SKKU Flea Market

Software Requirement Specification

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Introduction to Software Engineering

TEAM 10

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1. Introduction

1.1 Purpose

This document is a Software Requirements Specification (SRS) for providing Metabus Campus SKKU Flea Market Service. This service is designed and implemented by Team 10 of the Introduction to Software Engineering at Sungkyunkwan University. The requirements for this are summarized, analyzed, and the system is designed and implemented based on the contents described.

The purpose of this document is to outline and publish the Requirement Specification for a new metaverse campus service providing flea market service for students on VRChat platform.

1.2 Scope

This system is designed to hold an actual flea market in a metaverse space, encourage student users to socialize with each other, actively trade used items, and enjoy the metaverse campus life. The system is based on the metaverse platform 'VRChat' application which is windows application providing online VR environment. The system is not a program, nor including the front-end or back-end application, but the 'World' in VRChat which means the new service user can experience in VRChat. The system is developed by using VRchat SDK and Udon which are a Software Development Kit and a programming language provided by the VRChat Development Team.

1.3 Definitions, Acronyms, and Abbreviation

Table 1 Table of acronyms and abbreviations

Acronyms& Abbreviations	Explanation
SKKU	Sung Kyun Kwan University
VR	Virtual Reality
VRCSDK	VRChat Software Development Kit
SDK	Software Development Kit
QR Code	Quick Response Code
UML	Unified Modeling Language
MVC	Model, View, Controller
PK	Prime Key
FK	Foreign Key

The following table defines certain technical terms used in this document.

Table 2 Table of terms and definitions

Terms	Definitions
Steam	Video game digital distribution service platform
VRChat	Online virtual world platform
World	Environment which provides unique features in VRChat
Avatar	Player's character in VRChat
Udon	Programming language used to develop world on VRChat.
Model	Dynamic data structure, independent of the user interface
View	Any representation of information using Model
Controller	Accepts input and converts it to commands for the Model or View

1.4 References

Team 1. "SRS_TEAM1.docx". SKKU, Last Modified: Jun. 15, 2020.
https://github.com/skkuse/2020spring_41class_team1/tree/master/docs/SRS_TEAM1.pdf

IEEE Std 830-1998 IEEE Recommended Practice for Software Requirements Specifications, In IEEEXplore Digital Library. https://web.cs.dal.ca/~hawkey/3130/srs_template-ieee.doc

1.5 Overview

This Document includes four chapters and appendixes.

The First chapter, 'Introduction' provides an introduction of the document and the service. It provides the purpose of this document, the scope of the service of this document, definitions of the technical terms, and the overview description of this document.

The second chapter, 'Overall Description' provides an overall description of the product perspective including the several interfaces of system, user, hardware, software, and the operations that the users and the system administrator can interact with the service. And It also provides the descriptions of the product functions, the user characteristics of admin/user/vendor, the constraints, and the assumptions/dependencies of the system.

The third chapter 'Requirements Specification' provides the overall requirements specification of the service in detailed terms. It specifies external requirements including the user interfaces of the user interactions with the service, the software/hardware interface, and the communication interface. And It specifies the functional requirements, defining all the

functions for the users and the system administrator with detailed information of actor, course, pre/post conditions and the figures such as ‘use case diagram’ and ‘data flow diagram’. It also provides the product itself requirements including usability, performance, dependability, safety, maintainability, and the organizational requirements including environmental, operational, development, and the system requirements about safety, regulatory, limitations, and the evolution.

The fourth chapter ‘Supporting Information’ is about software requirement information and the document history.

2. Overall Description

2.1. Product Perspective

This system is designed for certain people who want to see or purchase SKKU goods or trade used items between users. This system will make it convenient for those people to select the product that will satisfy all their requirements by seeing the appearance and the price of items and comparing them. If people want to purchase a product, they can easily access the selling page.

2.1.1. System Interfaces

Users will interact in Unity, a VRChat based map. By using VRChat for inter-communicate, users can create their own 3D map or 3D avatars with VRChat SDK.

Unity is a game engine that provides a development environment for 3D and 2D video games and an integrated production tool for creating interactive content such as 3D animation, architectural visualization, and virtual reality.

VRChat is a large-scale, multi-user online virtual reality social service. In this VRChat system, users can interact with other users implemented as 3D character models.

2.1.2. User Interfaces

Map interfaces are provided through the VRchat platform, and the basic operation method is the same as that of VRchat. Users can move on the map through W, A, S, D keys. Users can change the viewpoint through the mouse and can interact with the object through left click. And users can communicate with other users through a microphone.

2.1.3. Hardware Interfaces

The system is intended for VRchat on desktop. For executing VRchat on desktop, it is needed to have at least 4GB ram and graphic card such as NVIDIA GeForce GTX 970, AMD Radeon R9 290, and Intel UHD Graphics 610.

2.1.4. Software Interfaces

The system is intended for VRchat and it is made using Unity 2019.4.30f1 and VRchat SDK3 (VRCSDK3-Avatars, VRCSDK3-Worlds).

2.1.5. Memory Constraints

The system should run on a desktop with least 4GB RAM for primary memory and the system requires at least 512 MB for installation and execution.

2.1.6. Operations

2.1.6.1. System administrator

- Making rooms

✓ Create a room for the type of products which are sold by sellers

✓ Make a object which is representing that type

✓ Users can make a trade in this room

- Making items

✓ Register pictures and price of objects which are sold on a web page

✓ Make a QR code which is linking the item and the web page

- Manage a bulletin board

✓ Register contents of product sales details for a promotion

✓ Delete promotions that have passed the registration period

2.1.6.2. User

- Entering

✓ Users can come to the ‘SKKU Flea Market’ through VRchat platform

- Register

✓ Users can register into the system just by downloading the map

✓ When users register into the system, users have to go through the authentication procedures

- Communication

✓ Users can communicate through chat using a keyboard, and communicate through a microphone at a close distance

- Trade between users

✓ Users make a deal by communicating with each other, and sharing their kakaotalk ID

- Purchase SKKU goods

✓ Users can see goods symbolizing the school

✓ Users can buy the goods by linking to QR code

- Menu operation

✓ Users can access the menu environment basically provided by VRchat, such as changing appearance or leaving the map through the esc key

2.2. Product Functions

2.2.1. Entering

After the users download VRchat, users can enter the map via searching our map name, “SKKU flea market”. After users login to the map, users can set the environment by pressing esc, for example, personal space, microphone, mouse sensitivities, voice options, and etc. If the users who want to sell something, should make their avatar with caps, and those who want to buy should make their avatar without caps, making them recognizable to each other.

2.2.2. Trading Method

After entering this world, if users want to trade their own product with other users, they have to find a room which is suitable for the category and enter. It is possible to distinguish whether it is a seller or a buyer through the users' appearance, and trades are made via voice chatting. They can share the details of products and check the pictures of products.

2.2.3. Promotion System

Since the promotion system is a single-time advertisement, it is a system that provides differentiation to sellers and promotes official events and official information to schools by promoting a total of five promotional items or five events and information on a large bulletin board. As a way to select five promotional items and promotions, five items are selected and promoted on a first-come, first-served basis by receiving mail contact from the map manager the day before the flea market opens. However, inappropriate items or promotions should be distinguished and promoted by the manager.

2.2.4. Link System

The SKKU flea market map will provide a booth that sells official goods sold by SKKU. When making a map, we will set photos on a map of official goods pictures sold by the university, show them at the booth, and provide QR codes that can be taken in front of them, so that they can be linked to the university's official sales website where you can buy university goods using QR.

2.2.5. Security System

First, before accessing the map, the password to prove that you are a student at Sungkyunkwan University on the system is provided only to SKKU students and allowed to enter. Within the map, we will introduce VRchat's own safety system. The "Safety" is a new menu tab that allows you to configure how users of each rank are treated in regards to how they display for users in VRchat. Users can handle voice, avatar, user icon, avatar audio, animations, shaders, and particles and lights.

2.2.6. Integration Ability

If Sungkyunkwan University provides a map of implementing the campus map for the Untact-Festival, integration ability will be enhanced by implementing portals. At the border of the SKKU flea market map implementing portals for connecting with SKKU map, and other maps designed by other teams, the integration between maps would be done.

2.3. User Characteristics

2.3.1. System Administrator

System administrators are limited to those who created the map or those who have sufficient knowledge and understanding of the map system. It is assumed that the system administrator may control problems occurring in the map and reflect the needs of users in the map. In other words, it refers to a person who has experience in creating a map using Unity after playing various maps of VRchat.

System administrators have roles such as adding space or changing part of the map according to the user's request, registers and deletes promotional bulletin boards, and manages school goods.

2.3.2. User

The users generally referred to in this document can be either seller or purchaser. Users are assumed to have the ability to speak Korean or English in a smooth way and understand its meaning and want to make a trade with other students or buy some school goods in the online trading system.

It is assumed that users have enough language skills to install and run VRchat, and that they have experience using VRchat enough to download the ‘SKKU Flea Market’ map and enter the map.

Generally, it is assumed that students who belong to Sungkyunkwan University regardless of age.

2.3.3. Vendor

Vendor is assumed to be a person who sells various goods on a university's official sales site and has knowledge to upload and sell things online at the shopping mall. It is assumed that the vendor is selling goods which are related to Sungkyunkwan University. And it is generally assumed that the school officials who sell goods online are vendors of this system.

2.4. Constraints

The system will be designed and implemented based on the contents mentioned in this document. Other details are designed and implemented by selecting the direction preferred by the developer, but the following items are observed.

- Use the technology that has already been widely proven.
- Avoid using technology or software that requires a separate license or pays for royalty.
- (Use the external data which is for free after checking the license.)
- Decide in the direction of seeking improvement of overall system performance.
- Decide in a more user-friendly and convenient direction

- Specify the source clearly when using open data
- Optimize the way building map to prevent waste of system resources
- Consider the system cost and maintenance cost
- Consider future scalability and availability of the system
- Consider future maintenance and add sufficient comments when building the map
- Develop with VRchat on desktop as metaverse platform
- Develop with Unity 2019.4.30f1 as tools making a map
- Develop with VRchat SDK3 (VRCSDK3)

2.5. Assumptions and Dependencies

All systems in this document are written on the assumption that they are designed and implemented based on the developing environment such as VRchat platform and Unity tools. Therefore, all contents are written based on the VRchat platform with SDK version 3 (VRCSDK3) and may not be applied to other operating systems or versions.

3. Requirements Specification

3.1 External Requirements

3.1.1 User Interfaces

Table 3 Table of General user interaction with avatar

Description	General user interaction with avatar
Description	The user of the system can manipulate avatar through a keyboard or HMD
Input source / Output destination	From user hardware(keyboard/VR device) to udon system button events.
Types	Types/InputJump : Spacebar on Desktop, typically a face button on controllers. Types/InputUse : Left-Click on Desktop, typically a trigger button on controllers. Types/InputGrab : Left-Click on Desktop, typically a grip button on VR controllers. Types/InputDrop : Right-Click on Desktop, press grip button on Vive Wands and some Windows Mixed Reality Controllers, release grip button on others.
Relationship with avatar	In general, each input acts as intended. (ex. Input Jump jumps and Input Use uses.)

Control restrictions	As long as other UIs do not have the control of the inputs, the avatar obtains control.
Time	The input should be async, and has high priority for user experience.
Data type	Udon system event class

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Table 4 Table of General user interaction using VRchat pointing.

Description	General user interaction using VRchat pointing.
Description	The general user interaction with the udon system, user can click the buttons and trigger the events. Using vrchat pointer.
Input source / Output destination	From user to udon system.
Execution	Asynchronous input, handle by event loop
Relationship with avatar	It will block other ui events. But the handler can be asynchronous.
Format	udon nodes/assembly
Interaction	1. The button click triggers a specified event. 2. Click on the textbox allows the textbox to get a keyboard input.
Screen	The UI seems to be floating in the air to the user. Therefore, all UIs must be visible in the user's field of view. The pointer should be able to point all components of the UI.

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Table 5 Table of Business Room

Description	Business Room
Description	It provides an interface for creating a room where exchanges take place. Sellers and buyers should be able to communicate with each other about goods. Buyers and sellers must be able to chat and deliver sales confirmation information to the database.
Input source / Output destination	From user to system
execution	It blocks user input events of all other UIs.

Format	TextBox : user chat, TextLabel : user chat logs, Button :Successful transaction, Transaction evaluation. .
Range	Chat log should be able to show everything. Updates are made in the database for every 100 chats. The transaction success button should be pressed once.
Type	Udon classes, text,textlabel, button
Exit	If the transaction has not been completed or evaluated, a notice will be posted.
Relationship with other user ui event	Bussiness Room can trigger Posting, Post List

Table 6 Table of Posting

Description	Posting
Description	Sellers should be able to write appropriate promotional articles. Consumers look at this article and inquire about purchases. Information such as title, product description, and price is input.
Input source / Output destination	From User to udon database system.
Types	Udon nodes/assembly, textbox textlabels, imageview
Relationship with other user ui event	Posting can be accessed from the postlist.
Format	TextBox : title, product information, price information, SelectBox : product category. ImageView: product image ImageView: QRCode
Exit	It should be confirmed that all information has been properly filled out. Otherwise, output a warning message. If the user cancels the writing, it ends when the user confirms after outputting a guide message.
Execution	Block other UI events, it takes all the user io events.

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Table 7 Table of Post List

Description	Post List
Description	It shows a list of posts posted by sellers. Users can register sales articles or check the seller's post.

Input source / Output destination	From User to udon database system.
Execution	It blocks user input events of all other UIs.
Format	TextBox : search, TextLabel : post titles, seller info,post date, page index Button : Enter to the post, Upload post, When the user searches for a product, the search input text queries the udon database system for input. Postlist parses and updates the contents newly updated by database.
Range	Each Pages shows max 20 posts
Type	Udon classes, text,textlabel, button
Exit	N/A
Relationship with other user ui event	PostList can trigger Posting UI, Posting UI exit will return to Post List,

Table 8 Table of Create a bulletin board

Description	Create a bulletin board
Description	Various boards are provided so that users can easily find the product they want.
Input source / Output destination	From User to udon database system
Execution	It blocks user input events of all other UIs.
Format	TextBox : board title, board description, Button : Upload the board, When the user enters board information into the board Title textbox and presses the Upload button, board in the udon system database
Range	N/A
Type	Udon classes, text,textlabel, button
Exit	When leaving, the PostList should check if there is a title for the same room.
Relationship with other user ui event	PostList can trigger Posting UI, Posting UI exit will return to Post List,

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Table 9 Table of VR Voice Communication

Description	VR Voice Communication
Description	Users can communicate through a microphone at a close distance
Input source / Output destination	Client / VRchat server
Execution	Async
Format	VRChat voice Stream
Range	10m
Type	Stream
Exit	Click mute button on ui
Relationship with other user ui event	N/A

3.1.2 Software Interface

1. The SKKU flea market shall communicate with the Users to control all the available components like Avatar Control, SKKU goods market

2. The SKKU flea market shall communicate with the System Administrator to control all the available components like Market World Managements, SKKU goods market registration management.

3.1.3 Hardware interface

Table 10 Table of hardware specification

name	specification
Computer	same as VRChat Minimum specification Intel® i5-4590 or higher AMD FX 8350 or higher more than 4GB RAM. NVIDIA GeForce® GTX 970 or higher AMD Radeon™ R9 290 or higher Intel UHD Graphics 610 or higher
Head Mounted Display	All HMD that support VRchat. Device like HTC VIVE,Oculus Rift, Oculus Quest, Valve Index

3.1.4 Communication interface

Table 11 Table of Client to udon system Interface

Description	Client to udon system
Description	Client updates their database to udon system. The udon system provides the ability to synchronize object data. Therefore, when the client communicates with the database of the udon system, other clients may receive the same database.
Input source / Output destination	client/host
Unit	Async
Time	depends on VRchat server
Relationship with other IO	All database queries
Format	size (limit), from (offset), sorting (ordering by), filtering, aggregation (sum, count, distinct) in object field.

3.2. Functional Requirements

3.2.1. Use Case

Table 12 Table of Use Case - Unregistered user

Use case name	Register
Actor	Unregistered user
Description	It is the process when an unregistered user tries to register with our system to use the functionality of the system.
Normal Course	1. All users face the log-in page when they execute the application. 2. Since our system allows only registered users to log in and use, the unregistered user clicks the register button within the log-in page. 3. The user who presses the register button is redirected to register page. 4. Unregistered user enters their profiles according to the register form to proceed with their registration. The information required to register includes: I. Email-address (ID) II. Password III. Nickname (doesn't have to be unique) IV. Age

	V. Gender 5. The system sends a verification code to the email address entered in the form. This is to make sure that the email address is correct in case of finding the password through email. 6. When the user finally clicks the Register button after filling out the form, the information is registered and returns to the login page.
Precondition	The user has not yet been registered in the system. The user enters the correct form of information. The email address entered by the user does not overlap with the already registered email address. The system checks the format of the email address and password to see if there is any information incorrectly entered by the user.
Post Condition	For security purposes, the password must be encrypted and stored in the user management database.
Assumptions	N/A

Table 13 Table of Use Case - Registered user

Use case name	Register
Actor	Registered user
Description	Login is a process when a registered user tries to enter the system to use the service. Logout is a process when a registered user tries to come out of the system after completing service use.
Normal Course	● Login 1. Users whose information is registered in the system want to enter the system to use the service. 2. When all users run the application, they face the login page. 3. After entering the email and password entered when registering, click the login button. 4. Check if the account matching the email entered is registered in the system, and if the information is correct, the system allows the user to enter the system, and then goes to the main market page. ● Logout 1. Users who have logged in and have finished using the service want to log out. 2. The user clicks the logout button (the logout button is on the main market page or profile page). 3. When the user terminates the application without clicking the logout button, the system arbitrarily terminates the session for that user.

Precondition	● Login The user should already be registered in the system. ● Logout The user should be in a logged-in status.
Post Condition	The user should be connected to network.
Assumptions	N/A

Table 14 Table of Use Case - Registered user2

Use case name	Register
Actor	Registered user
Description	It is the page where the user is able to check and modify the user information that the user entered when registration.
Normal Course	1. The user clicks the 'Profile' button to go to the profile page. 2. Users can check and modify the information entered at the time of registration. 3. If the user wants to modify the information, click the edit button to activate the information modification. 4. After the user modifies the information and clicks the 'edit' button one more time, the modified information is updated in the database and returns to the previous page.
Precondition	The user should be in a logged-in status and connected to network.
Post Condition	After the modification is completed, the information must be delivered to the database server and updated.
Assumptions	N/A

Table 15 Table of Use Case - Registered user3

Use case name	Register
Actor	Registered user
Description	It is the process when searching for the product the user wants. It shows products that match the search keyword.
Normal Course	1. After logging in, the user clicks the 'Search' button. 2. The user enters the ID or the keyword of the message of the product he or she wants to purchase. 3. The system searches for product information that matches this ID or message's keyword. 4. Display the search results as a list to the user.
Precondition	The user should be in a logged-in status and connected to network.
Post Condition	N/A
Assumptions	N/A

Table 16 Table of Use Case - Registered user4

Use case name	Register
Actor	Registered user
Description	It is a process when a user who wants to purchase a product checks the detailed information of the product.
Normal Course	1. The user can see more information by clicking on a specific product image or ID in the product list. 2. The user goes to the details page of the specific product. 3. Users can check product details including product ID, price, product description, and image. 4. When the user clicks the 'Back' button, it returns to the product list page.
Precondition	The user should be in a logged-in status and connected to network. There is one or more items shown to the user.
Post Condition	N/A
Assumptions	N/A

Table 17 Table of Use Case - Registered user5

Use case name	Register
Actor	Registered user
Description	It is a process in which the user wants to set a specific product as a potential purchase item.
Normal Course	1. The user wants to check the product and indicate that he or she is willing to purchase it. 2. When the user presses the 'Add to cart' button on the product list or detailed page, product information is stored on the wish list page.
Precondition	The user should be in a logged-in status and connected to network. There is one or more items shown to the user.
Post Condition	Product details should be saved in the database.
Assumptions	N/A

Table 18 Table of Use Case - Seller

Use case name	Register
Actor	Registered user (seller)
Description	This is the process when sellers expose their products to more users. Users can check the product, or official events or information.
Normal Course	1. Users who want to promote send information on the product they want to promote or details of the official event to the administrator on a specific day. 2. Products or official event information selected through specific criteria are entered into the promotion bulletin board.
Precondition	The user should be in a logged-in status and connected to network. The user should send information on promotional products to the administrator according to specific criteria on a specific date.
Post Condition	Items to which promotion is applied can be found on the promotion bulletin board.
Assumptions	N/A

Table 19 Table of Use Case – Seller2

Use case name	Register
Actor	Registered user (seller)
Description	It is the process when the user registers information of the item.
Normal Course	1. If the user wants to register a new item for sale, click the 'product register' button. 2. The user enters product details including the following information. I. Product ID II. Price III. Message IV. Image 3. When the user clicks the 'Registration' button, it is added to the product list, and other users can see it.
Precondition	The user should be in a logged-in status and connected to network.
Post Condition	When the product registration is successfully completed, it appears in the product list. It is also forwarded and updated to the database server.
Assumptions	N/A

Table 20 Table of Use Case - Buyer

Use case name	Register
Actor	Registered user (buyer)
Description	It is a process that connects with the seller of the product when the user wants to purchase a specific product.
Normal Course	1. The user clicks the 'connect to vendor' button on the product details page. 2. A room is created to communicate with product sellers.
Precondition	The user should be in a logged-in status and connected to network.
Post Condition	A room containing users and product sellers is created.
Assumptions	N/A

Table 21 Table of Use Case – System administrator

Use case name	Register
Actor	System administrator
Description	It is a process of creating an item or room when a system administrator receives a product registration or a connection to vendor request.
Normal Course	● Making rooms 1. The user tries to contact the seller to purchase the product. A request is received from the system administrator by clicking the 'connect to vendor' button. 2. The system administrator opens a room on the server and invites the user who clicks the button and the seller of the product. ● Making items 1. The user enters the product details and clicks the registration button. 2. Registration information is transferred to the database server, which is checked by the system administrator. 3. After the system manager's confirmation, the product is added to the server's product list so that users can see it.
Precondition	The user should be in a logged-in status and connected to network.
Post Condition	Rooms are opened on the server or products are added to the product list.
Assumptions	N/A

Table 22 Table of Use Case – System administrator2

Use case name	Register
Actor	System administrator
Description	It is the process when a system administrator registers a product on the bulletin board when a promotion product registration request is received, or deletes an expired or inappropriate product from the bulletin board.
Normal Course	1. A new promotion request is received on the bulletin board. 2. The system administrator selects content to be posted according to a specific criterion and stores it in a database server. 3. If there is an expired promotion or inappropriate promotion, modify it and save it to the server.
Precondition	The user should be in a logged-in status and connected to network.

Post Condition	The modified content on the bulletin board is delivered to the database server and saved.
Assumptions	N/A

3.2.2. Use Case Diagram

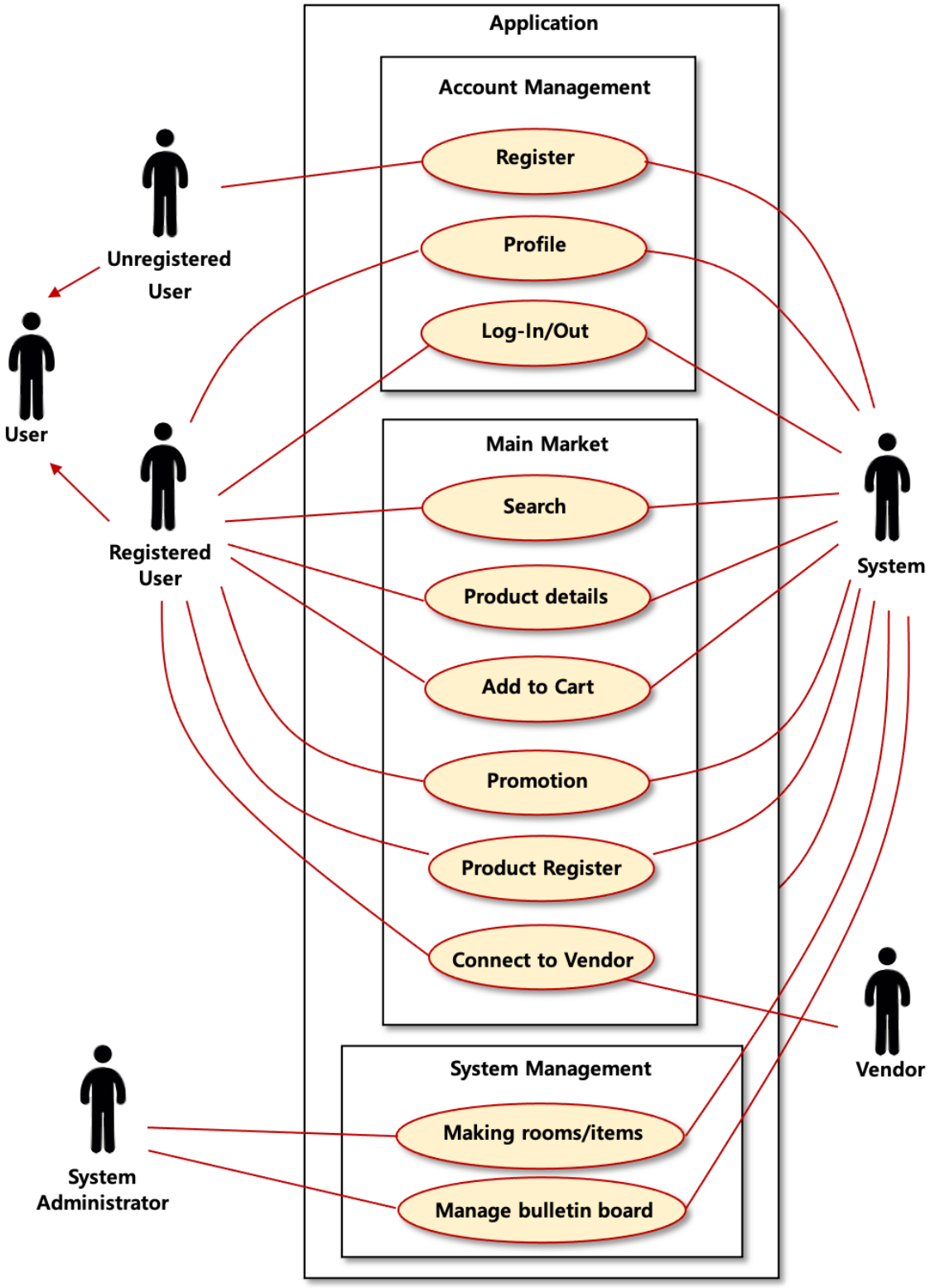

Figure 1 Use Case Diagram

3.2.3. Data Dictionary

Table 23 Table of Data Dictionary - User

Field	Key	Constraint	Description
Id	PK	Not NULL	User's ID (Email)
Nickname	PK	Not NULL	User's Nickname
Major		Not NULL	User's Major Subject
Student ID	PK	Not NULL	User's Student ID
Age			User's Age
Gender			User's Gender
Birthday			User's Birthday
Status Message			Brief Status Messages

Table 24 Table of Data Dictionary – Product Category

Field	Key	Constraint	Mode
Category		Not NULL	Book
			Furniture
			Food
			E-coupon
			Clothes
			Accessories
			Etc

Table 25 Table of Data Dictionary – Product

Field	Key	Constraint	Description
Title		Not NULL	Product's Title
Number	PK	Not NULL	Product's Unique Number
Date		Not NULL	Date / Time
Explanation		Not NULL	Short Explanation
Image			Product's Image
Price			Product's Price
Category			Product's Category
Vendor Info		Not NULL	Vendor Information

Table 26 Table of Data Dictionary - History

Field	Key	Constraint	Description
User_id	FK	Not NULL	Req. User
Query_id	PK	Not NULL	Search Query ID(Key)
Data		Not NULL	Search Data
User preference		Not NULL	Search Option

Table 27 Table of Data Dictionary - WishList

Field	Key	Constraint	Description
Product ID	PK	Not NULL	Product's ID
Price		Not NULL	Product's Price
Total Price		Not NULL	Total Price

Table 28] Table of Data Dictionary -Search History

Field	Key	Constraint	Description
Query_ID	PK	Not NULL	Search query ID(Key)
User_ID	FK	Not NULL	Req. User
Date		Not NULL	Search Date (Timestamp)
User_Preference		Not NULL	Search Option

Table 29 Table of Data Dictionary - Search Product

Field	Key	Constraint	Description
Query_ID	PK	Not NULL	Search query ID(Key)
User_ID	FK	Not NULL	Req. User
Date		Not NULL	Search Date (Timestamp)
User_Preference		Not NULL	Search Option

Table 30 Table of Data Dictionary - Search Result

Field	Key	Constraint	Description
Search Query_ID	PK/FK	Not NULL	Ref.Search_History
Product_ID	PF/FK	Not NULL	Req. Product

Table 31 Table of Making Room

Field	Key	Constraint	Description
Vendor_Info	PK	Not NULL	Vendor Information
User_ID	FK	Not NULL	User Information
Date		Not NULL	Room Date (Timestamp)
Product_ID	PF/FK	Not NULL	Product's ID

Table 32 Table of Communication

Field	Key	Constraint	Description
User_Info	PK	Not NULL	User Information
Product_ID	FK	Not NULL	Product Own Number
Vendor_Info	PK	Not NULL	Ref. Product
Link		Not NULL	Link to Vendor's Shop

Table 33 Table of Adminster

Field	Key	Constraint	Description
Id	PK	Not NULL	User's ID (Email)
Nickname	PK	Not NULL	User's Nickname
Major		Not NULL	User's Major Subject
Student ID	PK	Not NULL	User's Student ID
Age			User's Age
Gender			User's Gender
Birthday			User's Birthday
Status Message			Brief Status Meesages

Table 34 Table of Vendor

Field	Key	Constraint	Description
Id	PK	Not NULL	User's ID (Email)
Nickname	PK	Not NULL	User's Nickname
Major		Not NULL	User's Major Subject
Student ID	PK	Not NULL	User's Student ID
Age			User's Age
Gender			User's Gender
Birthday			User's Birthday
Status Message			Brief Status Messages
History			Vendor's History
Grade			Vendor's Grade

Table 35 Table of Promotion

Field	Key	Constraint	Description
Id	PK	Not NULL	Product's ID
Product name	PK	Not NULL	Products Nickname
Explanation		Not NULL	Brief Information
Price		Not NULL	Product's Price
Category		Not Null	Product's Category
Date		Not Null	Promotion Data
Status Message			Brief Status Messages
Image			Product's Iamges

3.2.4 Data Flow Diagram

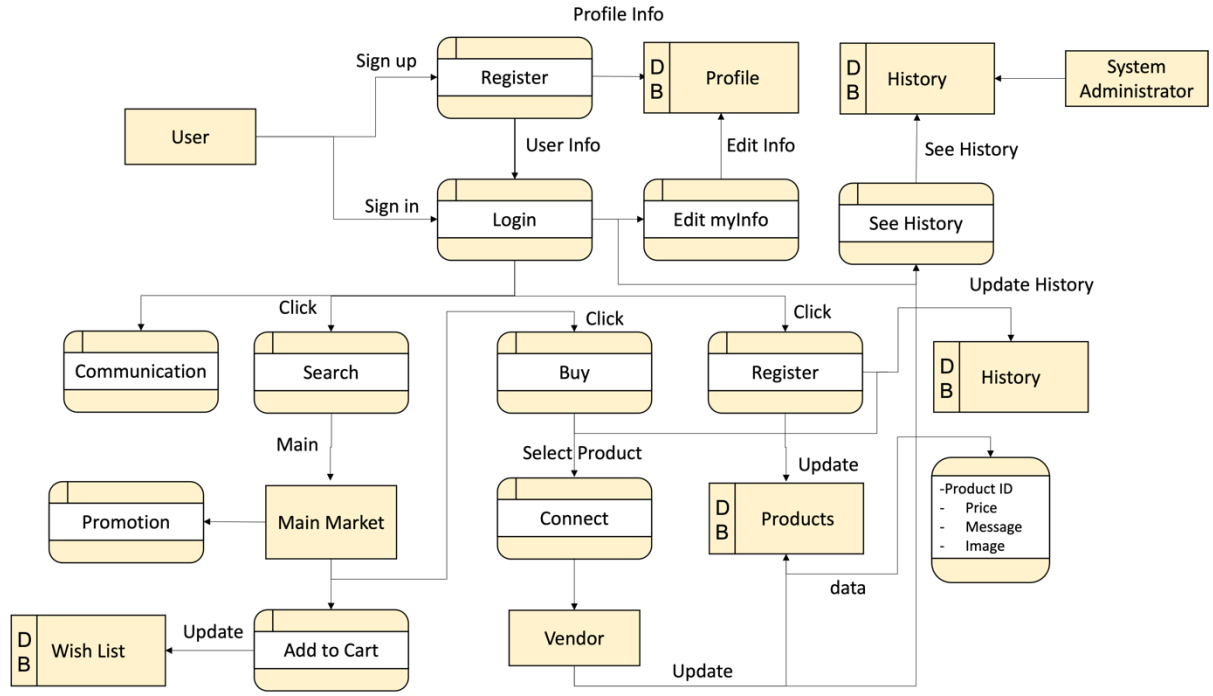

Figure 2 Data Flow Diagram

3.3. Product Requirements

3.3.1. Usability Requirements

SKKU Flea Market targets those who have used VRchat at least once. Users who have completed the literal of VRchat should also be able to use the SKKU flea market smoothly

it targets students at Sungkyunkwan University, so the terms of the school most of Sungkyunkwan University students know can be used.

There should also be a plan to provide English versions so that foreign students of Sungkyunkwan University can use them.

For proper use of the system, a Tutorial for using SKKU flea market should be provided at the time of initial use.

3.3.2. Performance Requirements

3.3.2.1 Static numerical requirement

a. There is a one system administrator(master) account in the system. system administrator has full authority over the participants of the system.

b. One system account can be accessed to one world with only one device at the same time. If you try to access another device, you cannot log in.

c. The system only supports Windows 10, The system runs only on PCs that meet the minimum specifications of VRchat.

Intel® i5-4590 or higher AMD FX 8350 or higher

more than 4GB RAM

NVIDIA GeForce® GTX 970 or higher AMD Radeon™ R9 290 or higher Intel UHD Graphics 610 or higher

DirectX : Version 11 or higher

3.3.2.2 Dynamic numerical requirement

a. At least 10 flea market worlds must be able to be created simultaneously.

b. The login transaction must be completed in 10 second.

c. Shop opening transactions must be completed in 10 second.

d. System Response Time**:** All reactions occurring in the software must be made in at maximum 0.5 seconds.

e. Screen Refresh Time: When a change occurs in the market, the UI must immediately reflect the changes and display them on the screen. Like System Response Time, it should respond within a maximum of 0.5 seconds. In addition, it should be possible to query changes in the DB with the refresh button.

f. Training Time: it should be enough for the user in the tutorial to understand all functions within 3 minutes.

g. Tutorial: The tutorial should be UI consisting of photos and documents within 5 pages.

h. Each world must satisfy the maximum number of concurrent users provided by VRchat.

3.3.3. Dependability Requirements

Actions performed at the shop must be performed atomically. if an error occurs during an action, the system should notify the user and rollback all matters in progress.

Consistency of information stored in the DB and information displayed in the shop should be guaranteed.

3.3.4. Safety Requirements

VRchat, SKKU Flea Market's platform, guarantees the security of member information. Therefore, this system guarantees security only for all information provided to the user's flea market.

3.3.5. Maintainability Requirements

Each udon code and class should have comments for the smooth of future changes. Comments must have input, output, description, and precaution(if it exists).

For example. The comment for a Function ‘Calculator’ should be

/*input: int arg1, int arg2, char op

Output: operation of arg1 and arg2

Description: This function returns the result calculated by the input operator of the two integers.

Precaution: do not use floating point inputs

*/

3.4 Organizational Requirements

3.4.1. Environmental Requirements

Users of SKKU flea market shall authenticate themselves using their health authority identity card.

3.4.2. Operational Requirement

Users of the system sign up through the user interface. After that, the user enters the market created by the administrator of the system and executes the action. User can have account management action, Main market action in software

The system administrator may take action on the making rooms/items and the Management Bulletin board.

3.4.3. Development Requirement

Developers should use VRchat SDK version 3 with Unity engine.

3.5 External Requirements

3.5.1. Safety / Security Requirement

The security of code and data must be maintained during the development process. The remote repository of VCS should also be private.

3.5.2. Regulatory Requirement

SKKU flea market is a SW with VRchat as a platform. And VRchat is registered in STEAM store. So This SW must comply with the terms and conditions of the VRchat and the terms and conditions of the STEAM.

student users of SKKU should not commit acts that violate SKKU's school rules within the SW.

3.6 Organizing the specification requirements

This section describes the system model using graphical notation based on integration. It shows the relationship between the diagrams described above. This helps us understand the overall structure of the system structure.

Modeling language (UML) and table format. The system model describes the relationship between the following.It shows systems, subsystems, components and surroundings, and more specific requirements.

This section specifies the process of system evolution and what to consider. Basic assumptions must be known to predict changes by evolution. We focus on implementing the market in VRchat. How the user's requirement can change within these limitations and assumptions, and how VRchat’s SDK can change, respond to it, and minimize the change. VR is sensitive to hardware changes as much as it requires high-performance hardware. Therefore, it is necessary to describe the hardware change. This can be an important guide material for developers when designing systems. In summary, SDK changes are faster than other platforms, and designs that do not take this into account can be fatal to evolution. VR should take a particular close look at the evolution section and has a great influence on the design decisions of developers.

3.6.1. Context Model

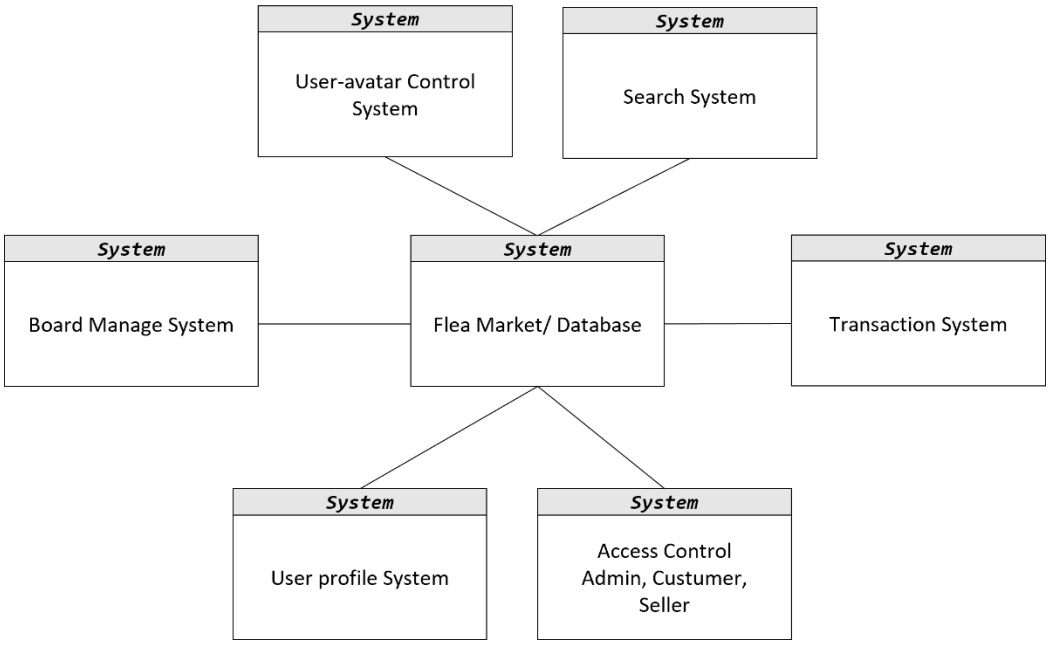

Figure 3 Context Model Diagram

3.6.2. Process Model

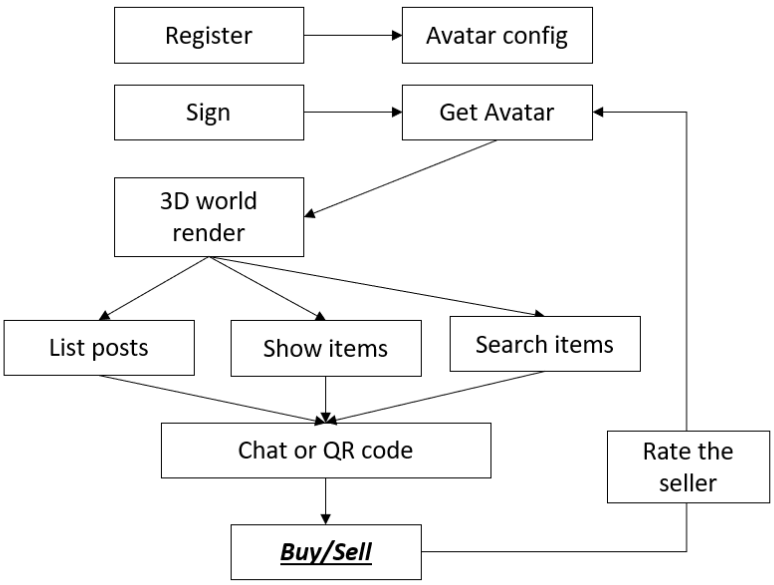

Figure 4 Process Model Diagram

3.6.3. Interaction Model

Refer to section 3.2.2.

3.6.4. Behavior Model

3.6.4.1 Data Flow Diagram

Refer to section 3.2.4

3.6.4.2 Sequence Diagram

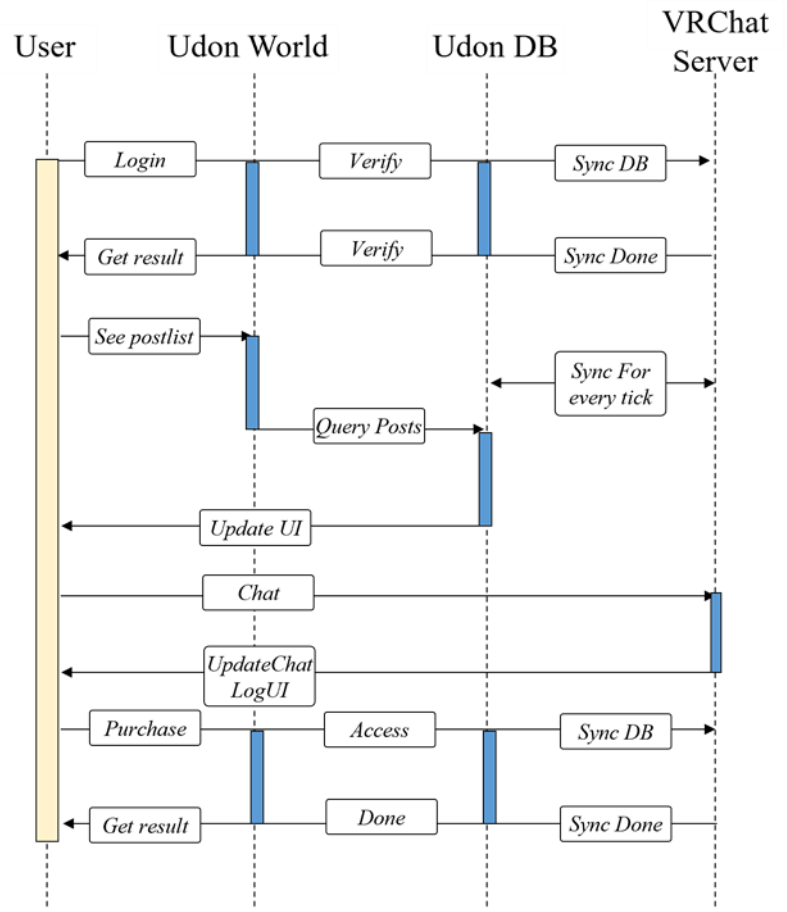

Figure 5 Sequence Diagram

3.7 System architecture

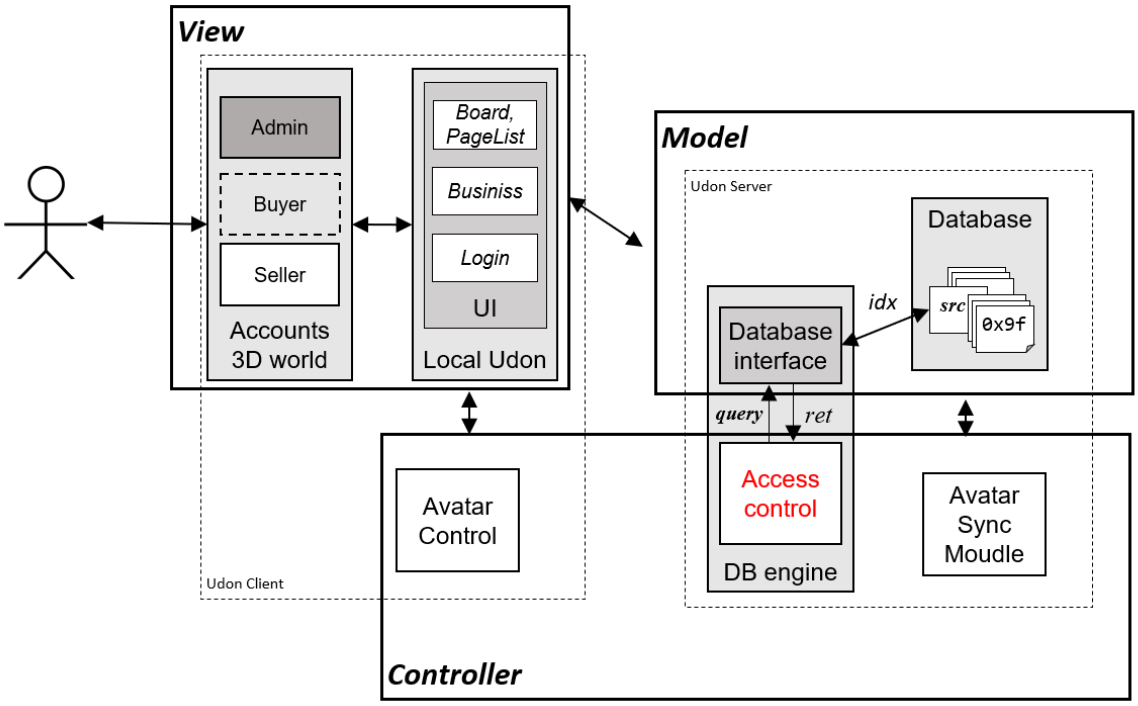

Figure 6 System architecture MVC Diagram

This section shows a high-level architecture. It shows how avatar control, access control, and database are used in the Udon system. This is very important when configuring a sub-system. We describe the construction of the architecture through MVC patterns. In addition, the division between the server and the client is also added to express in which part each function is implemented.

3.8 Limitations and assumptions

For VR, one standard is not yet properly established. Many companies, including Google, Facebook, Apple, and Microsoft, are introducing a variety of hardware and platform technologies and are competing for standards. We use VRchat for our development. VRchat is highly accessible in that it can be used not only by VR devices but also by general PC users, and is currently dominant in that it is the platform that has the largest number of users. However, it can be replaced by other platforms at any time. Despite these limitations, we assume that VRchat becomes the dominant platform considering the size of the market. Therefore, the change of SDK is not considered. Aslo, VRchat SDK has not yet provided functions for client servers and databases. Therefore, it is assumed that the user requirement does not change to a requirement requiring a server and a database.

3.9 System Evolution

3.9.1 User requirement evolution

Users may want to add more diverse functions. For example, convenience can be improved, such as auction, market price selection, and price remarks of similar products. Our system must have an interface that can accommodate these market functions. Since the market basically consists of price, quantity, sales, purchase, and product information, these characteristics must be designed well. As hardware advances, quality improvement may be required. User may want to accept better graphics and more transactions, and for this it is important to design algorithms and algorithms that use less resources.

3.9.2 SDK evolution

VRchat's SDK is being actively developed. The current version is sdk3, which has large change points in sdk2. Udon has been added and compatibility with existing avatars has become difficult. Design should be done by observing the direction of VRchat's SDK development.This is an important factor in responding to future SDK version upgrades. The system should use the latest API and technologies as much as possible.

4. Supporting Information

4.1 Software Requirement Information

This software requirements specification was written in accordance with the IEEE Recommendation (IEEE Recommended Practice for Software Requirements Specifications, IEEE-Std-830).

4.2 Document History

Date	Version	Description	Writer
2021/10/15	0.1	Overall Style form	Seongbin Yoon
2021/10/16	1.1	Addition of 1.1, 1.2, 1.3	Hajeong Lim
2021/10/17	1.2	Addition of 1.4, 1.5	Jiyoung Kim
2021/10/17	1.3	Addition of 2.1	Sanghun Kim
2021/10/18	1.4	Addition of 2.2	Hajeong Lim
2021/10/19	1.5	Addition of 2.3	Jihye Park
2021/10/20	1.6	Addition of 2.4, 2.5	Munsuk Jang

2021/10/21	1.7	Addition of 3.1	Sehyun Choi
2021/10/22	1.8	Addition of 3.2 v1	Jihye Park
2021/10/23	1.9	Addition of 3.2 v2	Jiyoung Kim
2021/10/26	1.10	Addition of 3.3	Seongbin Yoon
2021/10/27	1.11	Addition of 3.4, 3.5	Hajeong Lim
2021/10/28	1.12	Addition of 3.6, 3.7	Seongbin Yoon
2021/10/28	1.13	Addition of 3.8, 3.9	Munsuk Jang
2021/10/29	1.14	Addition of 3.9	Sanghun Kim
2021/10/29	1.15	Revision of 1	Sehyun Choi
2021/10/30	1.16	Revision of 2	Jihye Park
2021/10/31	1.17	Revision of 3	Sanghun Kim
2021/10/31	1.18	Overall Revision, style	Jiyoung Kim

List of Figures

List of Tables