - Positive	Checking game score API URL with positive input data.	Player username and player score will be sending through post method with the actual API URL.	URL - robot_chef_game/player_api.php?action=player_score Method – POST Player_Username – test123 Player_score - 50	Result in database should update with the new score points to the username.	Text indicates player score updated and database showing the new update score points to the username.	Passed
Game Score API - Negative	Checking with invalid inputs to get negative result.	Sending invalid username to the actual API URL.	URL - robot_chef_game/player_api.php?action=player_score	Result should show an error which indicates the invalid username.	Text indicating that the player score updating failed and additionally indicating the	Failed

			Method – POST Player_Username – 1234 Player_score - 50		invalid username.	
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Table 5.4 – Game Score API test case

The above table 5.4 explains the test case of game score API request and it includes positive testing and negative testing period. Overall this testing method tested the API request with the appropriate responses. The API URL ,POST method data and responses was checked in the testing period by putting a series of data for the expected responses.

5.6 User feedback

The Figure 5.2 shows the questions to get the player’s feedback after finishing the game which gives the statistical feedbacks.

Which level make you think harder? *

- Level 1
- Level 2
- Level 3

Which devices make you think runs smoothly? *

- Leap motion
- VR device

What is your highest score for a level? *

- 0 - 100
- 100-200
- 200 -300
- 300-400
- Above 500

What is your opinion about the game graphics? *

- Best
- Good
- Medium
- Poor
- Very Poor

Figure 5.2 – User feedback questions

5.7 Levels complexity

This topic describes the user feedback by giving the statistical diagrams of level complexity. The following Figure 5.3 shows the graph of level complexity by using player's average score of each level to calculate the level complexity value. The expected value of level complexity starts from the level 1 which indicates the game mechanics needs to be easier to complete the game levels [6].

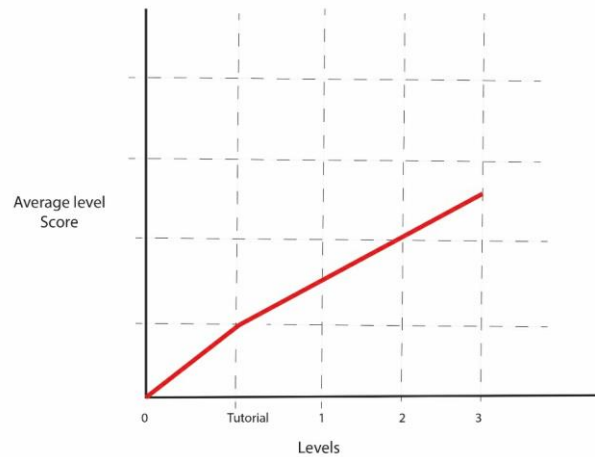


Figure 5.3 – Level complexity graph

Most players feedback points as the hardest level to the second level where the players get the lowest level score in the second level.

Chapter 6

Conclusion

6.1 Introduction

This final chapter concludes this report with the following topics like future development, user aspects and project challenges. This project described an approach to create VR game which has proper game mechanics and logics by exploring the game components. The players were enjoyed the entertainment aspects of VR technology and experienced the virtual game environment views. A few functionalities that could have been implemented to provide an effective outcome. These functionalities will be explained in the future development topics below.

6.2 User aspects

Which level make you think harder?

23 responses

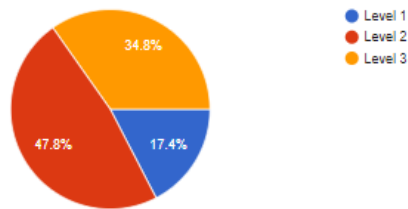


Figure 6.1 – Feedback of level complexity

User aspects explains the feedback from the users/players who have played this game. The above Figure 6.1 show the questionnaire results which indicates the level complexity. As per the user feedbacks level 2 is the complex level of this game which needs to keep the average complex value.

Which devices make you think runs smoothly?

23 responses

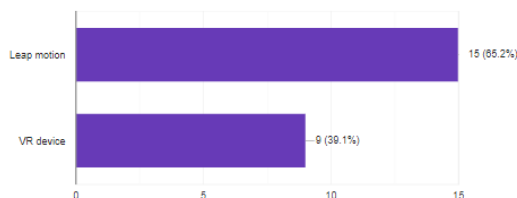


Figure 6.2 – Feedback of device usability

The above Figure 6.2 shows the device feedbacks without any delays where the Leap motion sensor gives the smoothest running device than the VR headset.

What is your opinion about the game graphics?

23 responses

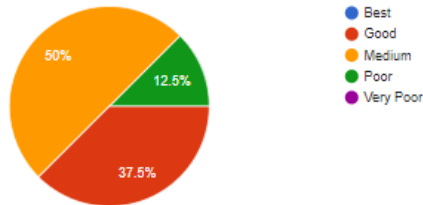


Figure 6.3 – Feedback of game graphics

Figure 6.3 shows the game graphics quality feedbacks from the players who have played this game. Overall the game graphics seems medium quality by using the VR device and the Leap motion sensor. The graphics should be optimized for the real-time process without any delays while playing the game.

6.3 Future Enhancement

This project would extend to the device usability and effectiveness of the virtual reality with more levels and more complex game mechanics. This game will include multiple combinations of gesture to perform more game controls to handle complex interactions with the devices [8].

Two players challenge - One player can able to challenge other players to play the game online.

Additional game upgrades - This upgrade feature gives additional motivation to gain extra scores.

Upgrades can be add in-app purchases which gives more profitable product [7].

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APPENDIX

CODE SNIPPETS

This section shows the main functionalities with the appropriate code snippets to explain how the code works. C# is the main programming language for this project which indicates the supported IDE is Unity3D. The following functions give the proper code explanation of the specific functionalities.

Leaderboard function

```
1 reference
void LeaderBoardPlayer_List(List<object> playersList)
{
    Dictionary<string, object> entry = new Dictionary<string, object>();
    entry.Clear();

    for (int i = 0; i < playersList.Count; i++)
    {
        entry = (Dictionary<string, object>)playersList[i];

        string player_id = (string)entry["player_id"];
        string player_username = (string)entry["player_username"];
        string player_score = (string)entry["player_total_score"];
        string player_rank = (string)entry["player_rank"].ToString();

        if (player_rank == leaderBoard_UI_Objs[i].GetComponent<LeaderBoard_Player_UI>().player_rank.ToString())
        {
            // LeaderBoard_Players_Update(player_username , player_score);

            leaderBoard_UI_Objs[i].GetComponent<LeaderBoard_Player_UI>().player_username = player_username;
            leaderBoard_UI_Objs[i].GetComponent<LeaderBoard_Player_UI>().player_score = player_score;
        }
        Debug.Log("Player Rank : " + player_rank + "Player Username : " + player_username + "Player Score : " + player_score );
    }
}

0 references
void LeaderBoard_Players_Update(string username , string score)
{
    for (int i=0;i< leaderBoard_UI_Objs.Length;i++)
    {
        leaderBoard_UI_Objs[i].GetComponent<LeaderBoard_Player_UI>().player_username = username;
        leaderBoard_UI_Objs[i].GetComponent<LeaderBoard_Player_UI>().player_score = score;
    }
}
```

This is the code segments of fetching data from leaderboard API URL to the leaderboard menu. The response data will be parsed to a array list and a for loop function will be looping to fetch all JSON array into a normal array list in C#.