AR Marker Capacity Increasing for Kindergarten English Learning

Min-Chai Hsieh and Jiann-Shu Lee

***Abstract*—In this paper, we propose a method reducing complexity and increase capacity of designing AR markers based on permutation and combination's concept. We present an Augmented Reality English Learning System (ARELS). The system helps kindergarten children to learn English. Through the combination of virtual objects and reality scenes, children can use ARELS to learn by playing English words. The preliminary implemented English teaching material will be also integrated into other courses in the future.**

***Index Terms*—Augmented Reality, Mixed reality, English Learning, Human-computer interaction.**

I. Introduction

In recent years, there have been more and more institutes doing research on augmented reality (AR). AR is also known as mixed reality (MR) that extends from virtual reality (VR). The Fig. 1 is reality and virtuality continuum [1]. VR attempts to replace the reality world. However, AR, a kind of application and technology through computer generates vision image and mixes them into reality environment. At present, AR has been used extensively, e.g. education, medical science, military training, engineering, industrial design, games, art and so on [2].

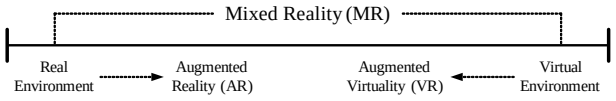

Fig. 1: Reality and Virtuality(RV) Continuum.

In the kindergarten children's learning, the media has provided various ways in teaching. In addition to enriching the learning content and to creating new interactive learning, children can play games in more ways to enrich the learning experience.

Generally, the present AR applications use Head-Mounted Display (HMD). In spite that HMD can immerse users in the environment, it has bad effect on kindergarten children, such as dizziness and being cumbersome. So in our system, we use webcam as video and monitor as display device.

In the beginning, the English beginners learn English from English alphabet and words. Teachers and students interact one another only with the body language and talking to each other in the classroom. The English learning card is static, lack of learning fun. (see Fig. 2.) We propose a system that can support children to learn English, providing different kinds of learning stimulation through the application of new media to make children like English more.

Fig. 2: General English word cards.

II. Related work

AR system is divided into two major software categories. One is open source, the other is plug-in software. The former is like ARToolKit [3], JARToolKit [4], MRToolKit [5], Matlab ARToolKit, etc. the users for these toolkits are required to have programming capability. However, the plug-in software like MIDAS (Media Interaction Design Authoring System) and DART (Designer's Augmented Reality Toolkit) allows users rapidly understand concepts of the augmented reality system and is easy to be implemented.

A large number of AR applications are applied to Education. But, these systems don't focus on kindergarten learning much. Brighton et al. [6] propose a Multimedia Augmented Reality Interface for E-Learning (MARIE) application for engineering education, in order to enhance traditional teaching and learning methods. This system uses virtual multimedia content information to interact with user in AR tabletop environment. Similar to MagicBook [7], it uses real page content through 3D virtual objects to superimpose it. However, users can interact with AR scene. Based on teaching application, Kaufmann et al. [8] builds a collaborative AR learning system for mathematics and geometry education. It employs Construct3D tool letting teachers and students set up mathematics and geometry education interactively, like constructing a 3D sphere in a cone through various subjects in classroom. The other is application of AR wearable system [9]. The system controls 3D virtual objects through the interface of a pen and a pad, though it supports true stereoscopic 3D graphics. But users must wear a lot of components, e.g. notebook, HMD and

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other assist components.

A lot of researches use mobile device to implement for mobile learning, e.g. PDA, laptop, cell phone and so on. ARCHEOGUIDE (AR-based Cultural Heritage On-site GUIDE) [10] is a personal guide system using mobile computing in cultural heritage sites. It assists visitors in touring around cultural sites. The system employs AR reconstruction of ancient ruins in cultural heritage. The cultural heritage renders in real time and is based on visitors' position and orientation. The displayed content includes cultural data and restoration information in multimedia database of cultural material.

The above-mentioned all use HMD and mobile devices. HMD is not only cumbersomely used for kindergarten and dizziness, but also costs a lot. The mobile devices have a problem of battery depletion.

III. System Design Method and Architecture

Due to designing a large number of AR markers is very complexity, we propose an idea to reduce the design complexity and increase its capacity. Based on permutation and combination's concept of mathematics, we can combine all kind of C_r^n markers, as in (1). Besides, the best pattern is asymmetric. The markers utilize a square blackborder pattern with a 15% border width and an interior image [11]. If we design a symmetric pattern, it may generate an ambiguous situation when the webcam captures the marker through video frames. So, we should deduct symmetric patterns from markers.

In order to evaluate that if we transform an original marker into a half one, the combination of the two half ones' capacity will be large than the original one's or not. We design a large number of markers corresponding 3D virtual objects one on one. List all of markers recognition rate. We verifies that the combination marker's capacity is more than the single one's. The capacity of single marker versus that of combination markers shows as Fig. 3.

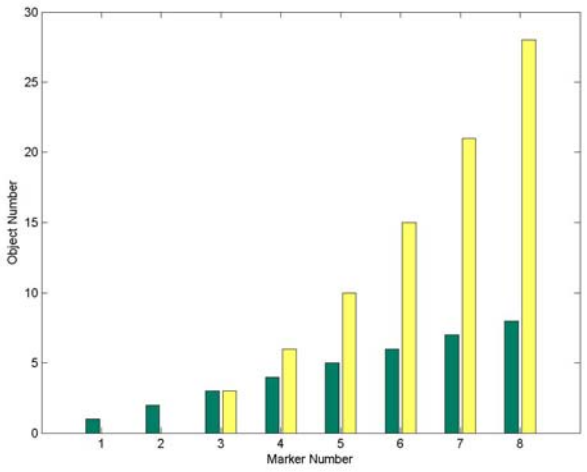

Fig. 3: Capacity of single marker vs. that of combination markers. Green bar is capacity of single marker, and yellow bar is capacity of combination markers.

$$C_r^n = \frac{n!}{(n-r)! \times r!} \quad (1)$$

So, if we design eight markers of different patterns, it can permutation twenty-eight variation, and every marker could not be repeated, so that creating twenty six English alphabet cards is enough, and each English alphabet corresponds to an English word, as shown in Fig. 4.

The AR English word cards are different from common English cards. There is an AR marker on the left side of the English card. AR English word cards consist of different AR markers' permutation and combination.

(a) Alphabet 'A' Airplane word.

(b) Alphabet 'B' Bed word.

(c) Alphabet 'C' Candle word.

(d) Alphabet 'D' Desk word.

(e) Alphabet 'E' Earth word.

(f) Alphabet 'F' Fan word.

Fig. 4: AR English word cards.

The system flowchart is shown in Fig. 5. When the user takes the AR English word card, the webcam captures the marker. The system can automatically recognize. The marker and the corresponding 3D virtual object will be superimposed to the word card.

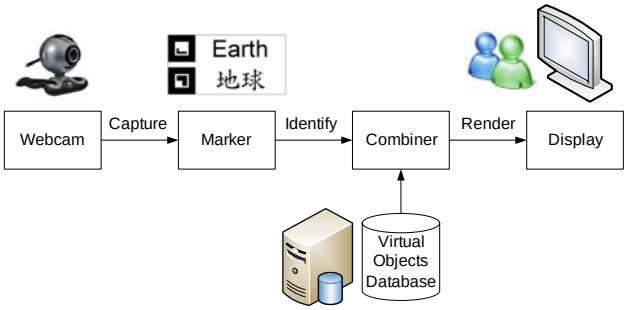

Fig. 5: System flowchart.

IV. Implementation

ARELS can present formats such as texts, images, music, animation, movies, and 3D models by user controlling English word marker. Each AR English word card corresponds to each 3D virtual object respectively.

The experiment result, we use alphabet 'E' Earth word as an example, and it shows under Fig. 6.

Users can turn and move around the AR English word card in any direction arbitrarily, but its printed surface must face the webcam. If users occlude any marker of the AR English word card with hand, the 3D virtual object would disappear.

(a) Look at the positive AR English word card.

(b) Turning 90°.

(c) Turning 180°.

(d) Occluding one of the markers.

(e) Occluding another

Fig. 6: (a) ~ (e) is an example for system manipulation.

The webcam is set up on the monitor. The distance between the webcam and the AR English word card is about 60cm. The length and the width of the AR English word card are 18cm and 9cm. Using ARELS just needs a PC and a webcam, without adding any equipment. The cost is very low, so it maybe a new trend in education. The system was implemented on a desktop PC with a Pentium IV 2.4GHz CPU. The captured device is Logitech QuickCam Pro 4000, the captured frame format is 320×240, and video frame rate is 15 fps.

V. Conclusions

This study mainly proposed an idea on reducing complexity and increasing capacity of designing AR markers. And, we have implemented an AR English learning system used for kindergartens. ARELS not only offers different learning stimulation but also supports traditional education to achieve a human-computer interaction (HCI) learning purpose. To sum up, students can have more fun in learning and interact better with teachers than before in the AR learning environment.

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