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Vocabulary Game Using Augmented Reality —Expressing Elements in Virtual-world with Objects in Real-world—

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***Abstract*— The purpose of this study is to express elements in virtual world with logical constraints using objects in real world with physical constraints. As an example to achieve this purpose, this paper presents an English vocabulary game utilizing game engine Unity and programming language C# along with ARToolKit, a software library for building Augmented Reality (AR) applications. This game, designed for the purpose of education by aiming at helping students memorize English vocabulary, can be classified as a serious game. Watching the question provided by the game program on the screen, which designates alphabets player can use to assemble into a word, the player arranges the cardboard boxes with alphabets on it in the real world. Through the camera, the AR program detects the arrangement and position of the markers which are the alphabets on the boxes. Then, the game program judges whether the arrangement is the correct English word. This game expresses the game objects in the game program using boxes in the real world.**

1. INTRODUCATION

Until the digital games became the mainstream of gaming, games were designed and played in the physical world using real-world objects. Recently, the mainstream digital games focus the player's attention on the screen of computers or smart devices. However, there seems to be an increasing interest in games with a focus outside the screen. With the growing globalization, Japanese government proposed enhancing English-language education by making it an official subject for fifth and sixth graders. Younger and younger students will need to study English. As the power of vocabularies are one of the foundations in the process of studying English or any foreign languages, we devised a way that students can memorize vocabularies by playing games. There are abundant of vocabulary games, but most of them are limited on screen, that is, in the virtual world. This paper proposes a vocabulary game using Augmented Reality which allows players play with the objects in the real world. This game system connects the real world with physical interaction to the virtual world through the game space developed with game engine Unity.

2. GAME DESIGN

On the devices' screen, the game program presents the player the question, which indicates the letters players can use to assemble into a word. The letters are presented in alphabetical order by sorting letters in an existing English word. If the letters are presented randomly, there is a chance that no word can be assembled using the listed letters. With the method we presented, all of the questions have a correct answer. We prepared 3 levels in this game: 3 to 4 alphabets are presented in the "easy" mode**;** 5 to 6 alphabets in the "normal" mode; 7 to 8 alphabets in the "hard" mode. In the first version of this game system, we prepared 10 words for each level. The game begins in the normal mode. If the player keeps answering the questions correctly, the game moves to the hard mode. Otherwise, the game moves to the easy mode. In the real world, we prepared 26 pieces of paper with printed alphabets. All the paper, which act as marker, are attached on the cardboard boxes. Figure 1 shows the markers on the cardboard boxes.

Fig.1. markers on the cardboard boxes

Player sorts the cardboard boxes in front of the camera. The boxes, along with their positions, are recaptured seamlessly in the game space. In the game space, it is possible to judge if the boxes are putting together in the real world by simply checking its counterpart in the game space. Setting a fictional game object on each left and right edge of the marker as shown in figure 2, the game program checks if a game object on the right edge of a marker contacts with the other game object on the left edge of the other marker.

Fig.2 game objects on the marker

Collision judgment program are embedded in the game object on the right edge of each marker. Names of all the game objects are assigned as the corresponding alphabets. If a game object contacts with the other, that is, the next letter in the word, the name of both game objects are stored. Word composition program then sort the stored letters according to their position, and delete the repeated alphabets. Finally, when the length of the composed word equals the length of the word presented in the question, the word judgment program checks its correctness. Figure 3 shows the screenshot of this game.

Fig.3 Screenshot

For the purpose of reducing the misrecognition of letters, only the letters which are designated in the question are on standby as markers. Compared with the algorism which all of the 26 letters are active for recognition, the misrecognition rate decreased considerably. We had a problem that symmetrical markers such as letter X, are tends to be tracked upside-down, which causes the malfunction during the collision judgment. We solved this by adding two little square in the bottom of such markers.

3. AUGMENTED REALITY

Augmented reality is a live, direct or indirect, view of a physical, real world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. ARToolKit is a computer tracking library for creation of strong augmented reality applications that overlay virtual imagery on the real world. To do this, it uses video tracking capabilities that calculate the real camera position and orientation relative to square physical markers in real time. Once the real camera position is known a virtual camera can be positioned at the same point and 3D computer graphics models drawn exactly overlaid on the real marker. So ARToolKit solves two of the key problems in Augmented Reality: viewpoint tracking and virtual object interaction. ARToolKit was originally developed by Hirokazu Kato of Nara Institute of science and Technology in 1999, and was released by the University of Washington HIT lab.[1] Figure 4 summarizes how ARToolKit tracking works.

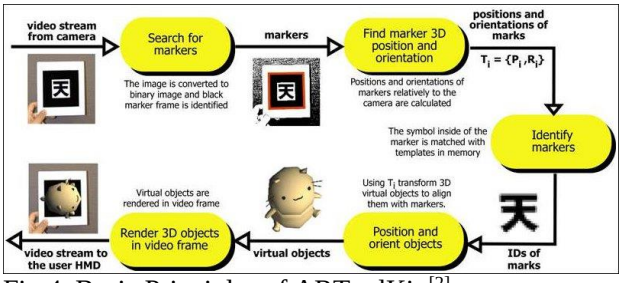

Fig.4. Basic Principles of ARToolKit [2]

4. PROTOTYPE DEVELOPMENT

This game system is implemented and examined on Mac OS X using game engine Unity, and programming language C#. Figure 5 shows the system configuration of this game system.

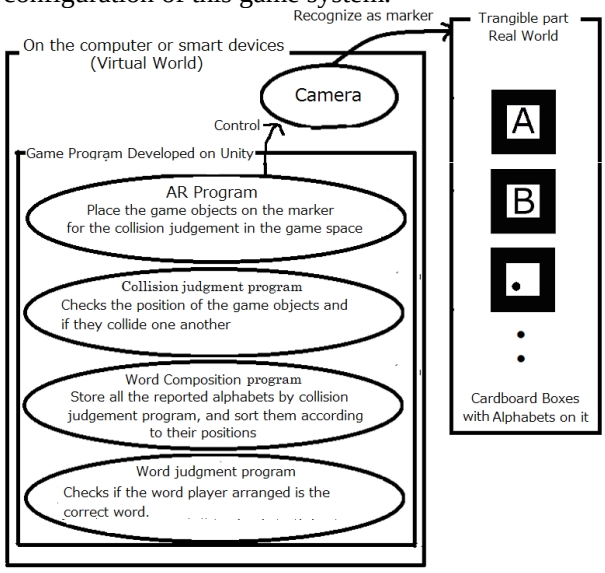

Fig.5. system configuration

5. CONCLUSION AND DISCUSSION

This game provides seamless connection between physical world and virtual world. In most AR games, the player controls the virtual game character on the screen, while the markers remain stationary. With the idea of moving the markers, players are able to have a novel game experience as this paper presented. However, there are some limitations in this game system. First, all alphabets can be used only once. Words are not supported in this game if the same alphabets appear more than once in the word. Second, the number of questions are limited. This can be solved by loading English words from online dictionary APIs.

This game system can be easily applied to vocabulary games in other languages by simply changing the markers and the word list.

REFERENCES

[1] Carleton Olegario M. Ximo (ed.), *ARToolKit* (U.S.A, U.K., Germany: Ject Press, 2012), p.1-4

[2]http://www.hitl.washington.edu/artoolkit/documentation/index.html