Waseda University Master Thesis

Micropayment System using Augmented Reality and Gamification

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ABSTRACT

Micropayment is usually inconvenient for using credit card. It is also troublesome to carry small coins. Therefore, micropayment system is introduced to deal with the problems of micropayment and store small coins as points in physical store. Game mechanics like reward, feedback and competition are introduced into the proposed system. Points, mission, badges, achievement and level will be adopted. Some mission for promoting customers' motivation like living a healthy life, protecting environment and promoting local economy will be proposed to provide them consultable measures of value. If customers succeed in completing the mission, they can get points in reward. Badges represent achievement. Customers can earn badges by reaching achievement. Levels are used for competition between customers. By augmented reality technique, customers can get intuitive and enjoyable feedback. Using augmented reality technique and gamification will make the customers pay more attention to the payment system and more willing to use this system. Customers can pay small change freely by clicking buttons on the augmented reality interface. The system consists of two parts. One part is the customer part and the other is the provider part. At the customer side, they can use the camera on the smartphone or smart glasses to recognize the AR marker. They can pay points in account. They can also check account, customer level, achievement and daily mission completion freely. At the provider side, merchant can confirm the mission for customer and deposit the spare coins as points during the payment.

Keywords: Ecommerce, Augmented Reality, Gamification

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Chapter 1

Introduction

1.1 Background

Micropayment is very common in our lives[1][2]. A micropayment is a financial transaction involving a very small amount of money. In the mid-to-late 1990s, a number of micropayment systems were proposed and developed and all of them were ultimately unsuccessful[3]. A second generation of micropayment systems emerged in the 2010s[4]. However, current micropayment system is almost designed for online content or services.

There are some different definitions of what is a micropayment. PayPal defines a micropayment as a transaction of less than £5 while Visa defines it as a transaction under 20 Australian dollars.

Payment can take a variety of forms. Barter, the exchange of one good or service for another, is a form of payment. The most common means of payment include use of money, cheque, debit, credit or bank transfers. Payments may also have complicated forms, such as stock issues or the transfer of anything of value or benefit. In trade, payments are frequently preceded by an invoice or bill.

These methods still have some limitations for micropayment. It is relatively heavy and inconvenient to carry changes especially in certain situation like jogging. Credit cards are not accepted

because it is too inexpensive to use. Other payment forms like cheque and bank transfers are also not suitable for micropayment.

1.2 Problem

Micropayment system are thought as a good way to deal with micropayment problem. However, it should be improved from several aspects:

1. Current micropayment system is designed for online shopping not well suitable for micropayment in physical store.

2. Current micropayment system is used just for the sake of transaction itself. It is no more than a means of payment. Consumers cannot get more satisfaction or value guidance.

3. The payment process in physical store is usually under the control of the provider while customers have limited permissions to participate in payment.

Chapter 2

General Background

2.1 Gamification

2.1.1 Overview

Gamification refers to the application of using game design elements and game mechanisms in a non-game contexts to enable users to solve problems and improve the contribution of users[5]. Commonly, gamification employs game design elements to improve organizational productivity, user engagement and more. Lots of research about gamification indicates that a majority of studies on gamification reveal that it exerts good effect on individuals. Certainly, the differences exist for different individual and different contextual[6]. An individual's ability to comprehend digital content and understand a certain area of study such as music is improved by studies on gamification[7].

2.1.2 Techniques

The gamification techniques are aiming at leveraging people's natural desires for achievement, competition, socializing or simply their response to the framing of a situation as game or play.

Andreas Lieberoth et al.[8] conducted studies that experimentally dissociates the psychological

impact of framing versus game mechanics, when presenting a serious activity as a game. Results demonstrate that the effects of simply framing the activity as a game though vernacular and artifacts holds almost as much psychological power as the full game mechanics.

Rewards are used by early gamification strategies for users who accomplish desired mission or competition to engage users. Rewards types include providing the user with virtual currency[9], the filling of a progress bar[10], achievement badges or levels[9] and points[11].

The paper written by Juho Hamari et al.[9] presents a framework for evaluating and designing game design patterns commonly called as "achievements". From the perspective of the achievement system, an achievement appears as a challenge consisting of a signifying element, rewards and completion logics whose fulfilment conditions are defined through events in other systems (usually games). From the perspective of a single game, an achievement appears as an optional challenge provided by a meta-game that is independent of a single game session and yields possible reward. Making the rewards for providing leader boards or accomplishing tasks visible to other players are ways of encouraging players to compete[12]. Another method of gamification is to make existing mission or task feel more like games[13].

The review written by John Rizzo et al.[12] says that motivation, created by game attributes such as timely feedback, teamwork, collaboration, problem solving, a sense of presence through avatars, vivid designs and even virtual economies are used by the authors to support their thesis that businesses will need to begin to make work more like games in order to keep employees engaged and increase the bottom line.

The book *Reality is Broken* written by Jane McGonigal et al.[14] explains the science behind why games are good for us–why they make us more creative, more resilient and better able to lead others in world-changing efforts.

2.1.3 Game Mechanics

Game mechanics consist of methods or rules designed for interaction with the game state and therefore provide gameplay[15]. Mechanics are used by all games; however, styles and theories differ as to their ultimate importance to the game. In general, the study and process of game design, or ludology, are efforts to come up with game mechanics that allow for people playing a game to have an engaging but not necessarily fun experience.

The interaction of various game mechanics determines the level and complexity of player interaction in the game, and in conjunction with the resources and game's environment determine game balance. Games has used some kinds of game mechanics for centuries, while others that have been invented within the past decade are relatively new.

Complexity in game mechanics should not be confused with depth or even realism. Go is probably one of the simplest of all games but it shows extraordinary depth of play. Most video games or computer feature mechanics, in terms of making a human do all the calculations involved, are technically complex even in relatively simple designs.

In general, commercial video games, as processing power has increased, have moved from simple designs to extremely complex ones. In contrast, casual games have generally featured a return to puzzle-like, simple designs although some games are becoming more complex. In physical games, differences generally come down to style, and are somewhat determined by intended market.

2.2 Augmented Reality

2.2.1 Overview

Augmented reality is technique that calculates the position and angle of camera images in real time and superimposes elements are generated by computer-generated sensory input such as

sound, video, graphics or GPS data to physical, real-world environment directly or indirectly[16]. It is related to a more general concept called computer-mediated reality, in which environment is modified (diminished or augmented) by a computer. Augmented reality can enhance one's perception of reality, while virtual reality, in contrast, replaces the real world with a totally virtual one. Augmentation techniques are typically performed in real-time. Real time and semantic context with environmental elements, such as supplemental information will be overlaid. The information about the surrounding environment of users becomes digitally manipulable and interactive with the help of advanced AR technology such as adding object recognition and computer vision[17]. Information about the objects and surrounding environment can be overlaid on the real world. This kind of visual information can be real or virtual. Real sensed or measured information such as electromagnetic radio waves overlaid in exact alignment with where they actually are in space[18]. Augmented reality combines the digital world with a person's perceived real world. There are currently two general definitions of augmented reality. One is proposed by Ronald Azuma from University of North Carolina in 1997. He believes that augmented reality includes three aspects:combining virtual object with reality, real time interaction and three dimension[19]. Another definition is put forward in 1994 by Paul Milgram Fumio Kishino, which is named Milgram's Reality-Virtuality continuum[20]. They took the real environment and the virtual environment as the two sides of the continuous system and the middle of system is called hybrid reality. Augmented reality is located between the real environment and mixed reality while augmented virtuality is located between the virtual environment and mixed reality.

2.2.2 Technology

Augmented reality is closely related to hardware, software and application level. In terms of hardware, an AR platform combines processors, displays, sensors, and input devices. In terms of software, the key to the AR system is how to integrate the augmented object with the real world. At the application level, it was used initially for the military and then extended to daily life.

Hardware components for augmented reality includes: input devices sensors display and processor. Modern mobile computing devices such as tablet computers and smartphones contain these elements which usually include a camera and MEMS sensors such as GPS, solid state compass and accelerometer to make them suitable AR platforms[21]. Current AR hardware includes optical projection systems, monitors, mobile devices, head mounted displays, head up displays and computers. Nowadays bionic contact lenses is in development. How realistically virtual object with the real world are integrated is a key measure of AR systems. The software should extract real world coordinates from camera images, which are independent from the camera. That process is called image registration which uses different methods of computer vision, mostly related to video tracking[22][23]. Lots of computer vision approaches of augmented reality are inherited from visual odometry.

Usually those approaches include two parts. The first stage is to detect interest points, optical flow or fiducial markers in the camera images. This step can use feature detection methods like thresholding, edge detection, blob detection, corner detection or other image processing approaches. Next stage restores a real world coordinate system from the data obtained in the previous stage. Some methods assume objects with known geometry or fiducial markers are present in the scene. In some of those cases 3D structure of the scene should be calculated in advance. If part of the scene is unknown simultaneous localization and mapping can map relative positions. Without information about scene geometry, structure from motion methods like bundle adjustment are adopted. Mathematical approachs adopted in the second stage include geometric algebra, projective geometry, kalman and particle filters, robust statistics, rotation representation with exponential map and nonlinear optimization[24].

Some software development kits have appeared to promote the development of augmented reality applications. Some SDKs such as CloudRidAR leverage cloud computing for performance improvement. Some of the well known AR SDKs are provided by Catchoom CraftAR Mobinett AR, Meta , ARToolKit, Blippar Layar, Wikitude, Vuforia and ARLab.

Chapter 3

Research Goal and Approach

3.1 Assumption

With the development of technology and the progress of the times, device hardware such as the smart glass or some other kind of devices, in the near future, will be more intelligent and completely portable-convenient. That means digital information can be easily obtained in our daily life. Imagine that in the future, human civilization is entering a digital era and everyone lives in a gamification world. Everyone can go shopping wearing smart glass (or some other convenient device) just like watching 3D movies with 3D glasses and more information such as merchandise label can be easily accessible.

3.2 Goal

In this research, three main goals are as following:

1. Improve micropayment convenience in physical store.
2. Provide customers with a new value for their lives in the digital era.
3. Strengthen the interaction between customer and system.

3.3 Approach

Due to the goal mentioned above, we decide to design and implement a suitable micropayment system. We introduce the augmented reality and gamification into the design and implementation of this system.

By using augmented reality technique and introducing gamification factors like reward and feedback, the process of payment will appeal to customers.

Game mechanics like reward and feedback are introduced into the proposed system. Points, mission, badges and levels will be used. Using augmented reality technique and gamification will make the customers pay more attention to the payment system and they will be more willing to use this system.

Customers can pay small coins freely by clicking buttons on the augmented reality interface.

Some missions for promoting customers' motivation such as living a healthy life, protecting environment and promoting local economy will be proposed to provide them consultable measures of value. If customers succeed in completing the mission, they can get points in reward.

The system consists of two parts. One part is the customer part and the other is the provider part. At the customer side, they can use the camera on the smartphones or smart glasses to recognize the AR marker. They can pay small change. They can also check account, customer level, achievement and daily mission completion freely. At the provider side, merchant can confirm the mission for customer and deposit the spare coins as points during the payment.

3.4 Novelty and Potency

1. This system uses the augmented reality technique to improve the visual effect. With augmented reality, the system can be digitally manipulable and provide users with better interoperability.

2. With gamification, this micropayment system is different from the traditional one by intro-

ducing point, mission, badges and levels. These game mechanics can give users intuitive feedback or reward and stimulate the enthusiasm of users. Users can complete daily task or fulfill achievement and provider can check the daily mission for users, which not only strengthen the interaction between customer and merchant but also set a new value evaluation plan for users.

3. By proposed system, customers can use points instead of using coins in micropayment. If customers do not like get small changes, they can also deposit small changes into this system. It can promote the convenience of micropayment in some degree.

Chapter 4

System Design

4.1 System Overview

The proposed system is designed for mircopayment with gamification and augmented reality introduced. This system includes two parts, one part is customer part and the other is provider part. Both two sides can use the camera of smartphones or smart glasses to use this system. By using smartphones or smart glasses,customers can scan the point card. At the customer side, they can pay small change. They can also check account, customer level, achievement and daily mission completion freely. At the provider side, merchant can confirm the mission for customer and deposit the spare coins as points during the payment.

4.2 Use Case Diagram

The usage case diagram of prototype system is shown as Figure 4.1. As shown in the diagram, users of this prototype system includes customers and provider. There are 7 use cases (register, login, pay, mission inquiry, achievement inquiry, account inquiry and level inquiry) for customers and 4 use cases for providers (register, login, changes deposit and mission confirm).

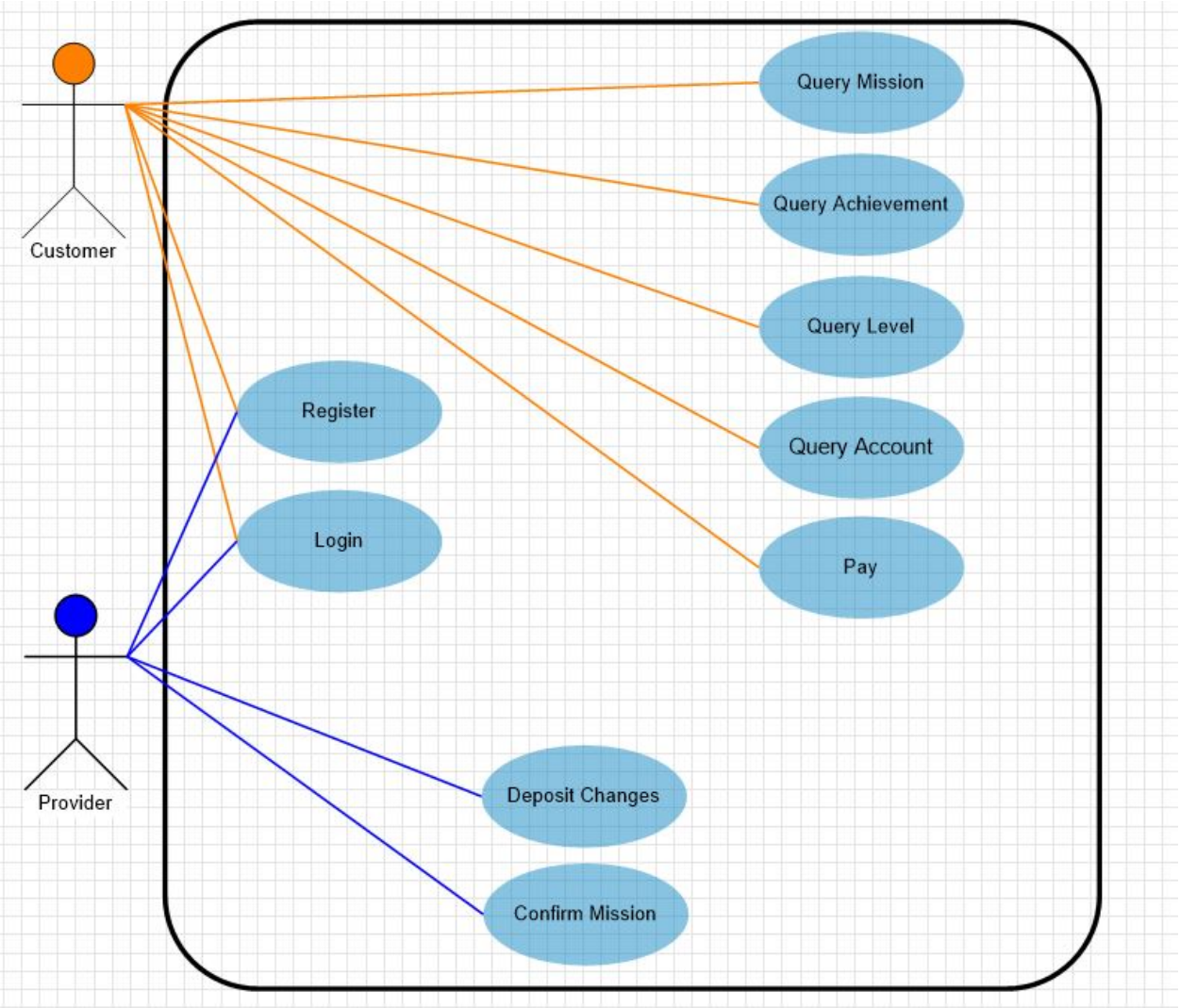


Figure 4.1 use case diagram

4.3 System Structure

The usage case diagram of provider using prototype system is shown as Figure 4.2. There are 3 layers, interface presentation layer, business logic layer and data access layer.

The first layer is the client (customer client and provider client), which has only simple input and output functions that deal with a small part of transaction. This layer mainly displays the

interface to the user, accepts a series of instructions from the user, and presents the message to the user at the interface.

The second layer is the server, which acts as the role of information transmission. When the user wants to access the database, they should send request firstly to the server. Then server send request for access to the database to the database. This request is usually implemented in a SQL statement.

The third layer is the database, which stores a large amount of data. When the database receives the request of the server, it will process the SQL statement and return the results to the server. The server will transform the data into some form to the client.

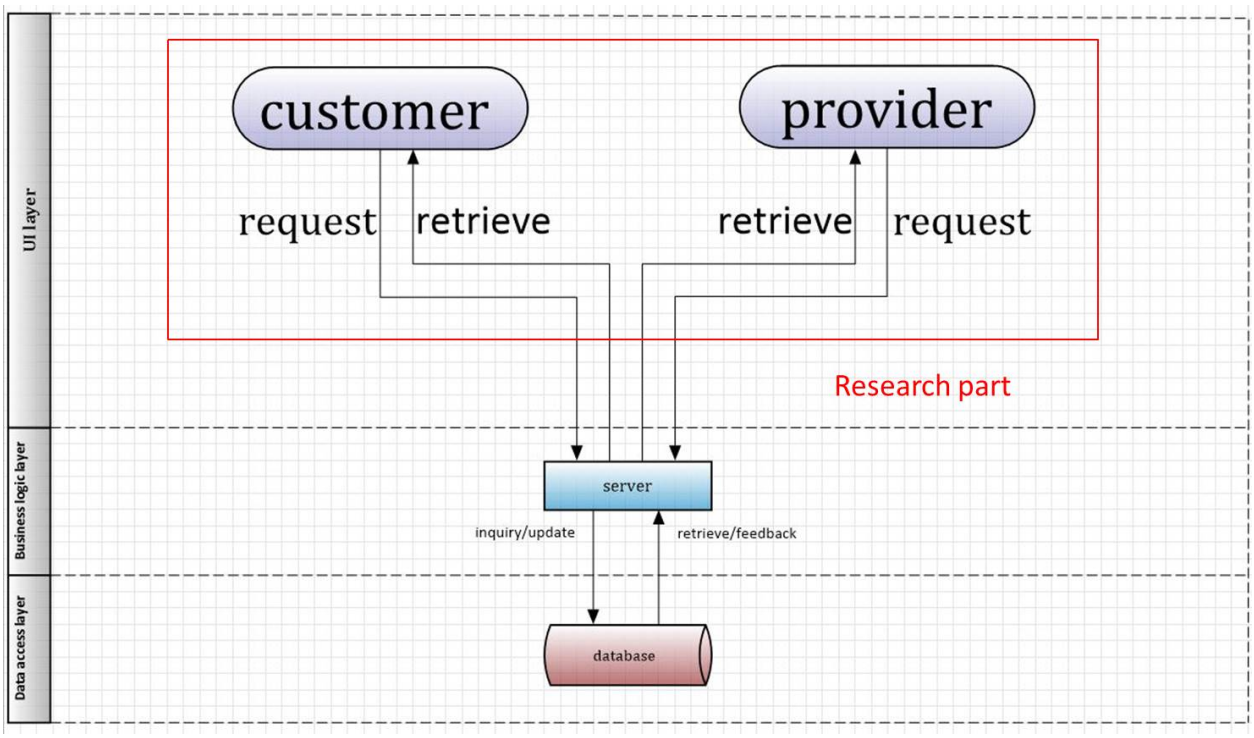


Figure 4.2 system structure diagram

4.4 Customer Module

4.4.1 Using Process

The following steps explains how customers use this proposed system:

1. At cash-desk, every customer can get a point card from the merchant(only the first time).
2. Start the application and register personal information at first time.
3. Check what kind of daily mission should be done.
4. Complete the mission to get points.
5. Check completion degree of daily mission, points, achievement and user level.
6. Repeat 3-5.

4.4.2 Usage Scenario

The usage scenario of customers using prototype system at physical store is shown as Figure 4.3. When customers go to the checkout counter first time, they can get a point card from the provider. They should start the application and register personal information at first time. After that, they can consume points in the card instead of paying small coins by using this system. If points are not sufficient, customers can pay banknotes and ask provider to deposit the change. After the payment is finished, provider will confirm the daily mission for the customers. If mission is done, customers can get corresponding points and his/her account will get corresponding EXP (empirical value).

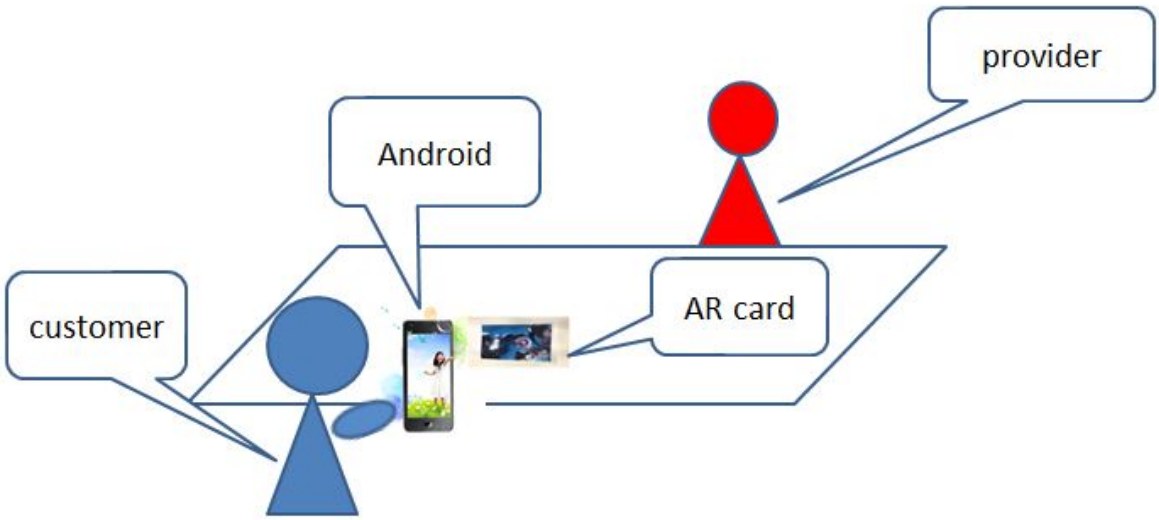


Figure 4.3 usage scenario diagram

4.4.3 Method of Use

After the application starts, the login interface will show and users need to input username and password to login at first. If users have not registered before, they need to input username and password in register interface to register personal information. If the username is not duplicated and password is allowed, the registration is completed and users can login in login interface. After login, application will start the camera to recognize AR point card. Customers put the AR point card on the desk and scan the card with camera. Then they can see the main AR interface on their devices and do some operation (pay) or view information (mission inquiry, achievement inquiry, account inquiry and level inquiry) by clicking the virtual object on the screen.

The interface jump relation is shown as Figure 4.4.

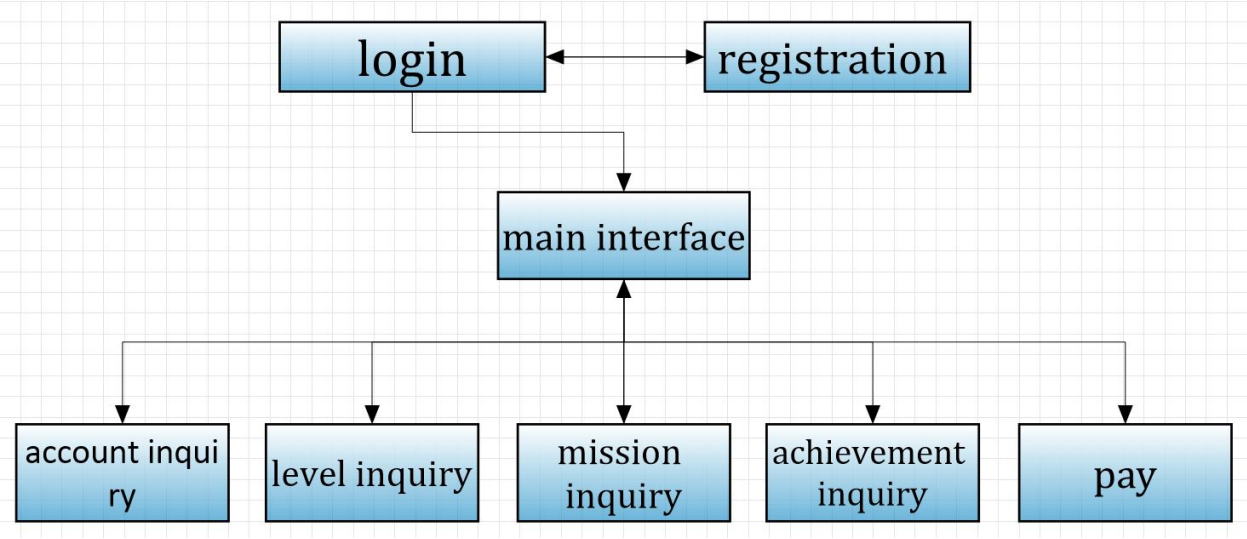


Figure 4.4 interface jump relation diagram

4.4.4 Gamification Element

Badge and Achievement

A badge is presented or displayed to indicate an accomplishment on the interface. Each achievement corresponds to one badge. Customers can click badge to see the content of corresponding achievement. According to the achieving degree, the brightness of badge will be modified. If customers achieve success in one field, the badge will be lighten. We try to using visual influence to improve the user's sense of self satisfaction. The correspondence between badges and achievements is shown as Table 4.1.

Table 4.1 correspondence between badges and achievements

Number	Badge	Achievement
1		Created new account
2		Buy eco-friendly goods consecutively for 30 days
3		Buy local goods consecutively for 30 days
4		Buy low calorie goods consecutively for 30 days
5		Take public transport or walk consecutively for 30 days
6		Not use disposable goods consecutively for 30 days

Point and Reward

Point will be used as a way of reward. If customers complete daily mission, they can get points. This game mechanism is used to inspire the motivation of customers to perform daily tasks. In the Table 4.2, we design the mission content and assign each mission with one point. That means if customer completes one daily mission, they can get one point in reward. The more daily mission they accomplish, the more points they will get. These points can be used during micropayment through this system. It is a good mechanism to make customers feel they get reward by their effort.

Level and Competition

In the game, competition is common. In this micropayment system, using points as criteria is not appropriate because point reflects the individual financial situation to a certain extent. If customers fulfill mission or achievement, they can gain EXP. If EXP is enough, account level will be upgraded. Using level as criteria can be good choice for competition. Customers can compete with others by the level of their account. This is considered as a very benign competition to stimulate willingness to accomplish mission and achievement.

Mission

Mission is daily task for customers to get points with their own effort. For customers, if they want to get more points, they need to promote self motivation to do something useful for themselves or society. The content of mission can be well designed to guide customers' value orientation. The correspondence between number and mission is shown as Table 4.2.

Table 4.2 mission design

Number	Mission Content	Points
1	Confirm point	1pt
2	Buy eco-friendly goods	1pt
3	Buy local goods	1pt
4	Buy low calorie goods	1pt
5	Take public transport or walk	1pt
6	Not use disposable goods	1pt
7	Buy 1 item	1pt
8	Buy 5 items	1pt
9	Buy 10 items	1pt

4.5 Provider Module

4.5.1 Using Process

The following steps explains how provider uses this proposed system:

1. At cash-desk, provider gives every customer a point card (Only the first time).

2. If customers use this system, provider will confirm micropayment is done.

3. If customers use banknotes to pay and do not want changes, provider will deposit changes for customers.

4. Confirm daily mission for customers and give them corresponding points.

4.5.2 Usage Scenario

The usage scenario of provider using prototype system is shown as Figure 4.5. When customers go to the checkout counter first time, provider gives a point card to customers. If customers use this system as Figure 4.3, provider will check whether micropayment is done or not. If customers use banknotes to pay and do not want changes, customers give his/her card to provider. Provider will deposit changes for customers. Finally, provider should confirm daily mission for customers and deposit corresponding points in customers' account.

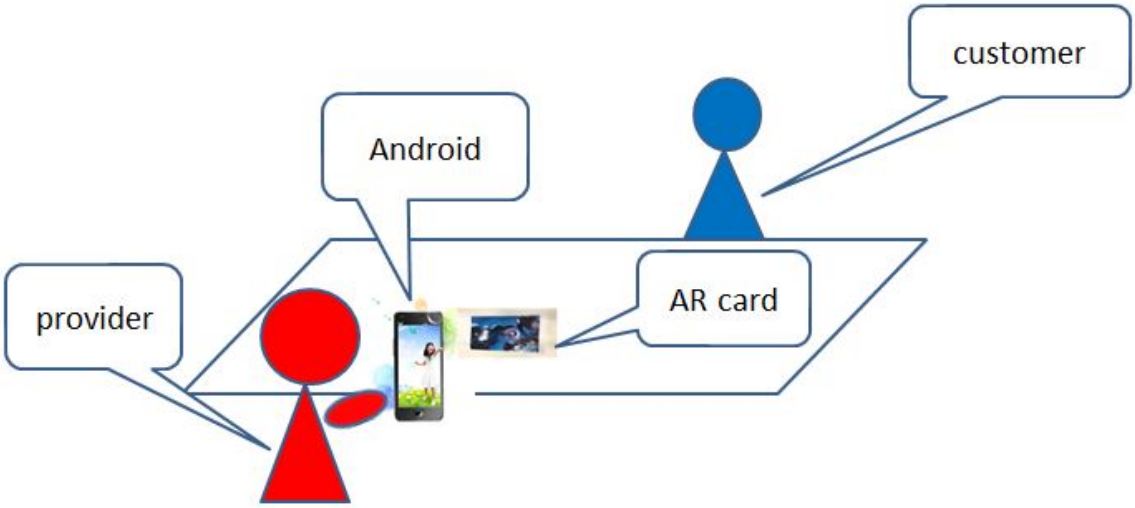


Figure 4.5 provider usage scenario diagram

4.5.3 Method of Use

At first time, provider should register an account with administrator authority. After login, application will start the camera to recognize AR point card. Customers give provider AR point card and provider scans the card. Provider can choose operation (deposit or confirm mission) by clicking corresponding button.

The diagram of interface jump relation is shown as Figure 4.6.

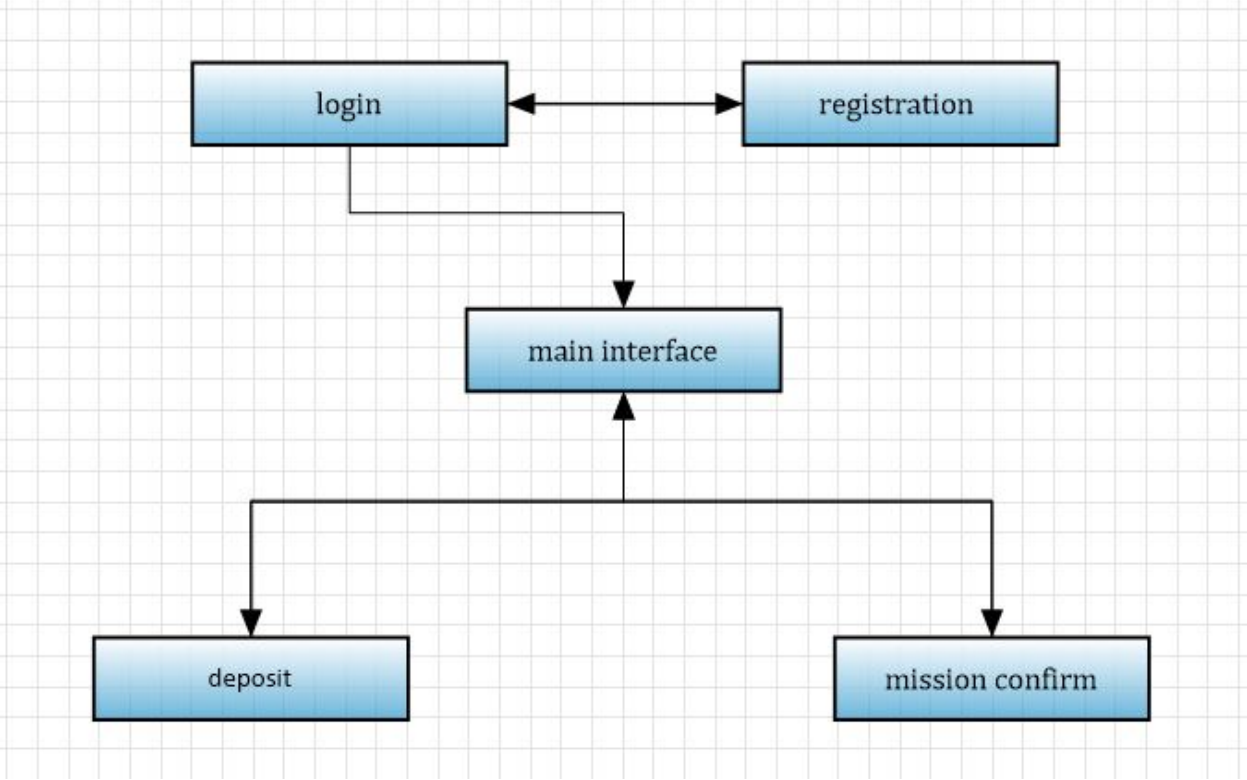


Figure 4.6 interface jump relation diagram

4.6 General Module

4.6.1 Login and Registration

Login and registration module is basic part for both customer module and provider module. Through personal information registration and verification, identity authentication can be achieved. We can enhance the protection of account security and access corresponding data like level and points for exhibition. The flowchart diagram of login and registration is shown as Figure 4.7.

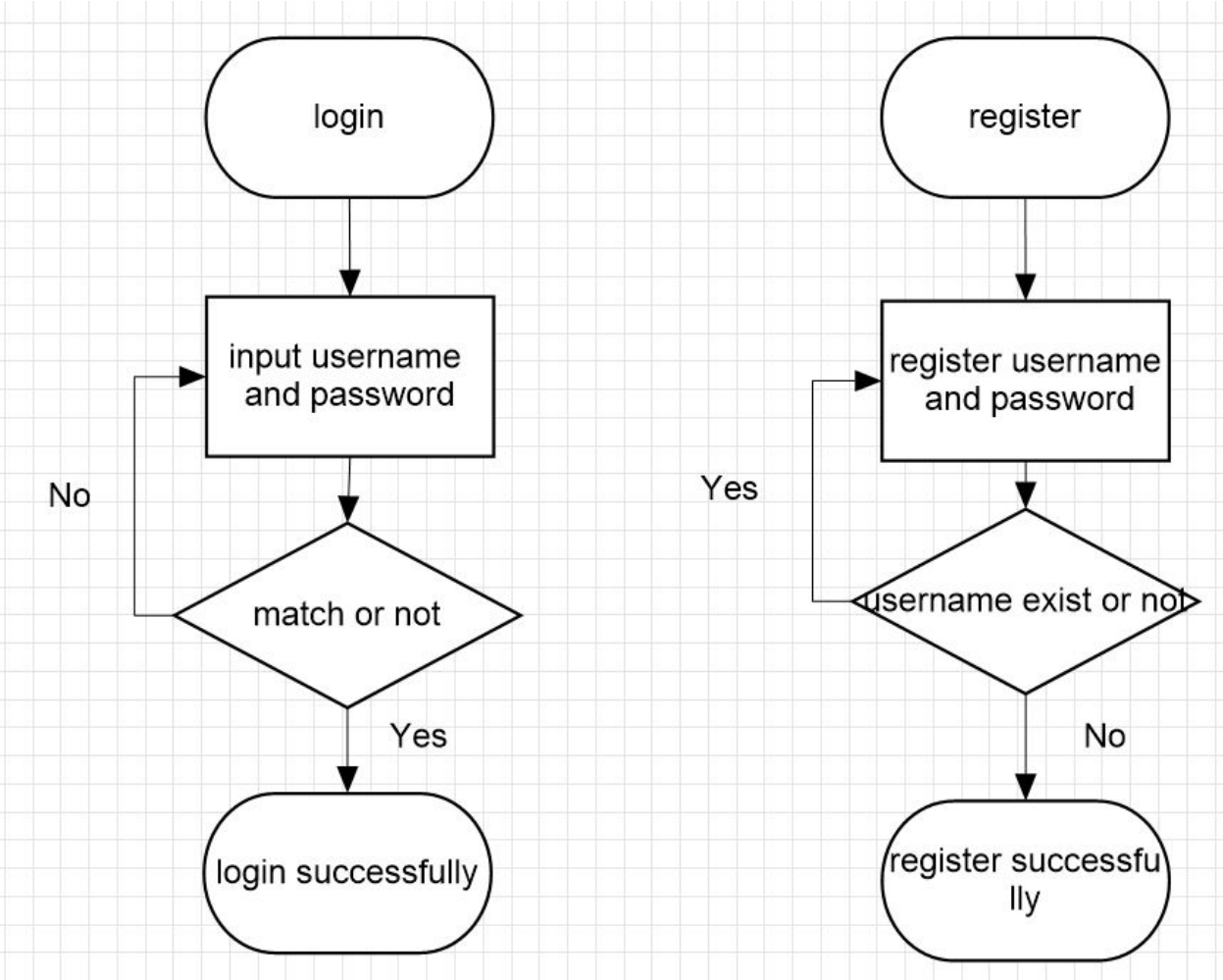


Figure 4.7 flowchart of login and registration

4.6.2 Server and Database

The server acts as the role of passing message. It receives requests from the client and sends requests to the database. The database stores individual data like username, password, points and level for each registered user. When the server requests data from the database, the database will retrieve all data, finds the corresponding information and passes it to the server. The server will process the data and feed it back to the client. Since this part is not the research part of our study, we will not describe too much about the implementation in following chapter.

Chapter 5

System Implementation

5.1 Development Environment

We develop this system using Unity 5.6.0 and development language is C#. Because it is an Android application, we use Android SDK and use Redmi HM 1S as terminal. The Android version of Redmi terminal is 4.4.4 KTU84P and MIUI version is MIUI 7.5.1.0 (KHCCNDE). As for Unity AR programming, we use Vuforia as SDK. Windows 10 is used as server environment and MySQL is used as database. PHP is used to implement the communication between the application and the server.

5.2 Original Card

The original card is shown as Figure 5.1. It has the same size as a ordinary card. Different recognizable patterns are printed on the surface of the card and the user can choose according to his or her preference. This picture can still be identified even if some parts are blocked or worn.

Figure 5.1 original card

5.3 Customer Module

5.3.1 Main Interface

Interface Display

The original point card is shown as Figure 5.2. As we can see from this picture, there are contains piggy model, coin model, star pattern, badge and pay button on main interface. Piggy model represents user's account. Piggy bank is usually used for storing small changes, which is similar to storing points in user's account. Coin model represents point. Because of protecting the privacy of user's account, using coin model can prevent accessing point directly. Each star pattern corresponds to one mission and the color of pattern indicates the progress degree of mission. Badges are located in the upper right corner of main interface. Customers can see the contents of the badge by clicking the badge. The brightness of the badge indicates whether the achievement has been achieved or not. When customers want to deal with micropayment, they can click pay

button to operate.

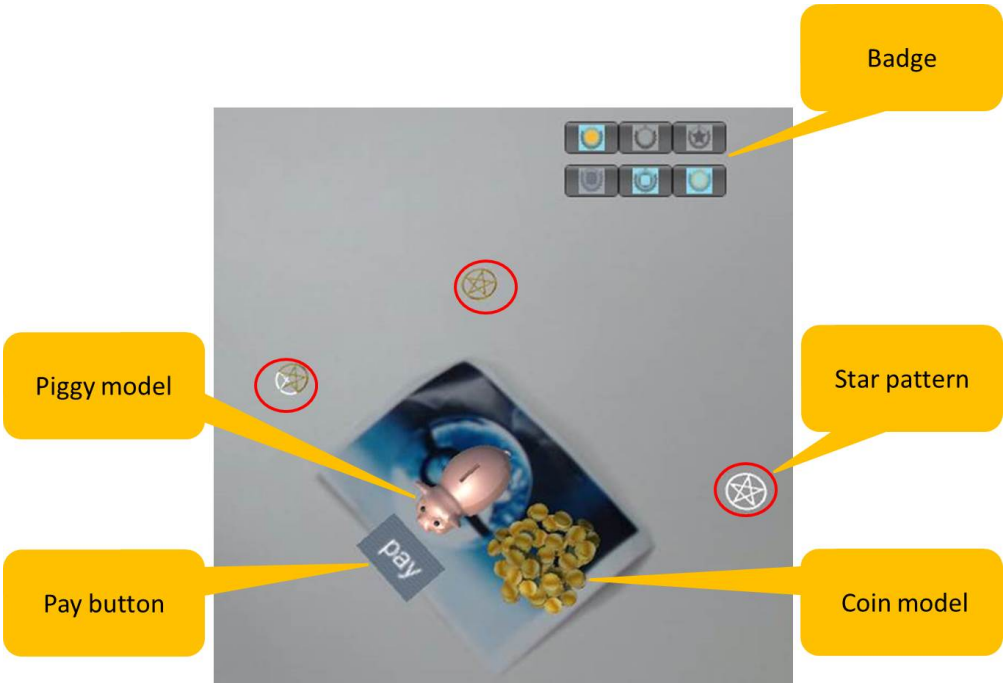


Figure 5.2 customer main interface

Implementation

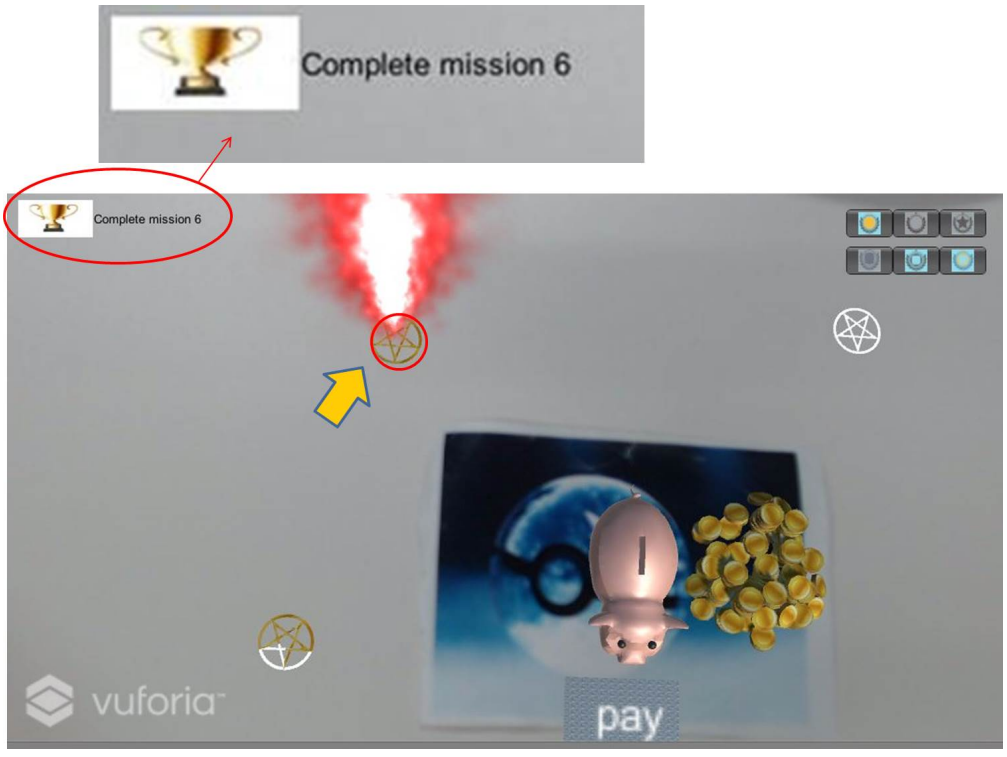
Badges and mission are displayed to give feedback to the customer. To achieve AR interface, Vuforia is used as SDK to implement this system. The image on the point card is predefined as an image target with many feature points. The more feature points, the easier the picture is to be identified. That means that everyone can choose the pattern they like. The collection of image target is target database. The piggy model, coin model, pay button and star patterns are pre-designed model that are fixed in advance while the badges appear under the control of C# scripts. The image of badges should also be predefined. The client will change the status of the badge and task based on the data obtained from the database.

5.3.2 Mission Interface

Interface Display

(a) mission before completion

(b) mission in progress



(c) mission after completion

Figure 5.3 mission

The mission before completion is shown as Figure 5.3(a). Customers can see the state of mission by looking at its color. If the mission button is entirely white, it means that the mission has not yet begun. If customer clicks the mission button circled in Figure 5.3(a), customer can see the mission content at the top left corner of the interface.

The mission in progress is shown as Figure 5.3(b). If the mission button is partially yellow, it means that the mission is in progress. If customer clicks the mission button circled in Figure 5.3(b), customer can see the mission content and progress of mission at the top left corner of the interface.

The mission after completion is shown as Figure 5.3(c). If the mission button is entirely yellow, it means that the mission has been completed. If customer clicks the mission button circled in Figure 5.3(c), customer can see congratulations message at the top left corner of the interface.

Correspondence between Interface and Mission

As we mentioned in Chapter 4, mission is one important element in our system. We can see from Figure 5.3, there are three stages of mission. The color of star pattern reflects the degree of completion, which is thought as progress bar. At each stage, customers can see different information on the screen. Augmented reality is used to give customers intuitive feedback.

Implementation

Depending on the task schedule, the color status of each part of the model is dynamically control by C# script. Collider components are added on star patterns to monitor collision events and C# script is wrote to handle the collision events. Different display modes are selected depending on the status of mission when mission button is clicked. If mission has not yet begun, only the content of mission will be displayed. If the mission is in progress, the schedule and content of mission will be displayed. If the mission is done, AR effect is used to give feedback to customers for enhancing the customers' sense of achievement.

5.3.3 Point Confirm Interface

Interface Display

The point confirm interface is shown as Figure 5.4. When customer touches the coin model, account points will be displayed at the upper left corner of the interface. Animation effects appear near the coin model.

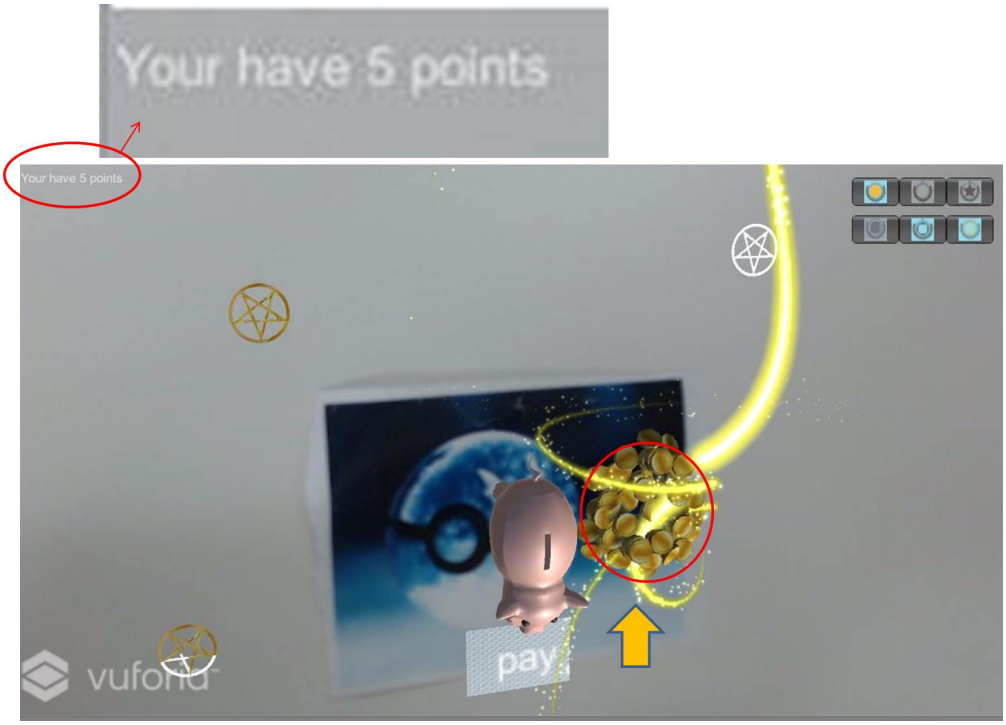


Figure 5.4 point confirm interface

Correspondence between Interface and Point&Reward

As we mentioned in Chapter 4, point&reward is one important game mechanism in our system. We can see from Figure 5.4, we can view the point in account by clicking the coin model. The design of showing points can prevent the information leakage to some extend. Points are used as reward of effort and can be used to pay during micropayment. Augmented reality is used to show point information on the screen.

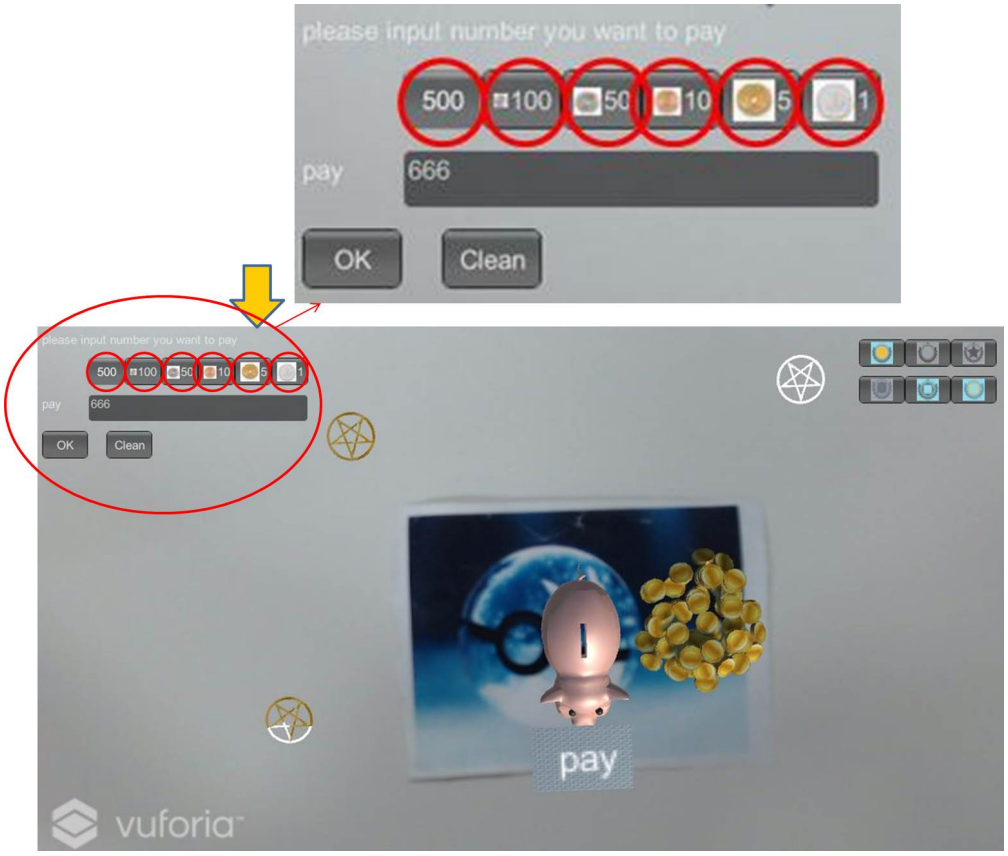
Implementation

Collider components are added on coin model to monitor collision events and C# script is wrote to handle the collision events. Once touching coin model is detected, animation will be displayed and OnGUI() function will be called to show points.

5.3.4 Micropayment Interface

Interface Display

(a) before input



(b) during input

(c) after payment

Figure 5.5 micropayment

The interface before payment is shown as Figure 5.5(a). When customer clicks the pay button, they can choose how much they want to pay by clicking button with coin image at the upper left corner of the interface. They can click different buttons for any times and point will be accumulated. If they press the wrong button, they can reset the points by clicking clean button. If they decide to pay, they can click ok button to confirm payment.

The interface during payment is shown as Figure 5.5(b). Figure 5.5(b) is an example of clicking all buttons once.

The interface after payment is shown as Figure 5.5(c). Figure 5.5(c) shows the interface after

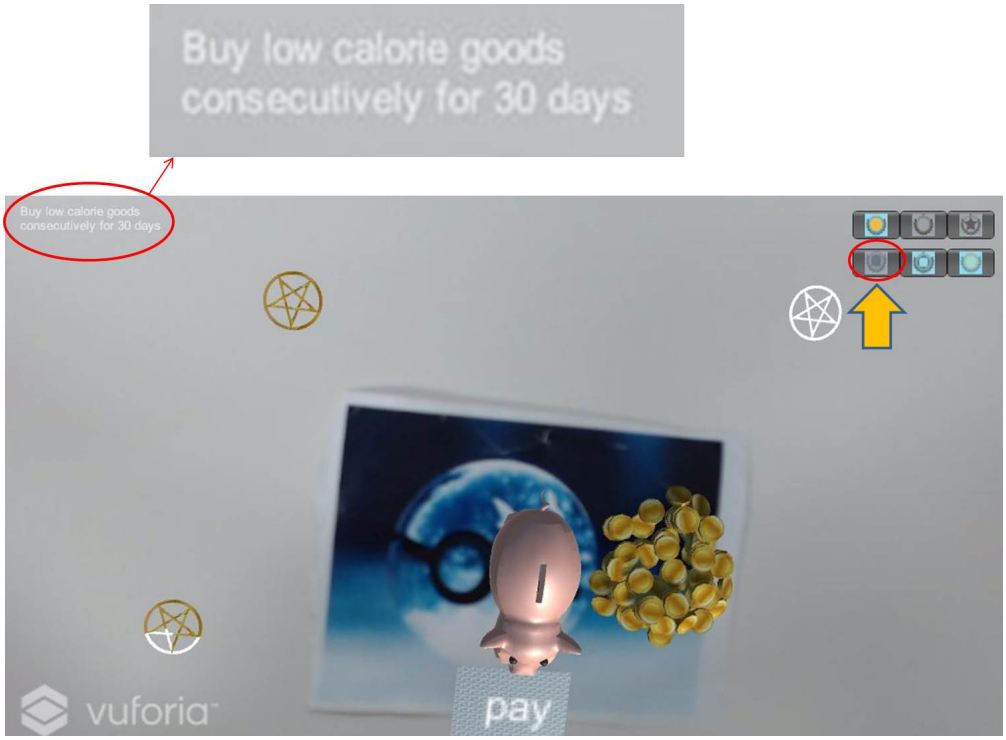
payment. There will be the notification of a successful payment.

Implementation

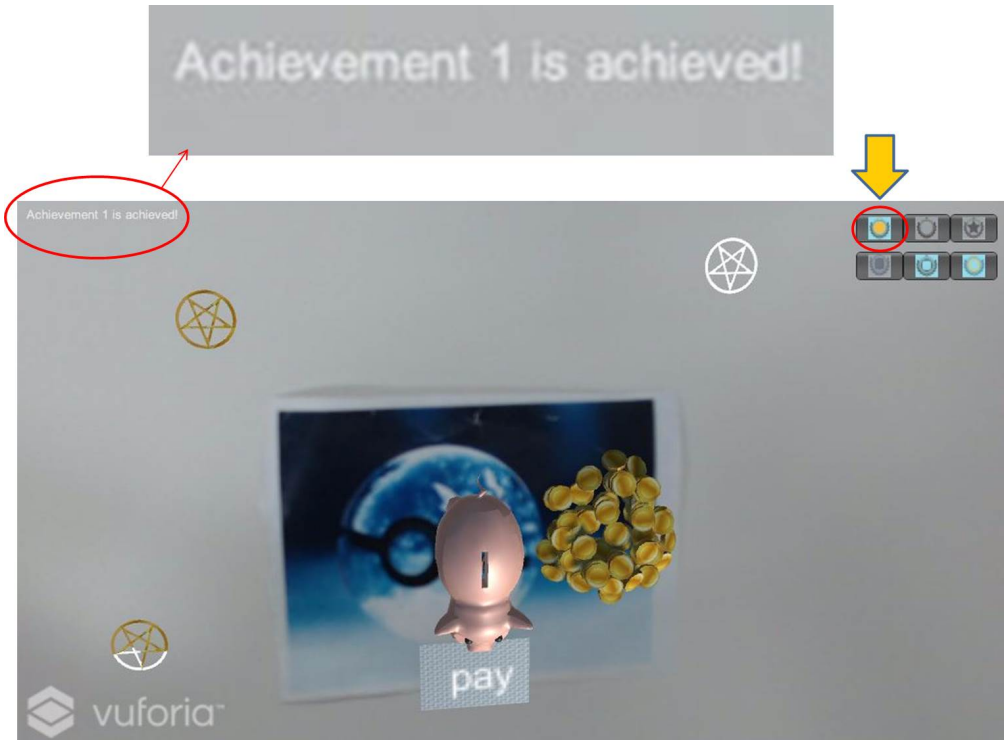
Collider components are added on pay button to monitor collision events and C# script is wrote to handle the collision events. Once touching pay button is detected, corresponding identification will be changed and identification will be judged in OnGUI() function. If condition are met, micropayment interface will be displayed. Once customer clicks the GUI components, corresponding script will be called to handle the message.

5.3.5 Achievement Interface

Interface Display



(a) before achieving success



(b) after achieving success

Figure 5.6 achievement

The interface before achieving success is shown as Figure 5.6(a). If customer clicks the dim badge, the content of achievement will be displayed at upper left corner of interface.

The interface after achieving success is shown as Figure 5.6(b). If customer clicks the light badge, congratulations will be displayed at upper left corner of interface.

Correspondence between Interface and Badge&Achievement

As we mentioned in Chapter 4, badge&achievement is one important game mechanism in our system. We can see from Figure 5.6, there are two stages of achievement. The color of badge reflects the degree of completion. At each stage, customers can see different information on the screen. Augmented reality is used to show achievement information to customers.

Implementation

If customer clicks the badge button, the GUI.Button() function will be called. Corresponding GUI components will be displayed.

5.3.6 Level Interface

Interface Display

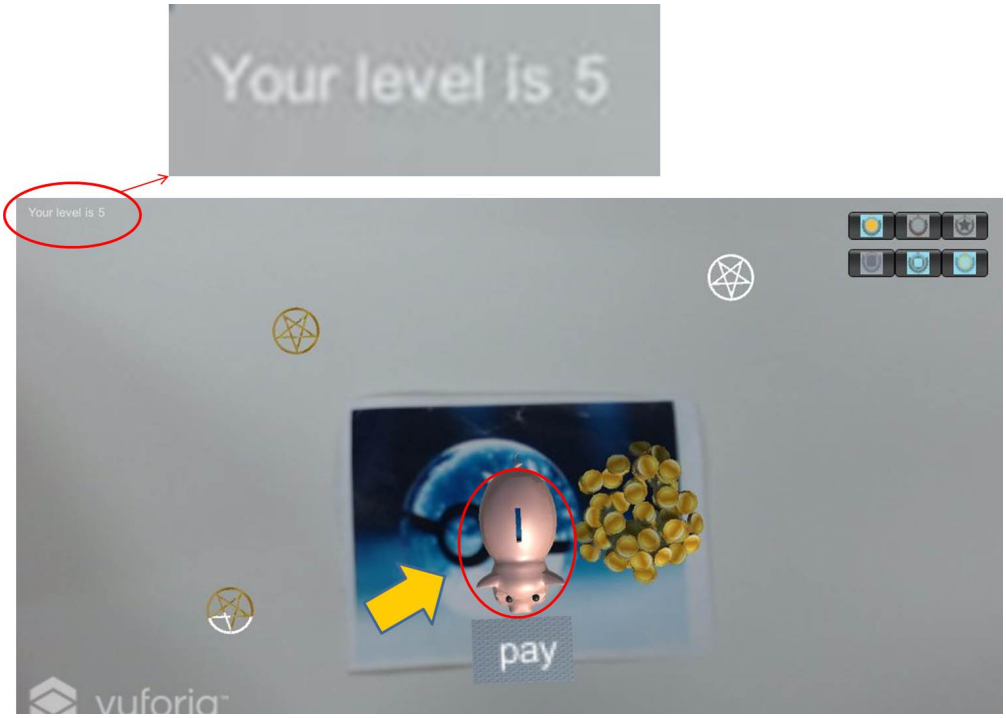


Figure 5.7 level interface

Correspondence between Interface and Level&Competition

As we mentioned in Chapter 4, level&competition is one important game mechanism in our system. We can see from Figure 5.7, if customers click the piggy model, they can see the level information. Customers can use level information to compete with their friends. Customer with

higher level can achieve a sense of achievement while customer with lower level will try to improve rating. Level information is showed by augmented reality.

Implementation

Collider components are added on piggy model to monitor collision events and C# script is wrote to handle the collision events. Once touching piggy model is detected, OnGUI() function will be called to show level information on the screen.

5.4 Provider Module

5.4.1 Main Interface

Interface Display

The interface before deposit is shown as Figure 5.8. The provider interface is slightly different from the consumers'. Provider can confirm mission and deposit changes while they can not see the account information.

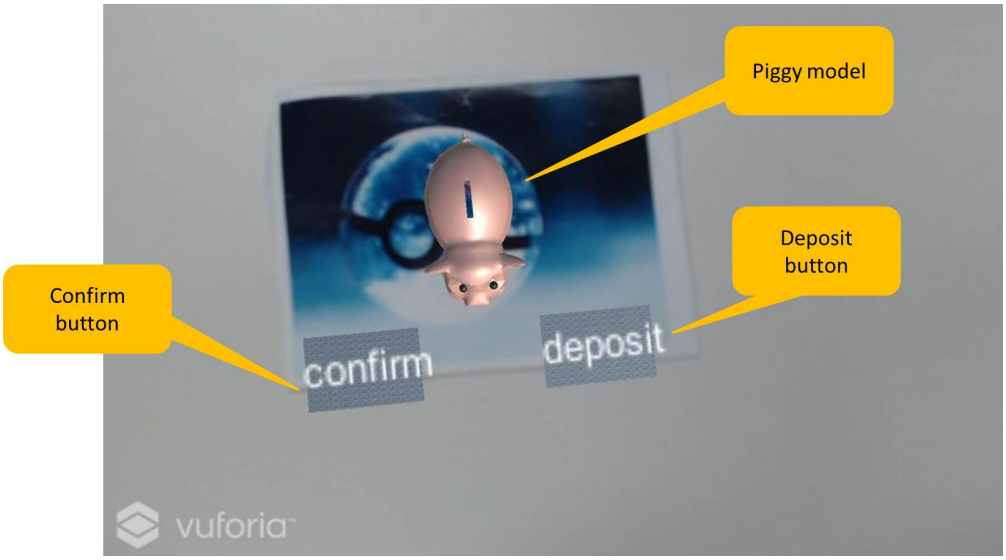


Figure 5.8 provider main interface

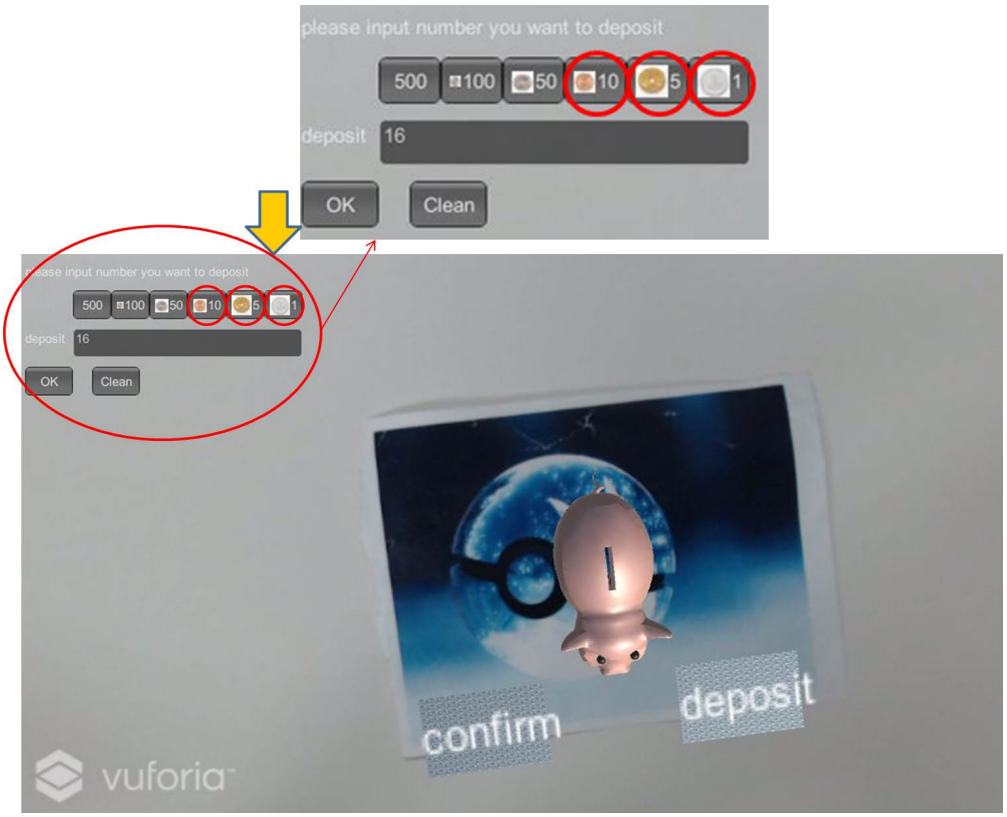
Implementation

To achieve AR interface, Vuforia is used as SDK to implement this system. The piggy model, confirm button and deposit button are pre-designed model that are fixed in advance.

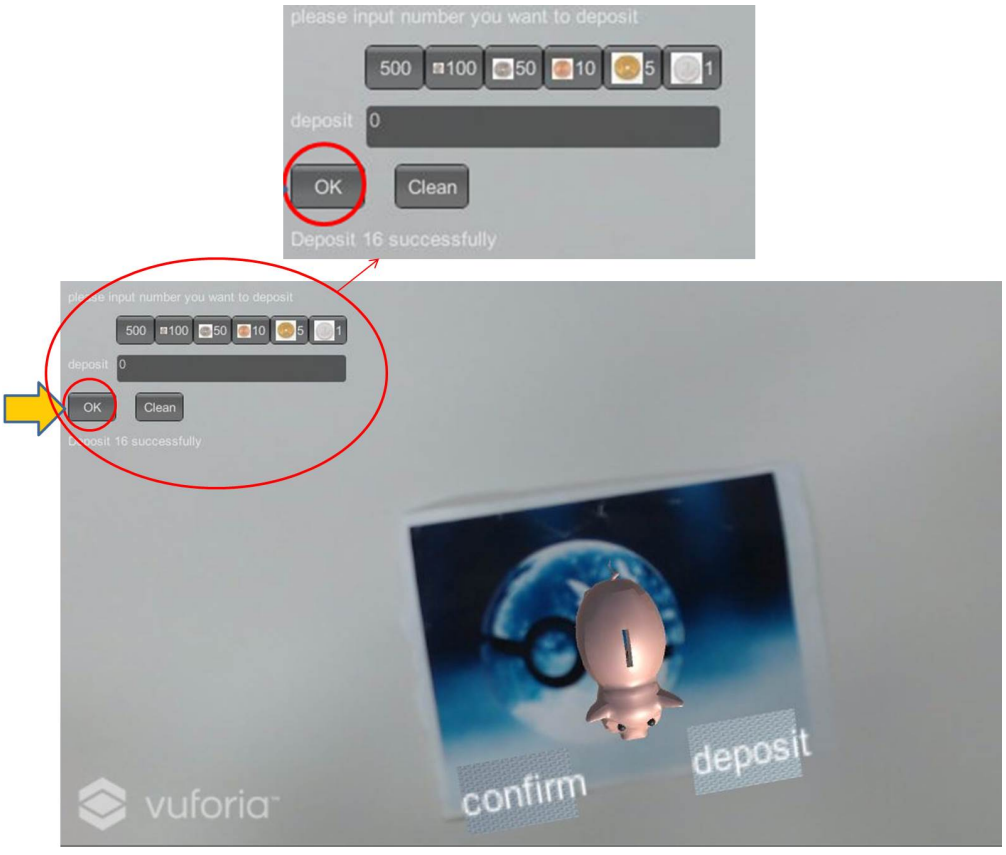
5.4.2 Deposit Interface

Interface Display

(a) before deposit



(b) during deposit



(c) after deposit

The interface before deposit is shown as Figure 5.9(a). When provider clicks the pay button, provider can choose how much points customer want to deposit by clicking button with coin image at the upper left corner of the interface. If they press the wrong button, they can reset the points by clicking clean button. If they decide to deposit, they can click ok button to confirm deposit.

The interface during deposit is shown as Figure 5.9(b). Figure 5.9(b) is an example of clicking 10, 5 and 1 once.

The interface after deposit is shown as Figure 5.9(c). Figure 5.9(c) shows the interface after deposit. There will be the notification of a successful deposit.

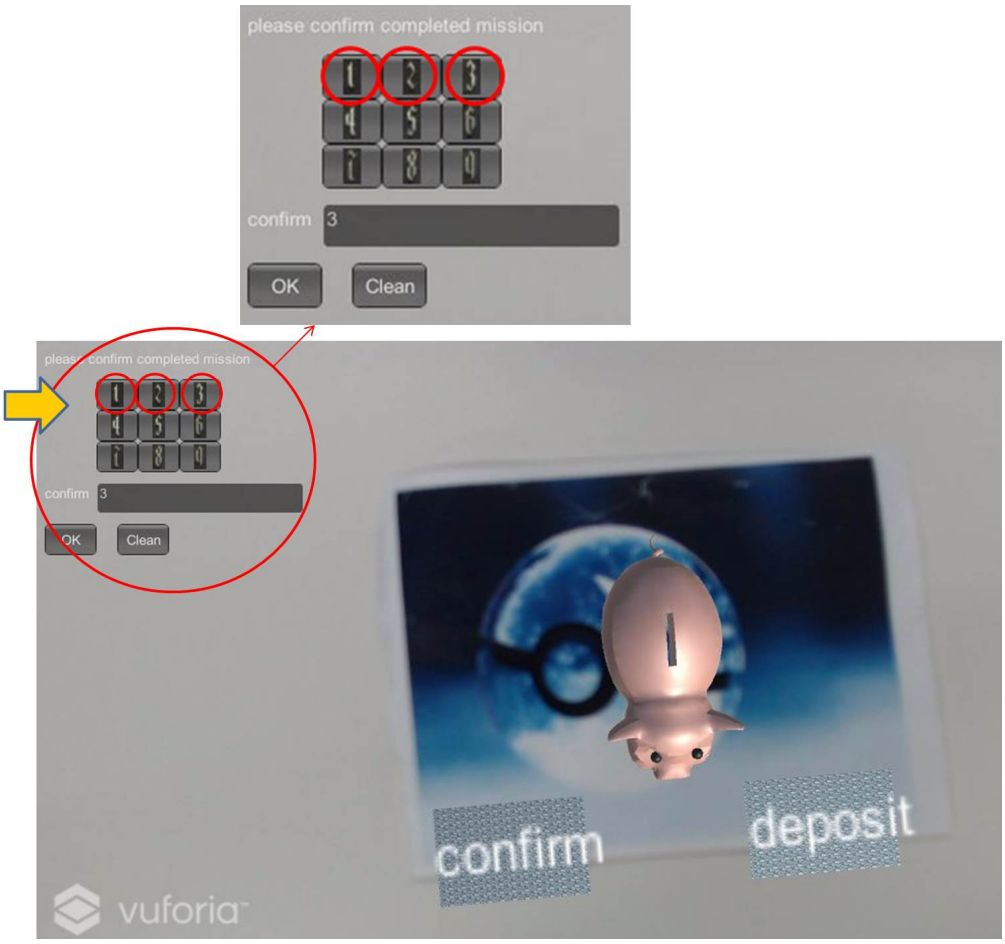
Implementation

Collider components are added on deposit button to monitor collision events and C# script is wrote to handle the collision events. Once touching deposit button is detected, corresponding identification will be changed and identification will be judged in OnGUI() function. If condition are met, deposit interface will be displayed. Once customer clicks the GUI components, corresponding script will be called to handle the message.

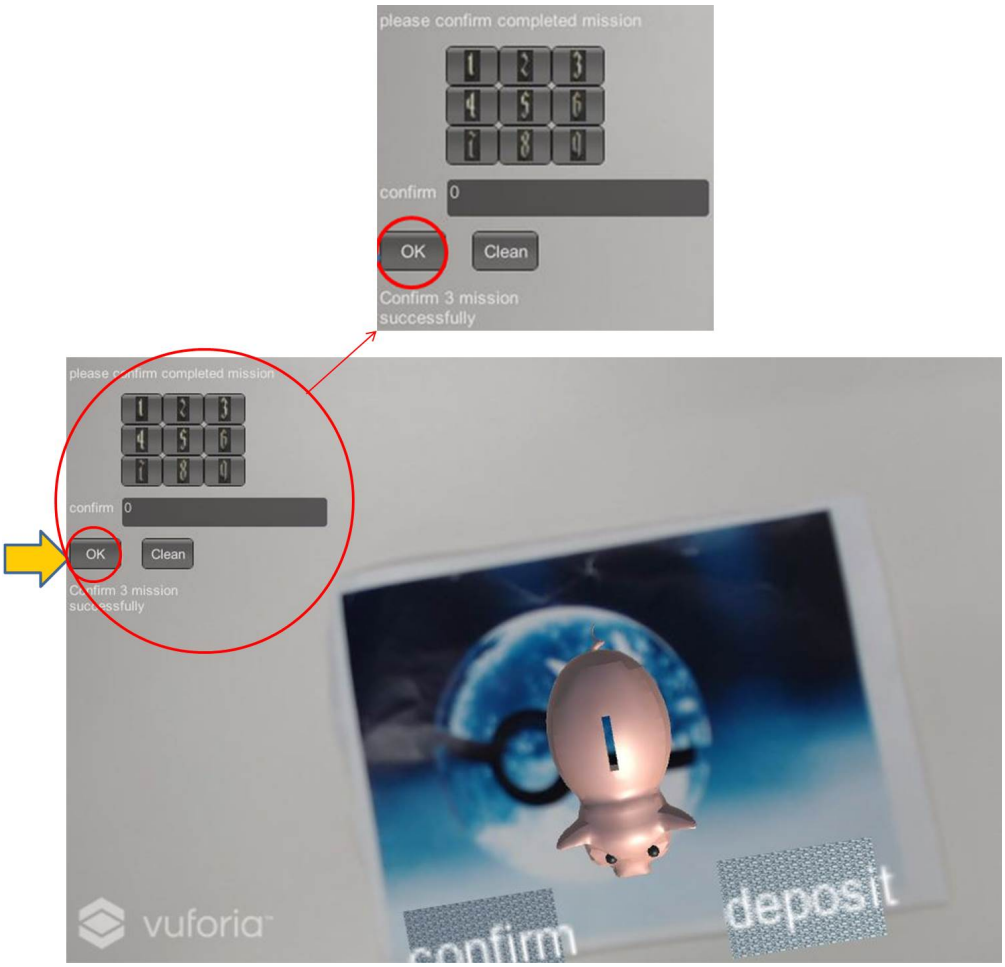
5.4.3 Mission Confirm Interface

Interface Display

(a) before confirm



(b) during confirm



(c) after confirm

Figure 5.10 confirm

The interface before deposit is shown as Figure 5.10(a). If provider click the confirm button, he or she can confirm the daily mission for customers. Once provider clicks the confirm button, there will be 9 buttons that represent different tasks at the top left corner of the interface.

The interface during deposit is shown as Figure 5.10(b). Figure 5.10(b) is an example of clicking 1, 2 and 3 once. The number in the text input field represents the total point of mission which is confirmed. In this case, the number of point is 3.

The interface after deposit is shown as Figure 5.10(c). Figure 5.10(c) shows the interface after

confirm. There will be the notification of a successful confirm.

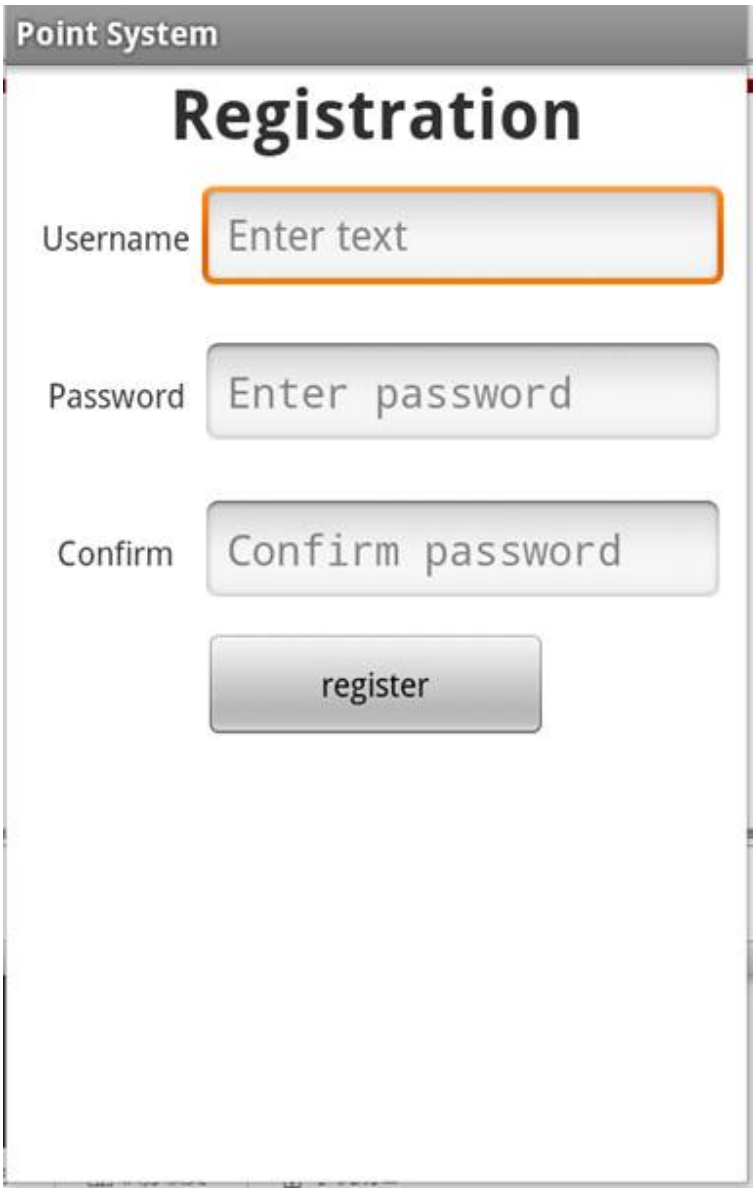
Implementation

Collider components are added on confirm button to monitor collision events and C# script is wrote to handle the collision events. Once touching confirm button is detected, corresponding identification will be changed and identification will be judged in OnGUI() function. If condition are met, confirm interface will be displayed. Once customer clicks the GUI components, corresponding script will be called to handle the message.

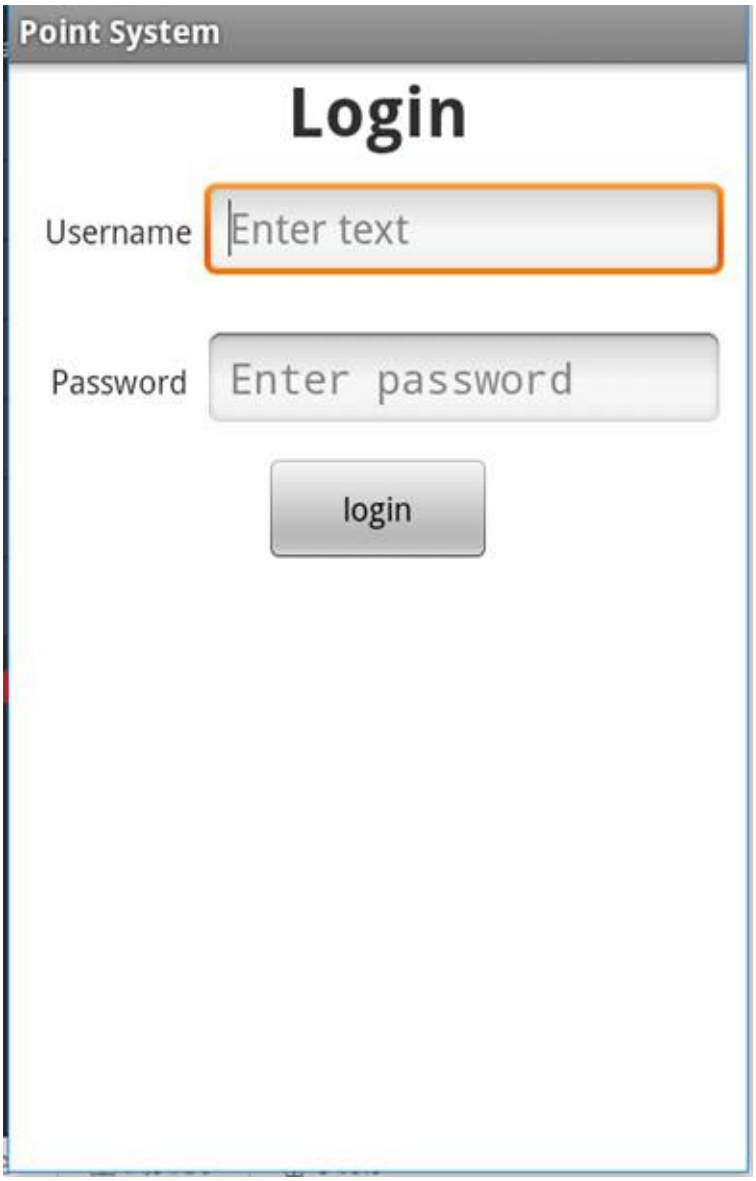
5.5 General Module

5.5.1 Interface Display

registration



(a) registration



(b) login

Figure 5.11 registration and login

Registration and login is the basic function of this system. The registration interface is shown as Figure 5.11(a). The login interface is shown as Figure 5.11(b).

In the registration interface, users need to register username and password. To avoid mistyping, system requires user to enter password twice to check whether the two password is the same.

In the login interface, users log in with username and password. This ensures that user data is invisible to others. Once the user logs in, client can fetch the corresponding information from database and display it if it is needed.

5.5.2 Implementation

To implement registration and login interface, we use eclipse as android development platform. Implementation includes interface design and logic control. XML files are used to set layout and .java files are used to handle event logic.

Chapter 6

Related Work

6.1 Research about AR and Gamification

The paper written by Ronald Schroeter et al.[25] calls for the design of innovative technologies and applications that make safe driving more pleasurable and stimulating for young males by applying gamification techniques. They think that design of automotive user-interfaces and personal ubiquitous computing devices in the future could effectively reduce risky driving behaviours among young males.

The paper written by Chantzi Athanasia Eleftheria et al.[26] proves that cultural education and life-long learning can be supported through the use of technological advances and techniques. In order to promote learning, this research proposal uses augmented reality and gamification to create an educational AR book. Using augmented reality and gamification techniques, the aim is to deliver a more comprehensive understanding while at the same time increase their enjoyment during the learning process.

6.2 Research about Eco-friendly activities and Gamification

The article written by Francesca Martelli et al.[27] aims at raising the environmental awareness and active citizenship for nature protection through volunteering with the use of new technologies.

The article written by Kim et al.[28] shows that Gamification has great potential in delivering messages for public interest and to suggest guidelines for researchers and public contents developers who engage in designing in relation to Gamification.

6.3 Research about Commerce and Gamification

The article written by Manoop Talasila et al.[29] presents results and lessons learned from two user studies on crowdsensing incentives-specifically on mobile gaming and micropayments. The analysis of the results suggests that gaming is a cost-effective solution for uniform area coverage, whereas micropayments work well for sensing tasks with tight time constraints or for long-term tasks for personal analytics.

The article written by Juho Hamari et al.[30] reports the results of a field experiment, which gamifies a utilitarian peer-to-peer trading service by introducing the game mechanism of badges that users can get from varied mission. The results show those users who actively monitored their own badges and those of others in the study showed increased user activity.

Chapter 7

Conclusion

7.1 Summary

In this researh, we analyse the present situation and propose some existing problems. In order to solve these problems and promote the optimization of micropayment system in the future, micropayment system with the introduction of gamification and AR is proposed and implemented.

In the proposed system, game mechanisms like feedback, reward and competition are adopted. To realize that, badge and point are used to show reward, AR is used to show feedback and level is used to show competition. In addition, we try to enhance user motivation to live eco-friendly and healthy life.

We assume that users can use this system through their smartphones or AR glasses in the future. In the system, there are some models and some buttons for customers. If customer clicks the piggy model, they can view their account level. If customer clicks the coin model, they can view their account point. If customer clicks the badge button, they can see the content of achievement. If customer clicks the star pattern, they can view their daily mission. If customer clicks the pay button, they can deal with micropayment. There is differnt interface for provider. If provider clicks the deposit button, they can deposit the small changes for customers. If provider clicks the

confirm button they can confirm progress of daily mission for customers.

7.2 Future Work

In the future, we will enrich the content of animation and try to introduce SNS as a competitive approach. According to different tasks and different achievement, the system will show different animation effects, which will make the system more attractive to users and improve their sense of achievement. In addition, increasing the interaction between users and develop their sense of benign competition through SNS is also considered very meaningful. We also want to evaluate the system through feedback from both customers and provider and improve proposed system.

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