Personal Health-tracking System Focused On Social Communication to Get Motivation

LI PENGYUAN

44171657-9

Master of Engineering

Supervisor: Prof. Jiro Tanaka

Graduate School of Information, Production and Systems

Waseda University

September 2019

Abstract

Personal health-tracking technologies have become a part of mainstream culture which is to record and improve health. The importance of others in health behaviors and in personal health-tracking is well-established but designer still focus on the individual. People struggle with impression management and lack of motivation to change their behavior.

Some research shows that some people now choose to share their photo of food in social software. They sought social support for their own tracking and healthy behaviors and strove to provide that support for others. This phenomenon shows that the social communication factor is a need in personal health-tracking system and it really works.

This research aims to help people to reach the right audiences and guidance when they share health information to get the motivation to change their behavior to maintain health. Our system helps people to finish the process: record, find friends, coach and be coached, change behavior.

How to design the communication part in personal health-tracking technologies system is a new challenge in the HCI community. According to the input environment condition, AR technology is used in our system to make communication and interaction smooth. The interface of the communication part is designed by timeline.

Also, a gamification part is designed in our system to offer people more motivation to change their behavior. The game part also is based on Augmented Reality.

Several experiments performed to verify the system is effective in terms of providing people with motivation.

Keywords: Augmented Reality, Motivation, Personal health-tracking, Change behavior

Acknowledgements

At the beginning, I am very glad to express my sincere gratitude and appreciation to my supervisor Prof.Jiro Tanaka, a very respectable and responsible mentor with rigorous academic attitudes and creative ideas. He has given me lots of help and encouragement, and is always very patient for guiding me to solve problems. Also, the device "Google pixel 2" is provided by him. Thanks a lot to him for the many valuable and earnest advices during every stage of preparation of this thesis.

Besides, it is grateful to all my dear labmates. They discussed a lot with me and always give me lots of inspiration. Thanks so much for their many helps in experiments so that our experiments could be performed successfully and the good results could be get.

Last but not least, I would like to thank my parents and all love ones. For my parents, they give me financial support and warm mental support throughout my master study life. I will keep going on and making progress to return all those people.

Contents

List of figures

List of tables

Chapter 1

Introduction

1.1 Introduction

Previous food tracking systems have often been designed to help people improve their behaviors. Researchers have also called for more research and design focusing on positive interactions and experiences with food[11].

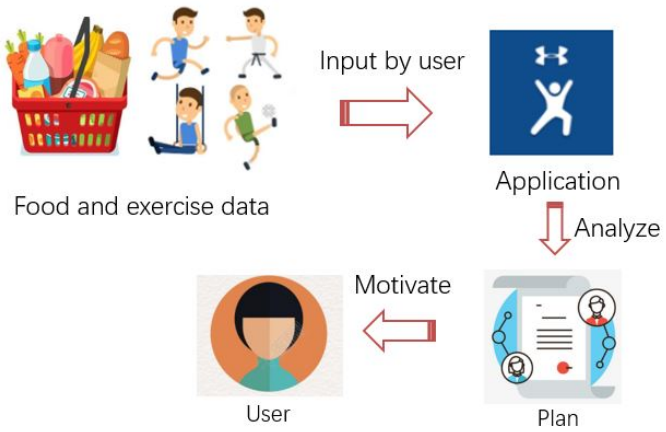


Fig. 1.1 Traditional personal health-tracking system

The figure 1.1 shows the traditional personal health-tracking system model. In the traditional personal health-tracking system, people focus on how to collect the data and how to analyze the data. On the other way, the models the HCI community uses to understand

and design for personal health-tracking tools still focus on the individual. Recently, some research shows that focusing on the individual will have some problems[7].

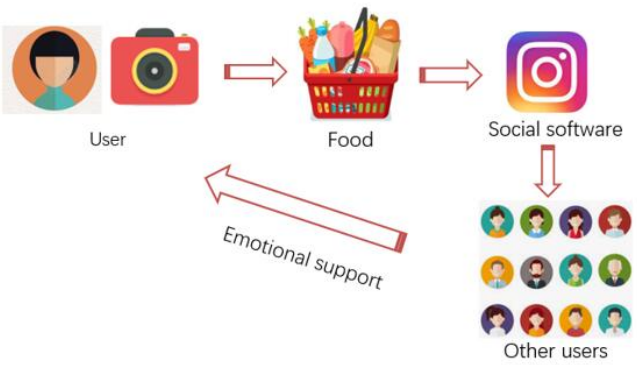


Fig. 1.2 People share their food photos on social software

Due to the focus of individual, people will struggle with impression management and lack of motivation to change their behavior. So some people turn to the social software to share their food photo and get motivation. As the figure 1.2 shows. But the problem is that the social software is not designed for personal health-tracking, people need lots of efforts to use it for managing the health.

Our system is designed to solve this problem. The idea is switching the point from individual to social. Using Augmented reality to support the environment(photo of food) to create a platform for people to communicate with each other and get motivation.

Chapter 2

Background

2.1 Personal health-tracking system

Study has confirmed the benefits of keeping track of the food people eat and the activity people do. It's simple - the more consistently people track their food intake, the more likely they are to lose weight. That's why every successful weight management program suggests that people keep a food diary and/or an activity log. But recording everything people eat

Fig. 2.1 A record of personal health-tracking system

without the right tools can be tedious at best, or simply impossible at worst. So the personal health-tracking system comes out. People usually tend to eat the same foods over time. The system can remember what people have eaten and done most often in the past, and makes it easy for them to add those foods again to log. Just like the figure 2.1 shows. After that, the system will analyze the data with lots of algorithm and give suggestions to the user.

2.2 Augmented Reality

2.2.1 Definition

The accepted definition of AR was proposed by a researcher named Ron Azuma who proposed that Augmented Reality has three key requirements[4]:

- It combines real and virtual content,
- It is interactive in real time, and
- It is registered in 3D.

From a larger perspective, augmented reality is a new approach or technology that makes the computer interface invisible and enhances user interaction with the real world[5]. AR allows users to see the real world, virtual objects superimposed in the real world or synthesized with the real world. Therefore, AR complements the reality and does not completely replace it. Ideally, users seem to have virtual and real objects coexisting in the same space[4]. Augmented reality is a direct or indirect real-time view of the physical, real-world environment. Its elements are "enhanced" by computer-generated perceptual information, ideally spanning multiple sensory patterns, including vision, hearing, touch, body and smell. [23].

The fig2.2shows a simple Augmented Reality example. The castle is virtual object, and other things are real world. These two things get together and make up the Augmented Reality.

Fig. 2.2 A simple Augmented Reality example

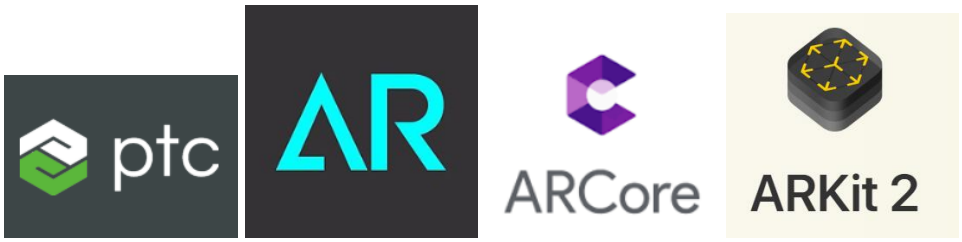
The main significance of augmented reality is that it brings the digital part of the virtual world into the real world and enhances people's perception. Augmented reality does more than just display the data, but further creates an immersive combination that is naturally seen as part of the environment. The first functional AR system emerged in the 1990s as the US Air Force Armstrong Lab and the virtual appliance system developed in 1992, providing users with an immersive mixed-reality experience.[20].

Augmented reality is used to enhance the natural environment, providing users with a perception-enhanced experience. With the development of AR technology, users can interact and digitize information with their surroundings[6].

2.2.2 Techniques

Augmented reality hardware consists of a processor, an output device, a sensor, and an input device. Recently popular mobile computing devices, such as smartphones and tablets that include cameras and MEMS sensors, including accelerators, GPS, solid-state compass, etc., are also suitable augmented reality platforms[16].

In order to implement augmented reality at the software level, an important issue of the AR system is how to truly combine virtual objects with the real world. The software in the system must go through a process called image registration that takes the real world coordinates of the camera off the camera image. In this process, people need to use a lot of video vision related computer vision methods[3].



(a) PTC Vuforia (b) ARToolKit (c) ARcore (d) ARKit2

Fig. 2.3 Some famous AR SDKs

Some software development kits (SDKs) are made to enable rapid development of augmented reality applications.The fig2.3 shows some famous AR SDKs:Vuforia, ARToolKit, ARCore, ARKit.

2.3 Gamification

Now, the distance between the game world and the ordinary world is gradually decreasing. Some of the more influential phenomena are symptomatic: serious games incorporate serious and interesting goals, provide teaching tools, and incorporate games and educational skills[18].

This trend is also more and more visible in interactive systems: an increasing number of non-recreational applications and services leverage game elements to offer users a more involving experience. Deterding, Dixon, Khaled, and Nacke[10] called this phenomenon gamification, defining it as “the use of game design elements in non-game context” [13].

The issues pointed out by some authors [18]suggest that we are not yet completely exploiting the means that games can provide to Human–Computer Interaction (HCI) and

interactive system design. Recently, HCI community has started to wonder whether we should go beyond the current gamification practice.

This research has the aim to find new elements, in the AR world, that could contribute to motivate users in online environments, engage them in the use of interactive systems and drive their behaviors toward healthier and more sustainable lifestyles.

Chapter 3

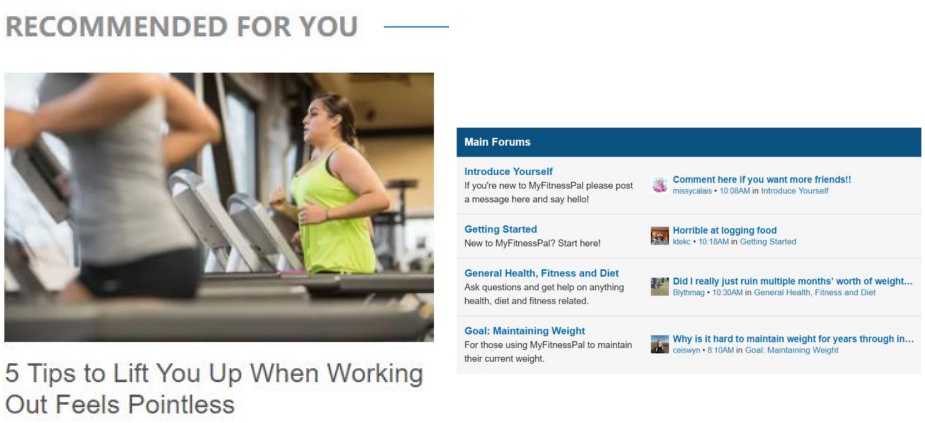
Research Goal and Approach

3.1 Problem

In the traditional personal health-tracking system, designers usually focus on the data-collection and data-analyze. How to offer people motivation is not seriously considered. Some research shows that now the motivation which traditional personal health-tracking system is not enough[8]. The Fig.3.1 show Myfitnesspal's motivation part. Myfitnesspal is a popular personal health-tracking tool which has more than 100 million users. It uses two ways to motivate its user:

1. As the fig(a) shows, it will recommend user some victory stories. Some users read the victory story and get some motivation.

2. As the fig(b) shows, it offer user a forum. Users can talk about things about eating or body exercising. But no more guidance.



(a) Victory story (b) Forum

Fig. 3.1 Myfitnesspal's motivation part

Many health personal tracking tools are hard to inspire long-term adoption because of the lack of motivation[2]. The lack of motivation also causes less behavior change of user[2]. So the lack of motivation is a serious problem in the personal health-tracking system.

3.2 Research Goal

According to the problem, the research goal is to make a personal tracking system which focus on motivating the user to change their behavior. To solve the problem, we decide to include these two things in our system:

1. Introduce social communication to the system. Some research shows that people want to share content to others and it is useful for them. "Their healthy behavior choices were often reinforced by reading other people's posts to learn healthy eating strategies and by receiving feedback from followers. Similar to Community Mosaic users, our participants also made healthier choices so they would not have and then share experiences that might negatively influence others"[7].

2. Add gamification factor in the system. Gamification usually can motivate people well. In the AR world, that could contribute to motivate users in online environments, engage

them in the use of interactive systems and drive their behaviors toward healthier and more sustainable lifestyles.

3.3 Research Approach

To motivate the user to change his behavior, the system must use something to motivate user. The input of user in personal health-tracking system is eating data and exercise data. According to the Characteristics of them, eating data is decided to use for social communication. And exercise data is for gamification part.

3.3.1 Augmented Reality Communication Part

To design an augmented reality communication part, we have to decide some framework.

In terms of content used for communication, the photo-based data is decided. Because photo-based data makes tracking easier and more engaging[9].Using photos to record is appropriate than the traditional way where people share text or blog information.

AR technology is used in this part. Because user need to take picture for the food. And when user uses camera to focus on the food, AR system can start to work for user. AR makes the interaction more smooth.

3.3.2 Gamification Part

Gamification is complex. We must find some ideas to guide us how to design this part.

The first idea is to not to make the gamification part alone. A alone game part in the personal tracking system is strange and unnatural. Combine the gamification with the social communication.

Make use of past and future selves. Provide user with a representation of her past and future selves along her present self, in order to trigger behavior change processes. Past can favor user reflection about the choices she made, the objectives she achieved and the transformations she produced on her own identity in time. Future can trigger behavior change

strategies by presenting ideal states that the user can tend to.It aims at suggesting behavior change strategies based on the presentation of user's representations that embody her past and future states[18].

Personal tracking include two kinds of data: food and exercise. Food data is photo-based, which is designed to used in social communication part. Then the exercise data will be used in gamification.

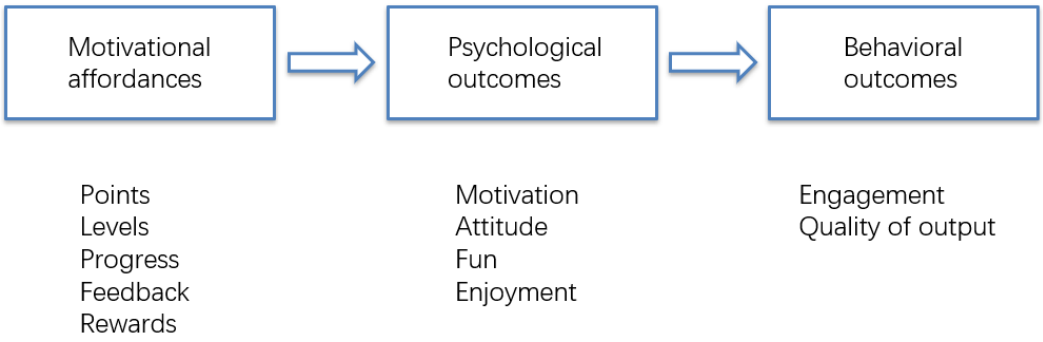


Fig. 3.2 How gamification works

The Fig 3.2 shows how the gamification works. Motivational affordances are provide for users. For example, points, levels, progress, feedback and rewards. These affordances can cause users' psychological outcomes which includes motivation, attitude, fun, enjoyment. Then it can make behavioral outcomes.

Provide meaningful rewards that incorporate some kinds of values for users. While aesthetic values can leverage the users' desire for appearing, and instrumental values can exploit their need of power and achievement, social values can trigger engagement based on the need of being recognized by others. Recompense users for their competence through a class of valuable rewards as a way to recognize their skills, enabling mechanisms of self-improvement based upon users' intrinsic motivations. Rewards, like points and badges, are not meaningful per se. They are representations that stand for something else. If this something is missing, they become meaningless and can only engage mechanical behaviors

or be rapidly discarded. How to find values that can give meanings to these representations should be one of the main aims of gamification strategies and how designing a reward system based on competence could enhance users' intrinsic motivation.[18].

Self-organization. Give users the opportunity to self-organize their groups, providing a general structure that can be freely shaped in different ways. Allow users to choose the group type that better satisfy their needs and desires, supporting the proliferation of a variety of opportunities[18].

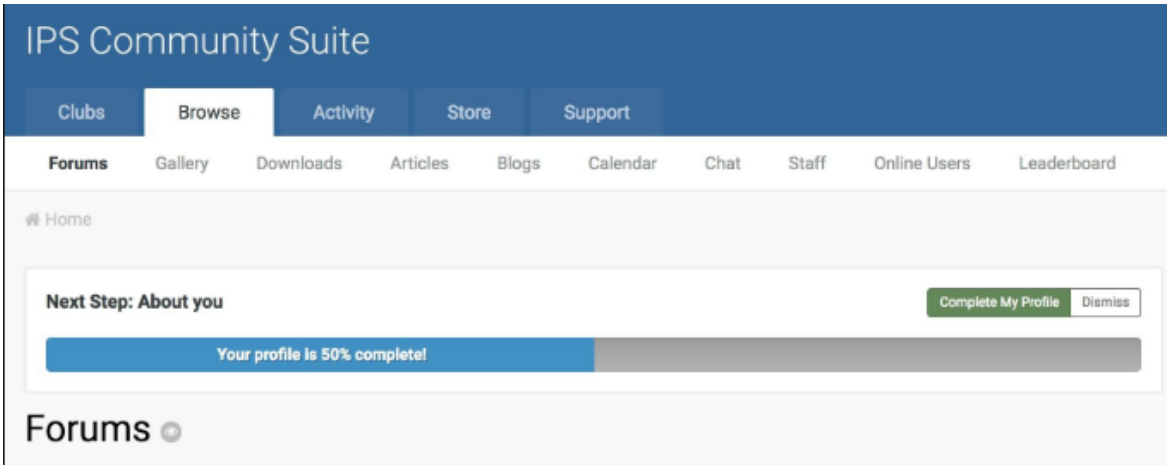


Fig. 3.3 An example for gamification community

Cooperation and friendship. Allow users to become part of a group and promote their identification in it, by fostering cooperation among members. Figure 3.3 is an example for gamification community. People can communicate with others and get the feeling of the group. Feeling of attachment to a community can arise through common identity, whereby members feel connected to a group's purpose (Tajfel and Turner[25]), or from interpersonal bonds, when individuals develop relationships, such as friendships, with other members (Prentice, Miller, Lightdale[17]).

3.4 Novelty

The novelty of our research mainly reflects in these aspects:

1. Make the health-tracking system become social. How to design the communication part in personal health-tracking technologies system is a new challenge in the HCI community. Because the models the HCI community uses to understand and design for personal health-tracking tools still focus on the individual.

2. Add gamification factor in the AR system. An alone AR game is easy to design. But in our research, we combine the AR game with communication to motivate user. It also is a challenge and do not have much reference.

Chapter 4

System Design

In this chapter, we will introduce our system design and each point of our approach. We will divide the the chapter into two parts:

- Part 1 is the system overview. How the system works is described in this part.
- Part 2 is about the process where we design the Augmented Reality part. We will explain the design in details and give a user scene.
- Part 3 is about the gamification part. We explain the aim of the game and how we design it.

4.1 System Overview

The system consists of two main parts: Augmented Reality communication part and game part. Augmented reality communication part is based on food data which input by user to motivate. And the game part is based on food data. The aim of game part is to support the Augmented reality social communication part. The figure4.1 shows how the system looks like.

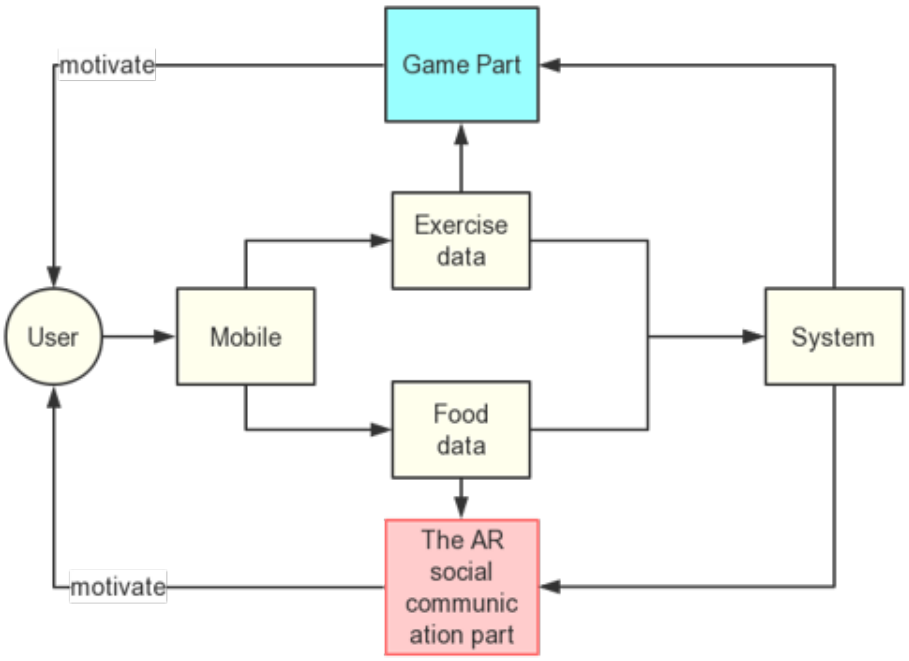


Fig. 4.1 system overview

4.2 Augmented Reality Communication Part

We use Augmented Reality technology in this part. And it is attached to the user's food data. After taking a picture for the food, the user will enter the Augmented Reality communication system. According to the user's status, the system's aim and interaction will be different.

4.2.1 Use Scene

There are five stages in the use scene.

- Stage 1: User uses the system for the first time. User has no friend or coach in the system at the system. At this stage, the system guidance is detailed to make user know

how to use the system. And the main aim of this stage is that the system will help user to make new friends.

- Stage 2: User now has some friends but no coach in the system. The system will help user to find a coach in this stage.
- Stage 3: User now has some friends and a coach in the system. This stage will be the longest stage. System will motivate the user to change his unhealthy behavior. And wait for him be qualified to be a coach.
- Stage 4: User now has more friends than before. And user now has changed lots of unhealthy behavior. He is qualified to be a coach. If user is willing to coach others, the system will help the user to find a people who need a coach.
- Stage 5: User now is a coach for other user. He can give the user who he is coaching suggestion about how to change the unhealthy behavior. The system will thanks for his contribution and motivate to do it continuously

4.2.2 Interaction Design

In this part, we will introduce the interaction design in our system. It includes how to use it and why we design it in this way.

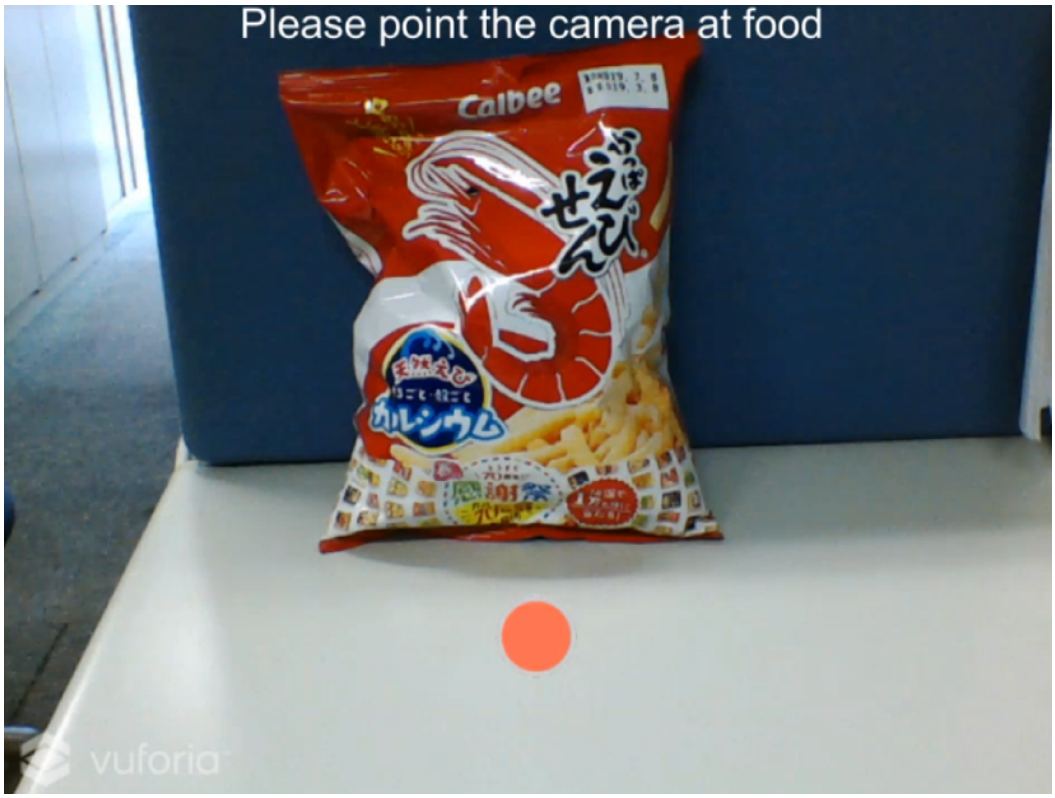


Fig. 4.2 start interface

The figure 4.2 shows the start interface. There are one piece of text "Please point the camera at the food" and a button for taking a picture. The background is the scene of camera. The user just need to click the button to take a picture of the food.

Fig. 4.3 main interface

The Fig.4.3 shows the main interface of our system which will comes out soon after taking a picture. There are three kinds of Augmented Reality information in the interface:

- The augmented reality girl in the right. She is the assistant of user in the system. User can click her to get information.
- The three augmented reality figures in the left. They are the users who are using our system. When the user use the system for the first time, the system will recommend him random users here. After user has his own friends, his friends will show here. User can click the figure to interface. The content of the interface will depend on the relation between them.
- The augmented reality comments which is attach to the food. The comments come from other users.

Then we will introduce the details about the interaction in the main part one by one.

The Fig 4.4 shows the situation when the user uses the system for the first time. The user click the assistant and she tells user that he needs to make some new friends.

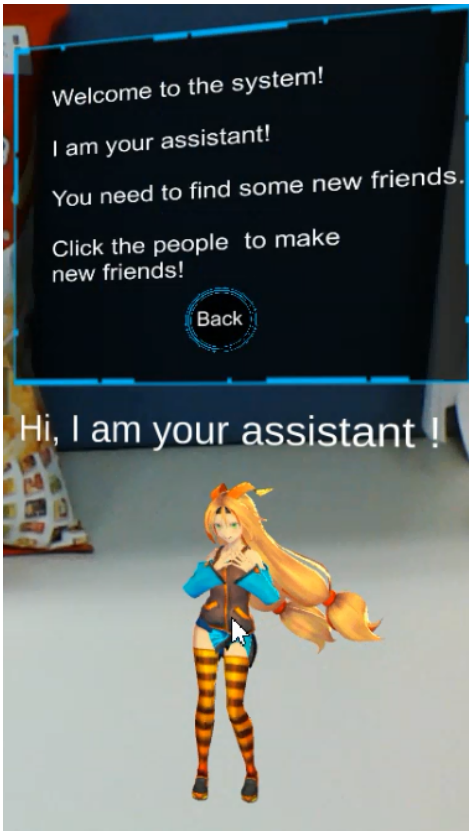
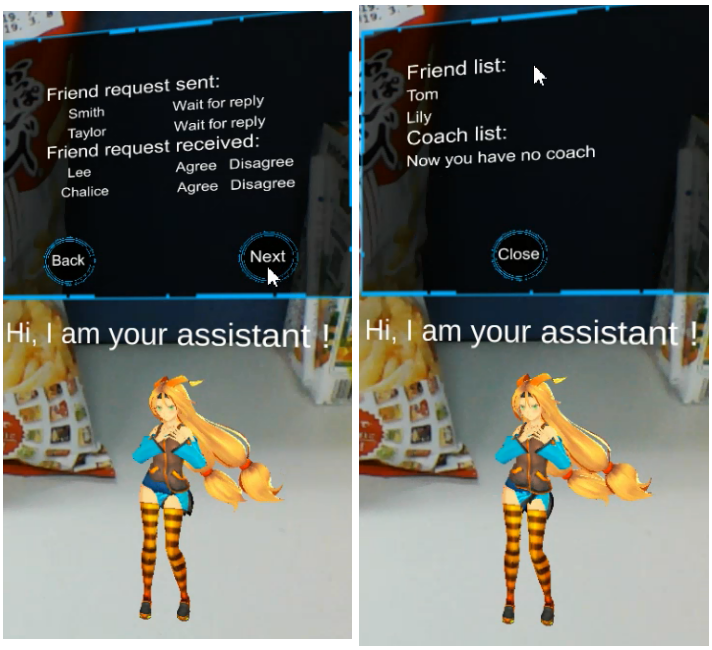


Fig. 4.4 Interact with the assignment I

After the first time, user can click the assistant to look over the message comes from other users and manage his interpersonal relationship. The Fig 4.5 shows the interface with the augmented reality assignment in this stage. The Fig (a) is designed for user to manage his interpersonal relationship. User can receive the request from other users to make friend, delete friends, receive the request from other users to become their coach. The Fig (b) is to look for the status of the user.



(a) Interact with the assignment(a)

(b) Interact with the assignment(b)

Fig. 4.5 Interact with the assignment II

As has said before, the augmented reality figures in the left part represent the other users who are using our system.

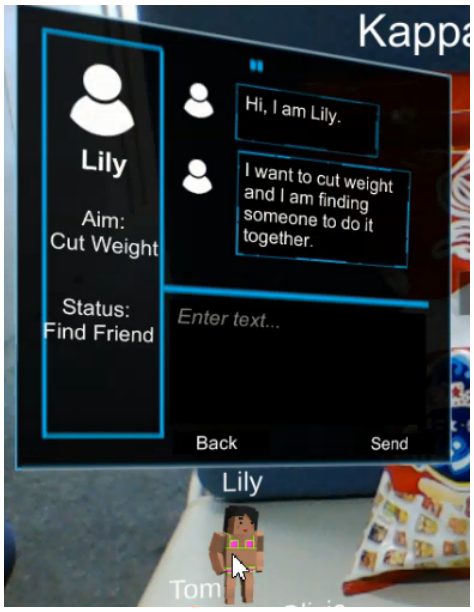


Fig. 4.6 Interact with strangers

When user has no friends, system will recommend some users for user and put them here. The user can click the augmented reality figure to know about him and send some messages. If user want to make friends with him, he just need to click the "Friend apply" button. The figure 4.6 shows the user-interface.

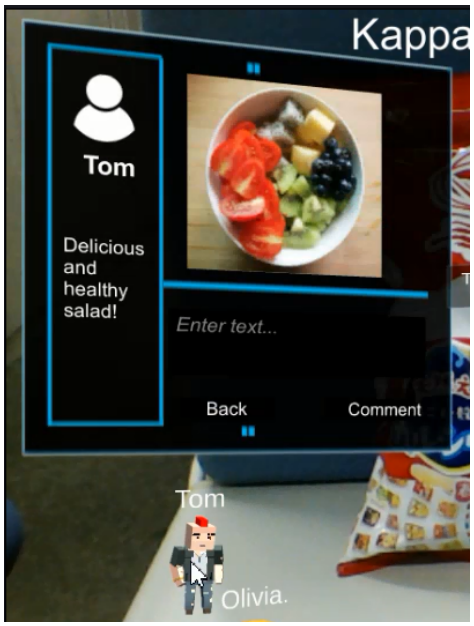
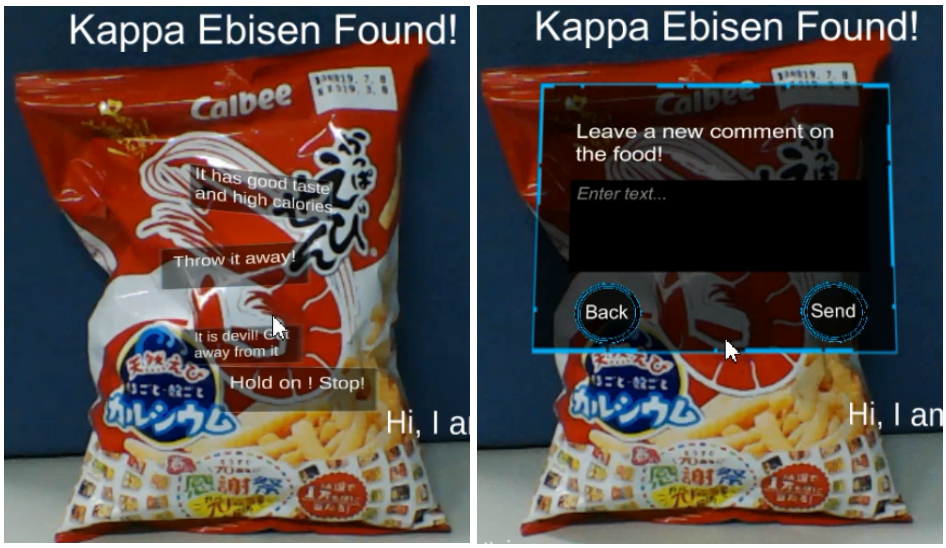


Fig. 4.7 Interact with friends

When user has some friends, system choose some friends who share the picture recently and put them here. The user can click the augmented reality figure to look over his friend's share. User can comment the share. The figure 4.7 shows the user-interface. The left part is friend's information and the shared text. The right part is the shared picture and user can give his comments about it.



(a) Interact with comments(a) (b) Interact with comments(b)

Fig. 4.8 Interact with the comments

User can see the augmented reality comments on the food. Just like the figure 4.8(a) shows. Click the comments, and user can leave a new comment on the food. The figure 4.8(b) shows the situation.

4.3 Game Part

According to the research approach part, the main idea of game part is to support the augmented reality part to motivate the user. Combining the gamification with the social communication and making use of the exercise data are the main aim.

We will give users the opportunity to self-organize their groups and try to provide meaningful rewards that incorporate some kinds of values for users.

We need to decide the rewards in the system. Rewards, like points and badges, are not meaningful by themselves. They are representations that stand for something else. If this something is missing, they become meaningless and can only engage mechanical behaviors or be rapidly discarded. How to find values that can give meanings to these representations should be one of the main aims of gamification strategies[18]. So we have to find that what

is meaningful for user in our system. According to the user scene in the au we can divide the users into three kinds:

- 1.User who is beginner : User uses the system for the first time. And the user's aim is to make new friends. So for the user, the valuable reward should be something which can help him to make new friends.
- 2.User who have a coach and some friends: User in this stage is supposed to change their unhealthy behavior. And his coach and friends will motivate him to do it. The rewards should help him to get more motivation.
- 3.User who has been a coach: When user becomes a coach for others, it shows that he has changed many unhealthy behaviors and he used to get lots of motivation from others. The system should offer him some rewards to motivate him to contribute to the system.

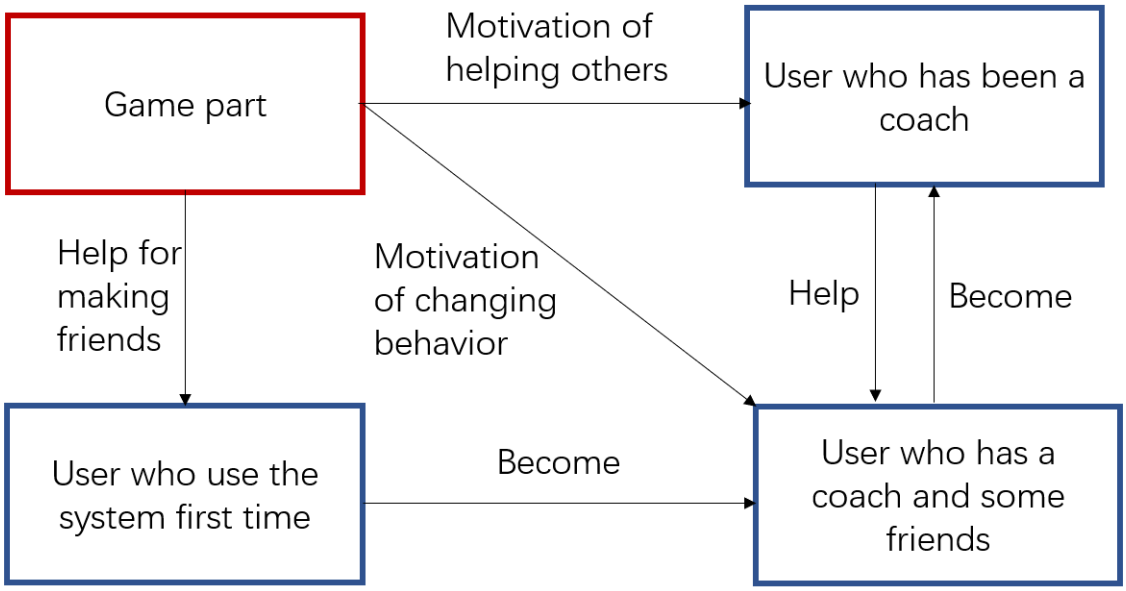


Fig. 4.9 The aim of game part

The Fig.4.9 shows the aim of game part. The game part needs to help user who use the system first time making friends, motivate user who has a coach and some friends to change

their unhealthy behaviors, motivate user who has been a coach to continue to help other users. And the rewards are one of the most important tool to finish the aim. So we design three kinds of aim in the system to finish the goal:

- 1.Rewards aimed for user who is beginner : A chance to make new friends.
- 2.Rewards aimed for user who have a coach and some friends: A chance to get timely motivation.
- 3.Rewards aimed for user who has been a coach: Chances to get eye-catching among the users.

4.3.1 Use Scene

The game part also is Dynamic. According to the user's status, the system's aim and interaction will be different.

- For user who is beginner: User urges to make new friend this stage. User can apply a mission card which contains some exercise missions from the system. Then user stick the mission card to some place, just like gym, playground. When other users find it and scan it by the mobile, he can get the Augmented Reality information about the details about the mission and the information about who post the mission card. By finishing the exercise mission, they are possible to become friend.
- For user who have a coach and some friends. User and his friends can post the mission to each other. When the mission is finished, they can get some points. When the user is depressed and need motivation, he can use the points to make the system post his help information to more users(Not only his friends). So it is more possible to get motivation when the points are used.
- for user who has been a coach: Every time the user's guidance get praised, he will get achievement points. The more achievement points he have, he will have more priority to show his Augmented Reality comments on the food. And there will be a rank leader board of every area.

4.3.2 Interaction Design

The system will set some missions in the random place randomly. As the Fig.4.10 shows, the user can look over the map and find the mission card which is between him.

Fig. 4.10 Get the mission location

Then he can come to the place and use the application to collect the mission. Just like the Fig.4.11 shows.

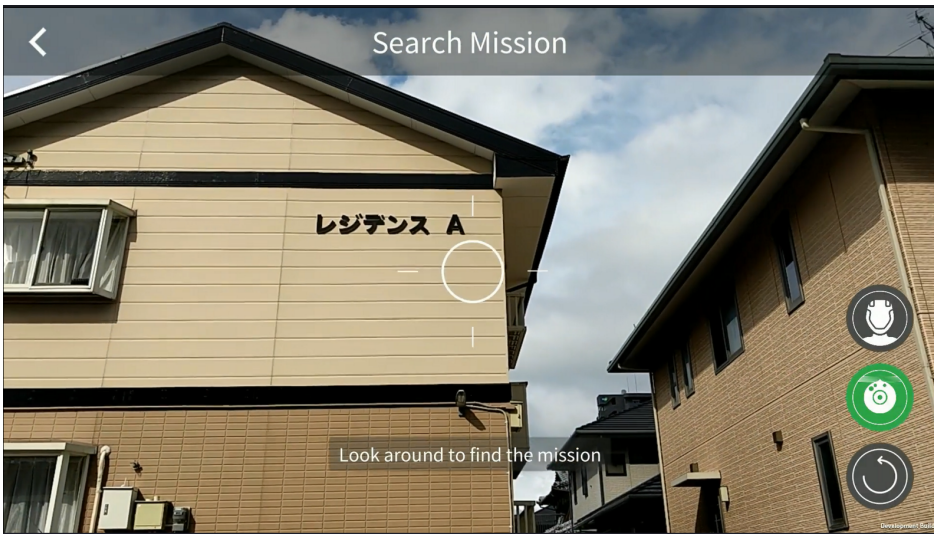


Fig. 4.11 Go to find the mission

Finally, the user find the mission. Just like the Fig.4.12 shows.

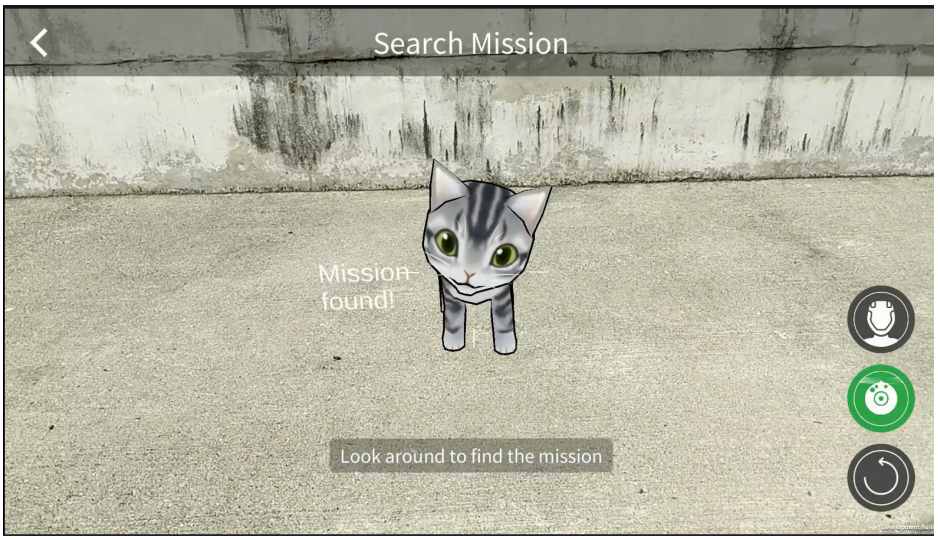


Fig. 4.12 Find the mission

Then he can return to the application and get the information of mission. Just like the Fig.4.13 shows.

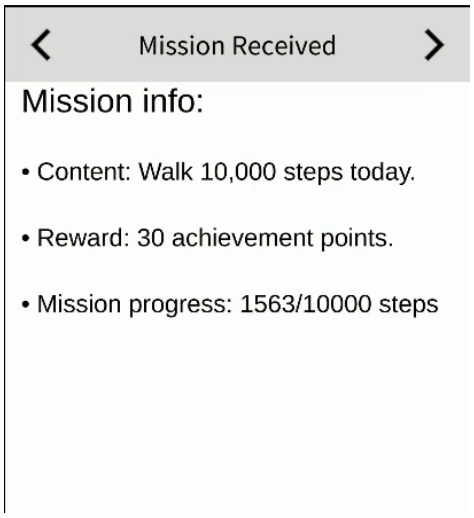


Fig. 4.13 The mission information

Every week, the application will give leaderboards of points about each area. The Fig.4.14 shows the leaderboard of HIBIKINO.

Fig. 4.14 The mission information

Chapter 5

System Implementation

5.1 Hardware and Programming Environment

We use some hardware and programming tools to create the system.

- Hardware Device for using system: Mobile with GPS and camera.
- Programming environment: Unity 3D, MySQL, PyCharm 2017.
- Google Cloud Vision API to do Object recognition.
- Google Maps JavaScript API to realize the Marker in the Google map.

To realize this system, the Android platform needs to be Android 7.0 or higher. So we use Google Pixel2 smartphone as the device. Google Pixel2 is an Android smartphone with great camera, which is good in developing the system, showing in Fig.5.1. To support the programming environment, we use a PC to program as Table.5.1shows.

Operation System	Microsoft Windows 10
CPU	Intel(R) Core(TM) i7-4710MQ @2.5 GHz
Graphics Card	NVIDIA GeFource GT 840M
Ram	8 GB
Software	Unity 2017.3.0f3(64-bit)

Table 5.1 The information of PC

Fig. 5.1 Google pixel 2

5.2 Framework

The Fig.5.2 shows the system diagram. It shows how the framework of the system. First, user take a picture for the food. Then the system starts to work for it. The picture is uploaded to the API URL to get information about the food which is in the picture. At the same time, the system will detect the outline of the food and the platform in the picture. Also, system will get the communication information from the database. After these works are finished,

system will show the Augmented Reality information to the user. When user interacts with the Augmented Reality part, the system will update the data in the database.

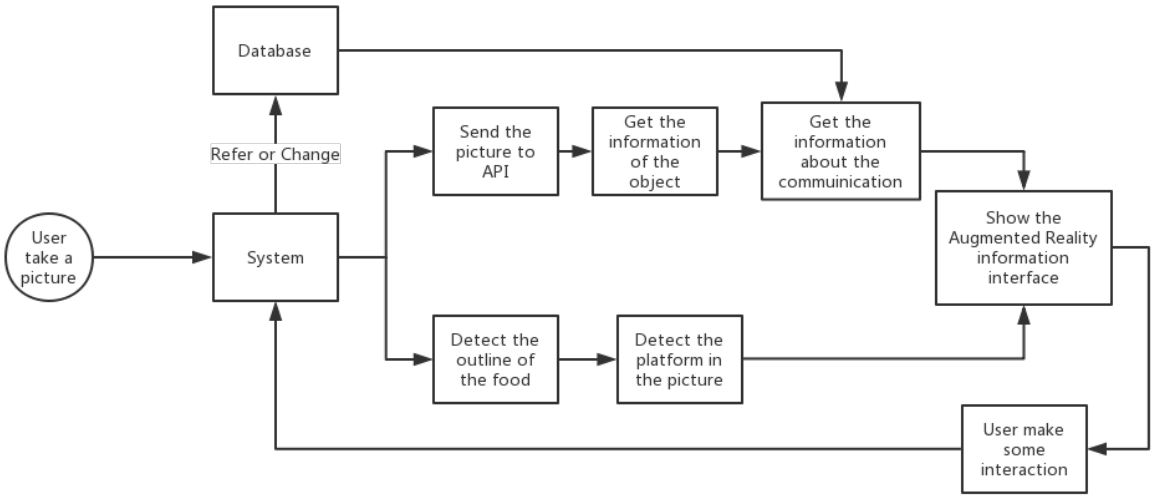


Fig. 5.2 System diagram

5.3 Augmented Reality

5.3.1 Platform Identification

As has been said in 5.2, we need to detect the platform to put on the Augmented Reality figure. We use ARCore to do that. To make use of ARCore, we need to know about some fundamental concepts.

The first thing we need to know is motion tracking. As our phone moves through the world, ARCore uses a process called concurrent odometry and mapping, or COM, to understand where the phone is relative to the world around it. ARCore detects visually distinct features in the captured camera image called feature points and uses these points to compute its change in location. The visual information is combined with inertial measurements from the device's IMU to estimate the pose (position and orientation) of the camera relative to the world over time. By aligning the pose of the virtual camera that renders our 3D content with

the pose of the device's camera provided by ARCore, developers are able to render virtual content from the correct perspective. The rendered virtual image can be overlayed on top of the image obtained from the device's camera, making it appear as if the virtual content is part of the real world.

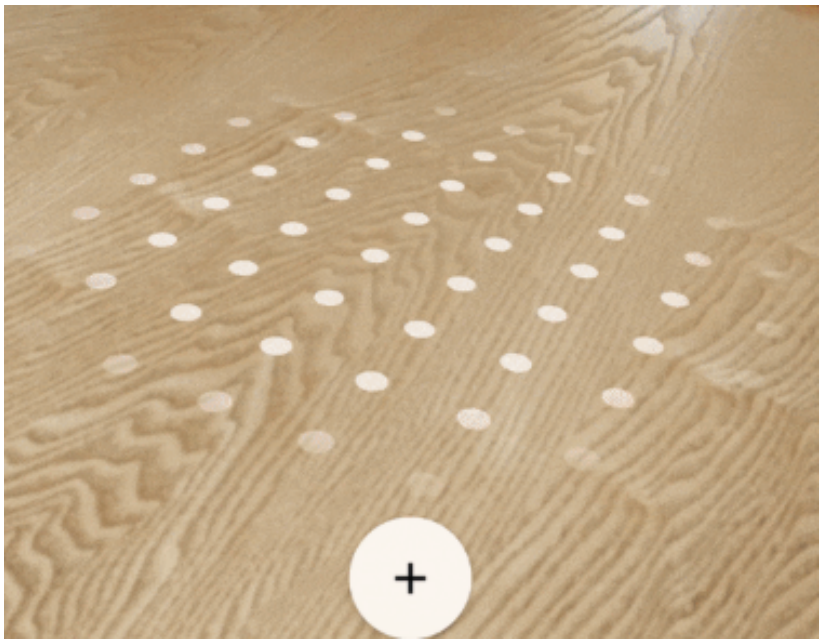


Fig. 5.3 Environment understanding

The second thing is environmental understanding. ARCore is constantly improving its understanding of the real world environment by detecting feature points and planes. ARCore looks for clusters of feature points that appear to lie on common horizontal or vertical surfaces, like tables or walls, and makes these surfaces available to our app as planes.Just like the Fig.5.3shows. ARCore can also determine each plane's boundary and make that information available to our app. We can use this information to place virtual objects resting on flat surfaces.Because ARCore uses feature points to detect planes, flat surfaces without texture, such as a white wall, may not be detected properly.

Last is light estimation. ARCore can detect information about the lighting of its environment and provide us with the average intensity and color correction of a given camera image. This information lets us light our virtual objects under the same conditions as the environment around them, increasing the sense of realism.

To use ARCore in our application, we will need an ARCore supported phone(In our system we use google pixel 2) and A USB cable to connect our phone to our computer. We use the Unity 2017.4.26f1 or later with Android Build Support selected during installation. The The Android SDK 7.0 (API Level 24) or later is need to be installed using the SDK Manager in Android Studio.

After the preparation, we need to create a new project and import the SDK:

- 1.Open Unity and create a new 3D project.
- 2.Unity 2019 only:
    1) Unity 2019 only: Select Window > Package Manager.
    2) Unity 2019 only: Select and install the following packages:
        - a.Multiplayer HLAPI (required by the CloudAnchors sample)
        - b.XR Legacy Input Helpers (Instant Preview requires the TrackedPoseDriver)
- 3.Import the ARCore SDK for Unity:
    1) Select Assets > Import Package > Custom Package.
    2) Select the arcore-unity-sdk-1.9.0.unitypackage that you downloaded.
    3) In the Importing Package dialog, make sure that all package options are selected and click Import.

5.3.2 Object Identification

In our system, we use google cloud vision API to identify the object. Google cloud vision is .

Before we use the API, we need to authenticate to the Cloud Vision API first. We can use a Google Cloud Platform Console API key to authenticate to the Vision API. To do it, we have to:

- 1.Follow the instructions to create an API key for our Google Cloud Platform Console project.

- 2.When making any Vision API request, pass your key as the value of a key parameter. Just like the Fig.5.4 shows.

```
POST https://vision.gooogle.com/v1/images:annotate?key=YOUR_API_KEY
```

Fig. 5.4 HTTP port

Then, we will make a Vision API request by JSON request format. The body of your POST request contains a JSON object, containing a single requests list, which itself contains one or more objects of type AnnotateImageRequest. Every request must contain a requests list. The Fig.5.5 shows one example of the post.Within the requests list:

- 1.image specifies the image file. It can be sent as a base64-encoded string, a Google Cloud Storage file location, or as a publicly-accessible URL. See Providing the image for details.
- 2.features lists the types of annotation to perform on the image. You can specify one or many types, as well as the maxResults to return for each.
- 3.imageContext (not shown in the example above) specifies hints to the service to help with annotation: bounding boxes, languages, and crop hints aspect ratios.

```
"requests":[
{
    "images":{
        "content":"/9j/7QHMSNGJJ....image contents.../Coajk//Z"
    },
    "features":[
    {
        "type":"LABEL_DETECTION",
        "maxResults":1
    }
    ]
}
]
```

Fig. 5.5 HTTP post example

The last, we need to providing the image. We have three ways to do that:

- 1.As a base64-encoded image string. If the image is stored locally, you can convert it to a string and pass it as the value of image.content. The Fig.5.5 shows the base64-encoded image string.

- 2.As a Google Cloud Storage URI. Pass the full URI as the value of image.source.imageUri. The file in Cloud Storage must be accessible to the authentication method we're using. If we use an API key, the file must be publicly accessible. If we use a service account, the file must be accessible to the user who created the service account. The Fig.5.6 shows the situation.

```
"requests":[
{
    "images":{
        "sources":{
            "imageUri":"https://www.google.com/XXX/XX.jpg"
            }
        },
        "features":[
        {
            "type":"LOGO_DETECTION",
            "maxResults":1
        }
        ]
    }
    ]
}
```

Fig. 5.6 Post by Google Cloud Storage URI

- 3.As a publicly-accessible HTTP or HTTPS URL. Pass the URL as the value of image.source.imageUri.

In the system, we finally decide to use the base64 to transfer the data to the API, because it is the most convenient way. We use python to transfer the picture to the base64. Just like the Fig.5.7 shows.

```
import base64

with open("C:\\Users\\Administrator\\Desktop\\ww\\1.jpg", 'rb') as f:
    base64_data = base64.b64encode(f.read())
    s = base64_data.decode()
    print('%s' % s)
```

Fig. 5.7 Transfer picture to Base64 by python

5.4 System Database

Name	Type	Description
ID	LONG	The unique ID of the photo.
Name	VARCHAR	The filename of the photo.
Creation_time	DATETIME	The creation time of the photo.
uID	LONG	The ID of the user who uploaded the photo.
Image	BLOB	The byte array of the photo.
lID	LONG	The location ID where the photo was taken.
oID	LONG	The ID of the object.

Table 5.2 Picture table

The Tab.5.2 shows the structure of picture data in the database. The picture entity refers to the photo taken by user. The picture entity stores the information including photo's name, creation time, user's ID, image byte array, object name.

Name	Type	Description
ID	LONG	The unique ID of the user.
Name	VARCHAR	User's name for login.
Password	VARCHAR	User's password for login.

Table 5.3 User table

The Tab.5.3 shows the structure of user data in the database. The user entity stores user's account information.

Name	Type	Description
uID	LONG	The ID of the user.
fID	LONG	The ID of the user's friend.
isBidirection	BOOLEAN	Whether the friend relationship between these two users is bidirectional.

Table 5.4 Friend table

The friend entity keeps the user's friend list. The Tab.5.4shows that each column stores the user's unique ID and the ID of his friend. Only when two users are two-way friends, the friend relationship is established.

Name	Type	Description
ID	LONG	The unique ID of the location.
Latitude	DOUBLE	The latitude of the location.
Longitude	DOUBLE	The longitude of the location.
Description	VARCHAR	Human-readable address translated from latitude and longitude.

Table 5.5 Exercise table

The Tab.5.5 shows the structure of exercise data in the database.

Name	Type	Description
ID	LONG	The unique ID of the comment.
oID	LONG	The ID of the object where the comment is
uID	LONG	The ID of the user who left the comment

Table 5.6 Comments table

The Tab.5.6 shows the structure of comment data in the database.

Chapter 6

Related Work

The related work will be introduced in this part. There will be two kinds of related work, the first is the work about social health-tracking system and the second is about gamification part in the social communication system.

6.1 Social health-tracking system

As has said before, the importance of others in health behaviors and in personal health-tracking is well-established. But the models the HCI community uses to understand and design for health-tracking tools still focus on the individual[7]. Andrea Grimes and Richard Harper observed that food could bring people together and have discussed the role of technology in human-food interaction[12].

Within our knowledge, there are some social health-tracking systems we could find about the social health-tracking system.

The paper[15] presents a social health-tracking system which focus on aging populations by creating a social net by fridge. They propose FridgeNet as a way of promoting social activities for these people—this social technology assists older people in re-establishing communication with their families, old acquaintances, and new friends. By automating and encouraging the sharing of dietary information, FridgeNet helps members of this population to establish mutual support in a virtual community.

FridgeNet records personal food intake information and promotes communication and social activity among senior citizens. The system uses sensor-equipped processing units (tablets mounted on standard refrigerators) and a cloud service to store and propagate food information. The system automatically stores users' dietary histories and down-loads the corresponding nutritional information. Similar to existing social networking websites, the system lets users post comments, pictures, and voice messages.

Users can browse nutrition information through simple clicks on the tracked food list. If a food image is available, synchronizes individual dietary history, together with the cached nutrition in-formation of newly added food, to the cloud server.

Because the process of searching for nutrition information is time-consuming and often unstructured, some researchers suggest building a social interface to encourage the exchange of food tips or recipes[24].

The idea of social navigation is to aid users to navigate information spaces through making the collective, aggregated, or individual actions of others visible and useful as a basis for making decisions on where to go next and what to choose. These social markers should also help in turning the navigation experience into a social and pleasurable one rather than the tedious, boring, frustrating, and sometimes even scary experience of a lonely traveler. To evaluate whether it is possible to de-sign for social navigation, they built the food recipe system Kalas. It includes several different forms of aggregated trails of user actions and means of communication between users: recommender system functionality (recommendations computed from others' choices), real-time broadcasting of concurrent user activity in the interface, possibilities to comment and vote on recipes, the number of downloads per recipe, and chatting facilities. Recipe author was also included in the recipe description.

6.2 Gamification part in the social communication system

There are some basic gamification elements in the gamification applications. Among these typical game design elements[22], are points, badges, leader-boards, performance

graphs, meaningful stories, avatars, and teammates. We mainly use three of them: points, badges, leaderboards in the system.

Points are basic elements of a multitude of games and gamified applications.They are typically rewarded for the successful accomplishment of specified activities within the gamified environment and they serve to numerically represent a player's progress[26]. Various kinds of points can be differentiated between, e.g. experience points, redeemable points, or reputation points, as can the different purposes that points serve. One of the most important purposes of points is to provide feedback. Points allow the players' in-game behavior to be measured, and they serve as continuous and immediate feedback and as a reward[21].

Badges are defined as visual representations of achievements and can be earned and collected within the gamification environment. They confirm the players' achievements, symbolize their merits, and visibly show their accomplishment of levels or goals. Earning a badge can be dependent on a specific amount of points or on particular activities within the game. Badges have many functions, serving as goals, if the prerequisites for winning them are known to the player, or as virtual status symbols. In the same way as points, badges also provide feedback, in that they indicate how the players have performed[19]. Badges can influence players' behavior, leading them to select certain routes and challenges in order to earn badges that are associated with them. Additionally, as badges symbolize one's membership in a group of those who own this particular badge, they also can exert social influences on players and co-players, particularly if they are rare or hard to earn.

Leaderboards rank players according to their relative success, measuring them against a certain success criterion[1]. As such, leaderboards can help determine who performs best in a certain activity and are thus competitive indicators of progress that relate the player's own performance to the performance of others. However, the motivational potential of leaderboards is mixed. Werbach and Hunter regard them as effective motivators if there are only a few points left to the next level or position, but as demotivators, if players find themselves at the bottom end of the leaderboard. Competition caused by leaderboards can create social pressure to increase the player's level of engagement and can consequently

have a constructive effect on participation and learning. However, these positive effects of competition are more likely if the respective competitors are approximately at the same performance level[14].

Chapter 7

Evaluation

7.1 Experiments

7.1.1 Participants

We invited 10 participants to use our system, ranging in age from 20 to 25 and including 2 female and 8 male.

7.1.2 Method

All participants are given a brief introduction of the system. Each participant needs to use our system to record their eating and. During the process, they also will communicate with other users in the system.

After that, the participant will be asked to fill in a questionnaire. The questionnaire has following 5 questions and these questions use the 5-point Likert scale.

- The system is easy to operate.
- The way of interaction is useful or interesting.
- The system is easy to make new friends.
- The rewards in the game part is enough.

- The system can provide enough motivation for changing behavior.

7.1.3 Questionnaire

The questionnaire is showed in Fig. We plan to investigate the basic information of each participant and get their feedback.

QUESTIONNAIRE

Name: Age: Gender: F / M Date:

QUESTIONS

The questions are based on 5-point scale.

Answer the following questions by circling the most appropriate answer

1. **The system is easy to operate.**

   Strongly Disagree *Disagree* *Neutral* *Agree* *Strongly Agree*

2. **The way of interaction is useful or interesting.**

   Strongly Disagree *Disagree* *Neutral* *Agree* *Strongly Agree*

3. **The system is easy to make new friends.**

   Strongly Disagree *Disagree* *Neutral* *Agree* *Strongly Agree*

4. **The rewards in the game part is enough.**

   Strongly Disagree *Disagree* *Neutral* *Agree* *Strongly Agree*

5. **The system can provide enough motivation for changing behavior.**

   Strongly Disagree *Disagree* *Neutral* *Agree* *Strongly Agree*

   How could the system be improved?

   _____ _____

Fig. 7.1 Questionnaire

7.2 Results

After collecting the results given by the participants, the evaluation of using the spatial note system to enhance family connection can be carried out. All the participants are asked to rate on a Likert Scale ranging from 1 to 5.

It is necessary to introduce the Likert Scale. A Likert scale is a psychometric scale commonly involved in research that employs questionnaires.

Table 7.1 Answers Statistics of Investigative Questions

Question	1	2	3	4	5
Q1:The system is easy to operate.			2	6	2
Q2:The way of interaction is useful or interesting.				3	7
Q3:The system is easy to make new friends.		1	1	7	1
Q4:The rewards in the game part is enough?			3	7	
Q5:The system can provide enough motivation for changing behavior.				9	1

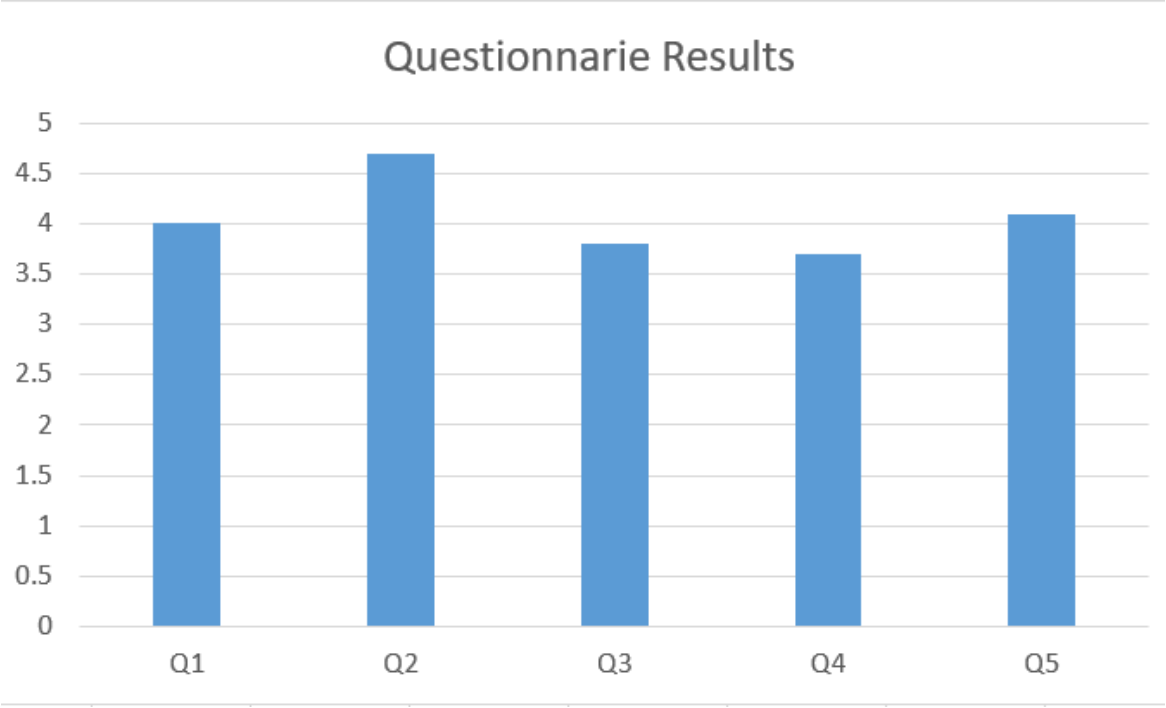


Fig. 7.2 Results

The Fig 7.2 and the Table 7.1 show the results of questionnaire. Q3 is 3.8 point. Q4 is 3.3 point. Q5 is 4.1 point.

The average score of Q1 is 4 point. Q2 is 4.7 point. The two questions are used to judge the interface UI design in the system. Most of participants think the interface way is interesting. But two participants think the interface UI is a little complex.

The average score of Q3 is 3.8 point. Most of participants think they can find new friend by the system easily but two participants don't agree. They think the user should exchange more information to make new friends. The interface content is not enough to make new friends.

The average score of Q4 is 3.7 point. Most of participants think the rewards is good and three participants are neutral.

The average score of Q5 is 4.1 point. Most of participants think the core function of the system which main to provide user with motivation to change their behavior is effective.

Overall, we got a positive feedback through the preliminary user study. We also get some comments and suggestions from participants:

1. "You can find more beautiful user figures in the system. It will look better!"

2. "Maybe more factors should be added in the game part."

3."The interaction of the system is a little bit complex, sometimes I don't know where to look at my current state. "

Chapter 8

Conclusion and Future Work

8.1 Conclusion

In this thesis, we proposed a health-tracking system which focused on motivating the user to change their unhealthy behaviors.

We took use of user's eating data and exercise data to create a social communication system. And we designed a game part to support it. Augmented Reality technology also is used to make the interaction more smoothly and attractive. We provided a user scene to show how the system worked. The scene contained four stages, where the user changed from the beginner to a coach.

User in the system could make friends with the help of system quickly. Then user could interface with other users in the Augmented Reality environment when he took record of his eating data. Also, user could invite his friend to be a coach to give him more suggestions. The coach would get rewards as achievement points for motivation. Last step, the user became a coach to give his friends suggestions. During these process, the user changed his role: from beginner to the people who were coached, then became a coach for others.

The game part also was designed to offer people more motivation to change their behavior. User could set the Augmented Reality mission in the place to communicate with other users. It was a chance for user to make more friends. The game part also provided achievement points to user as the motivation.

Last, several experiments were performed to verify the system is effective in terms of providing people with motivation.

8.2 Future Work

Our system is a new attempt about how to design a social health-tracking system. So the system focused on how to create the platform for users to communicate with each other. And the guidance from the system is a little poor. Using the new technology like deep learning or big data to analyze the data which the user recorded and generate some specific suggestion is one kind of possible idea.

References

[1] Jo ao P. Costa, Rina R. Wehbe, James Robb, and Lennart E. Nacke. Time's up: Studying leaderboards for engaging punctual behaviour. In *Proceedings of the First International Conference on Gameful Design, Research, and Applications*, Gamification '13, pages 26–33. ACM, 2013.

[2] Stavros Asimakopoulos, Grigorios Asimakopoulos, and Frank Spillers. Motivation and user engagement in fitness tracking: Heuristics for mobile healthcare wearables. *Informatics*, 4:5, 01 2017.

[3] Ronald Azuma, Yohan Baillot, Reinhold Behringer, Steven Feiner, Simon Julier, and Blair MacIntyre. Recent advances in augmented reality. *IEEE computer graphics and applications*, 21(6):34–47, 2001.

[4] Ronald T. Azuma. A survey of augmented reality. *Presence: Teleoperators & Virtual Environments*, 6(4):355–385, 1997.

[5] Mark Billinghurst, Adrian Clark, Gun Lee, et al. A survey of augmented reality. *Foundations and Trends® in Human–Computer Interaction*, 8(2-3):73–272, 2015.

[6] Dimitris Chatzopoulos, Carlos Bermejo, Zhanpeng Huang, and Pan Hui. Mobile augmented reality survey: From where we are to where we go. *IEEE Access*, 5:6917–6950, 2017.

[7] Chia-Fang Chung, Elena Agapie, Jessica Schroeder, Sonali Mishra, James Fogarty, and Sean A. Munson. When personal tracking becomes social: Examining the use of instagram for healthy eating. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, CHI '17, pages 1674–1687, New York, NY, USA, 2017. ACM.

[8] James Clawson, Jessica A. Pater, Andrew D. Miller, Elizabeth D. Mynatt, and Lena Mamykina. No longer wearing: Investigating the abandonment of personal health-tracking technologies on craigslist. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing*, UbiComp '15, pages 647–658, New York, NY, USA, 2015. ACM.

[9] Felicia Cordeiro, Elizabeth Bales, Erin Cherry, and James Fogarty. Rethinking the mobile food journal: Exploring opportunities for lightweight photo-based capture. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 3207–3216, New York, NY, USA, 2015. ACM.

[10] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. From game design elements to gamefulness: Defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*, MindTrek '11, pages 9–15, New York, NY, USA, 2011. ACM.

[11] Andrea Grimes and Richard Harper. Celebratory technology: new directions for food research in hci. In *CHI*, 2008.

[12] Andrea Grimes and Richard Harper. Celebratory technology: New directions for food research in hci. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '08, pages 467–476, New York, NY, USA, 2008. ACM.

[13] Kai Huotari and Juho Hamari. Defining gamification: A service marketing perspective. In *Proceeding of the 16th International Academic MindTrek Conference*, MindTrek '12, pages 17–22, New York, NY, USA, 2012. ACM.

[14] Richard N. Landers and Amy K. Landers. An empirical test of the theory of gamified learning: The effect of leaderboards on time-on-task and academic performance. *Simulation & Gaming*, 45(6):769–785, 2014.

[15] Yuju Lee, Mei-Chih Huang, Xiaoyi Zhang, and Wenyao Xu. Fridgenet: A nutrition and social activity promotion platform for aging populations. *IEEE Intelligent Systems*, 30:23–30, 07 2015.

[16] Rachel Metz. Augmented reality is finally getting real technology review. *Internet WWW-page, URL: http://www. technologyreview. com/news/428654/augmentedreality-is-finally-getting-real/(10.07. 2013)*, 2012.

[17] Deborah A. Prentice, Dale T. Miller, and Jenifer R. Lightdale. Asymmetries in attachments to groups and to their members: Distinguishing between common-identity and common-bond groups. *Personality and Social Psychology Bulletin*, 20(5):484–493, 1994.

[18] Amon Rapp. Designing interactive systems through a game lens: An ethnographic approach. *Computers in Human Behavior*, 71:455 – 468, 2017.

[19] Scott Rigby and Richard M. Ryan. *Glued to games : how video games draw us in and hold us spellbound*. Santa Barbara, Calif. : Praeger, 2011.

[20] Louis B. Rosenberg. Virtual fixtures: Perceptual tools for telerobotic manipulation. In *Virtual Reality Annual International Symposium, 1993., 1993 IEEE*, pages 76–82. IEEE, 1993.

[21] Michael Sailer, Jan Hense, Heinz Mandl, and Markus Klevers. Psychological perspectives on motivation through gamification. *Interaction Design and Architecture(s) Journal*, 19:18–37, 12 2013.

[22] Michael Sailer, Jan Ulrich Hense, Sarah Katharina Mayr, and Heinz Mandl. How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction". *Computers in Human Behavior*, 69:371 – 380, 2017.

[23] Patrick Schueffel. The concise fintech compendium. *Fribourg: School of Management Fribourg/Switzerland.*, 2017.

[24] Martin Svensson, Kristina Höök, and Rickard Cöster. Designing and evaluating kalas: A social navigation system for food recipes. *ACM Trans. Comput.-Hum. Interact.*, 12(3):374–400, September 2005.

[25] Henri Tajfel and John Charles Turner. *Psychology of Intergroup Relations*, pages 7–24, 1986. cited By 43.

[26] Kevin Werbach and Dan Hunter. *For the Win : How Game Thinking Can Revolutionize Your Business*. Wharton Digital Press, 2012.