Developing the AR Application for English Vocabulary Learning

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Abstract

This paper introduces an intuitive approach of memorizing new vocabulary through the use of Augmented Reality (AR) for English learners. In this study, English texts are recognized, and virtual objects are placed upon them in an AR environment. Verbs are visualized through the movements of 3D images and videos. This application was created using Unity 3D and the Vuforia library. The developed application was tested on an Android device. Although the present application can visualize nine nouns and five verbs, it is not a complicated task to prepare other words even in other languages.

1 Introduction

Today, the Augmented Reality (AR) technology is applied in various fields of education. These applications are found in curriculums for subjects such as biology, chemistry, math and foreign language learning. In this particular project, we develop an AR application for English vocabulary learning. Our application recognizes English texts and automatically displays the corresponding 3D pictures and videos.

2 Overview of AR Technology

2.1 Augmented Reality

Augmented Reality (hereafter AR) is a variant of Virtual Reality (hereafter VR). In AR, information is attached to or emphasized in the surrounding environment, and it therefore extends the perception of its user [1]. Whereas VR replaces the real environment with an artificial one, AR is a technique to alter the perception of surroundings. In contrast to VR, in which for example a virtual room, virtual table or virtual teapot is created in an interactive environment, and the user can interact with virtual objects.

2.2 Related Studies

AR technologies have been introduced and used in many different studies. Some examples include pedestrian navigation systems, traffic warning systems, medical scan systems and mobile games. And more recently, some educational applications use AR features.

2.2.1 Navigation and Touring

Narzt et al. discussed navigation paradigms for outdoor pedestrians and cars [2]. The AR pedestrian navigation system and the traffic warning system are implemented in cars for signals indicating routes, highway exits, approaching cars or gas fuel prices overlaid in the AR environment. They prototyped video see-through PDAs (Personal Data Assistant) and mobile phone and envision eventual use in the car's windshield.

2.2.2 Medical Applications

There are several AR applications tested in medical field. One of such applications is live overlays of ultrasound, CT, and MR (Mixed Reality) scans. Vogt et al. used video see-through HMD (Head Mounted Displays) to overlay MR scans on body parts to be examined [2].

2.2.3 AR Games

There are many AR games being created by people. For example, Piekarski and Thomas created "ARQuake" where mobile users fight virtual enemies in a real environment [3]. The general-purpose outdoor AR platform "Tinmith-Metro" evolved from this work, and it is available at the Wearable Computer Lab [4]. This game is similar to other outdoor games such as "Sky Destroyer" [5] and the adventurous "Game-City" [6]. Also, a number of games have been developed for prepared indoor environments such as "AquaGauntlet" [7] (alien-battling) "ContactWater" (dolphin-juggling), "AR Hockey", and "2001 AR Odyssey" [8]. Currently, the most popular AR smartphone game is "Pokémon GO" [9]. The game was initially released in selected countries in July 2016. The game utilizes the GPS of a player's mobile device to locate, capture, battle, and train virtual creatures called Pokémon. They appear on the screen as if they are at the same real-world location as the player (Figure 1).

Figure 1: Mobile AR game "Pokémon GO"

2.2.4 Educational AR

LearnAR [10] is a pack of ten AR curriculum resources that teachers and students can use by using a webcam. The resource pack consists of interactive learning activities across math, science, physical education and English. As part of the teaching strategy called flexible learning, LearnAR can be used in class by teachers and students. It can also be used at home by individual learners, exploring the subjects independently. As shown in Figure 2, the moment a specific AR marker is being recognized, the endocrine system is displayed. In Figure 3, AR markers are used to create a link between colors and word categories; each word category is associated with a specific color.

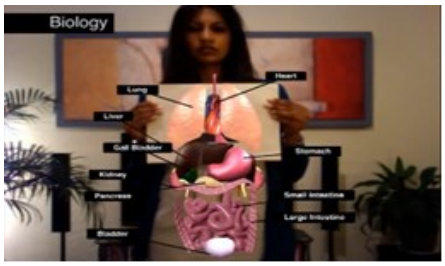

Figure 2: LearnAR in education of biology [11]

Figure 3: LearnAR for English education [11].

3 Description of Learning System

3.1 Implementation of our AR system

Our system consists of a marker and digital data associated with the marker. Any image can be used as the marker; although, images with more distinct points can be recognized more easily. The marker image is imported into Unity. The following sections describe how to create AR application. Readers may also refer to the instructions in web site [12]. The environment described in Table 1 was used for implementing the AR Technology in this study.

Device	ASUS Zenpad 3s 10
OS	Windows7
Libraries	Vuforia
Development Environment	Unity

Table 1: The environment for implementing the AR technology

3.2 Vuforia

Vuforia [13] is a software development kit (SDK) for the AR application programming by applying computer vision approaches such as pattern and object recognition. Vuforia was created by the company called Qualcomm Technologies. Computer vision technology is used to recognize and keep track of simple 3D objects like boxes and two-dimensional images in real time. When carrying out the development of the AR application using Vuforia, it is rather simple to use 3D objects and images instead of markers. In this research, we use Vuforia along with the Unity engine described in the next section. To use Vuforia with Unity, it is necessary to prepare "Database Package". The information of AR markers is managed by single database, and it is referred from other applications, such as Unity. There is a web site to prepare the Database Package in Vuforia site [14]. After registration of AR markers in the Database Package, the user can choose which digital data may be associated with the marker.

Create a Database and Image Target

First, prepare database for managing the relational information of digital data and AR markers. From the top menu bar (① in Fig. 4), choose the item "Develop → Target Manager". Then "Target Manager" menu appears in main window (②) and select "Add Database" from the menu. In the popup window (③), specify the name of database to fill the text box entitled "Name" and choose "Device" in the radio button entitled "Type". Push the button "Create" to create the database.

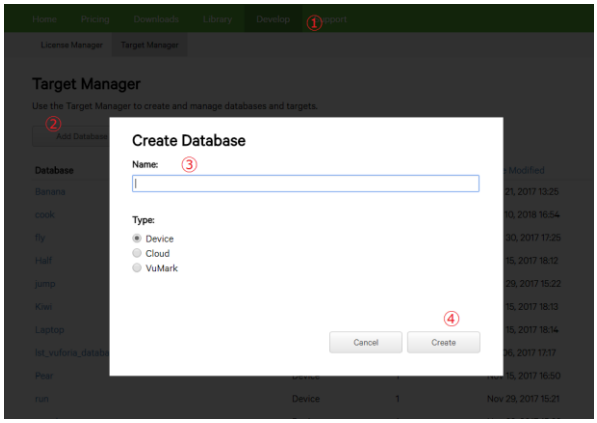

Figure 4: Create the database

In the next step, add images to the newly created database. Select the database and click “Add Target” 1 (Fig. 5). Then “Add Target” menu appears in the main window and select “Type” from the menu. In this study, select “Single Image” as it displays 3D model on English text (②) Select “File” (③) and fill the text box entitled “width” (④) and type in “Name” (⑤). Push the button “Add” to add the image to the database.

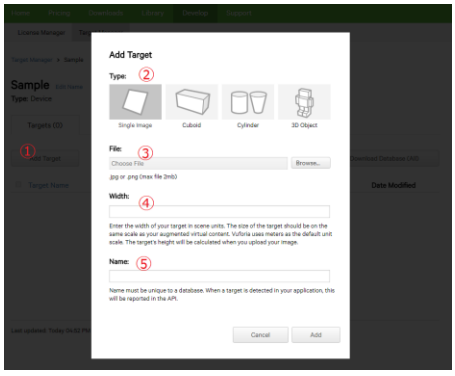

Figure 5: Add image target

For the next step, download the database and confirm “Rating”. The target is added and the “Download Dataset” option is displayed (Fig. 6). What is important here is “Rating”. Good rating means that it can be used for tracking. Tracking is a function to trace the model even if it is outside the marker. Push the button “Download Database” to download the database (⑥).

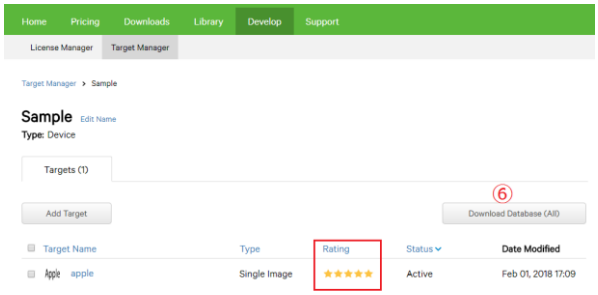

Figure 6: Download database and confirm “Rating”

Download the Database

As the final step in Vuforia, download the database. Select the “Download Database” and a popup window appears (Fig. 7). In this popup window, choose “Unity Editor” in the radio button saying “Select a development platform”. Click “Download” to download the database including the image target. It is called “Unity package”. This will generate a Unity package containing trackable information about this database (⑨). The database will be imported later in Unity.

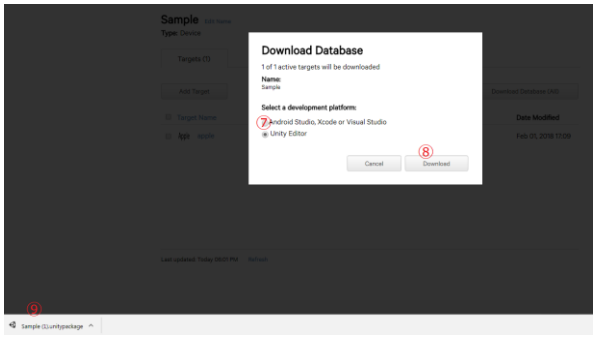

Figure 7: Download database and get Unity package

3.3 Unity3D

Unity [15] is a 3D game engine developed by Unity-Technologies. It incorporates an integrated development environment (IDE) for multiple platforms, and numerous developers use it to create web game plug-ins and games for smartphones. Unity and Vuforia are used in a complementary fashion. Unity is responsible for processing input from the user and rendering the 3D content. Then Vuforia is charge of estimating to estimate camera pose, position and image recognition.

In Unity, we can import 3D models in the Unity Asset Store. The Unity Asset Store is a web store where users can buy digital data. Several digital data (3D models and 2D images) are available. We can download certain items for free or purchase others. We add the digital data and associate it with marker information. The final step is to build the project for Android. When the android device recognizes the AR marker, the digital data associated with the marker (e.g., 3D model) will automatically appear on the marker.

Advance preparation in Unity

After creating a new Unity3D project, we need to import the Vuforia Unity packages (Fig. 7). We import the 3D models from the Unity Asset Store (Fig 8). How to prepare the digital data of tiger and associate it with the marker information is as follows. From "Window → Asset Store," import the tiger model for free.

Figure 8: Import 3D models

As a next step, add an "AR camera" and "Image Target" to "Scene View" (①) (Fig 9). "AR camera" is an Augmented Reality camera prefab from Vuforia. From the "Project Window" (②), get the items "Assets → Vuforia → Prefabs" and drag it into our "Hierarchy Window" (③).

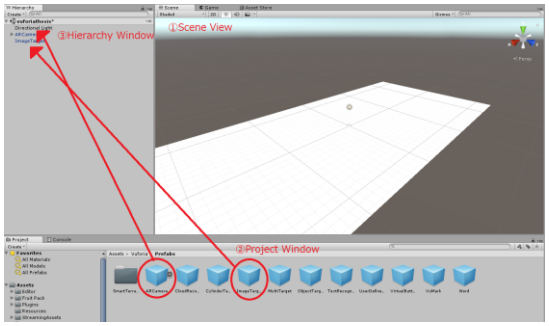

Figure 9: Add an AR camera and Image Target

Set the digital data

"Image Target" is already added to our "Hierarchy Window" (②). Set the "Image Target Behavior" to connect the AR marker and digital data (Fig 10). In the "Image Target Behaviour", we need to change "Database" to "Tiger" (④) and "Image Target" to "IMG_4414 (Tiger's text)" (⑤). When completed, the tiger text image will appear in our "Scene View".

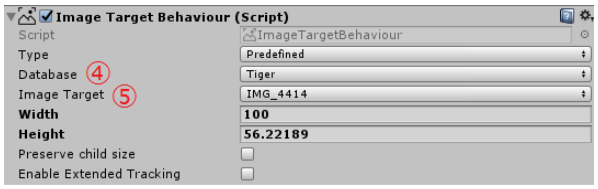

Figure 10: Change the Database and Image Target

For the next step, drag our Tiger 3D model onto the scene. It can be found under the "Asset → Tiger → tiger_idel" from the "Project Window". For the tiger to appear on "Scene View", it needs to be child of "ImageTarget" as shown in Figure 11.

Figure 11: Set the tiger image

Build and run

As the last step in this study, we build the project for Android to display it on an Android device. From the top of the menu bar, choose the item "File → Build Setting" and go to the "Build Setting" window (Fig 12) to select "Add Open Scene" so that you can add the current scene from this window. Then, choose "Android" as the "Platform" (⑦). We will also need to have an Android developer environment set up before we can test our Unity games on the device. This involves downloading and installing the Android SDK [16] with the different Android platforms and adding our physical device to the system. Finally, click the button "Build and Run" to run this project on Android (⑧). We can point the mobile device's camera to the marker and watch the 3D picture as shown in the following sections.

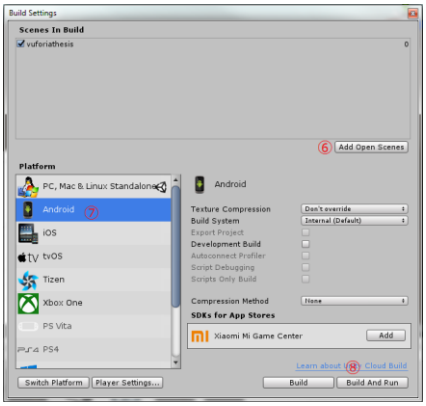

Figure 12: Build and Run on Android

4 Results and Discussion

The application displays a 3D picture of the recognized noun and a moving 3D model of the recognized verb. In this study, nine nouns and five verbs were selected for demonstration. They are five kinds of fruits, the word "Laptop", the word "Tiger", the word "Half", and the word "Witch". Figure 13 shows their visualizations on associated text markers. Figure 14 shows enlarged view of the visualization for the word "Tiger".

Figure 13: Creating AR technology in Unity 3D

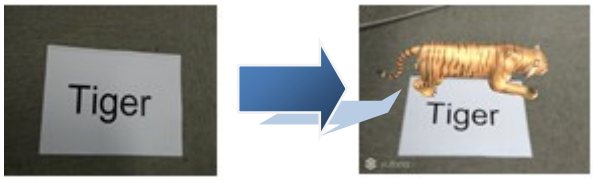

Figure 14: Augmentation of tiger text with 3D pictures

Also, 3D character animations for five verbs were prepared using a digital character query-chan [17]. Her action changes depending on which verb chosen. Figure 15 shows all five verbs, and figure 16 shows when the marker "walk" is selected. The action described by the specific verb is displayed upon selection.

Figure 15: Creating five verbs in Unity 3D

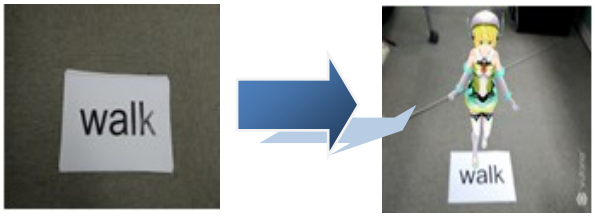

Figure 16: Displaying 3D picture of the walking motion

One of the important problems is that there are some kinds of verbs which are difficult to express by character animation. As a solution, we can display a video clip on top of the text as shown in Figure 17, and thus we can include more varieties of verbs in our system.

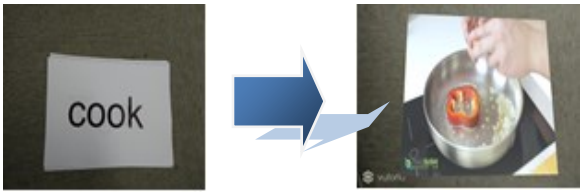

Figure 17: Displaying a video clip on the text

The result of this study shows that we can display 3D images of English nouns and verbs in an intuitive and comprehensible way in the AR environment.

5 Conclusion

In this study, we developed an AR application for English vocabulary learning. This application was implemented for Android devices using Vuforia and Unity 3D as development tools. Our application

recognized English nouns and verbs and displayed 3D pictures or video clips over the text. The result raises a number of questions for future research on AR English vocabulary learning. In this study, we did not include all categories of words; only nouns and verbs were tested. There are some word categories that cannot be easily expressed using images such as adjectives and adverbs.

For future research, we would like to add more types of words and express them intuitively to help young people memorize them. Also, it was part of the study to ask some children to be part of the experiment and check the performance of this application.

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