

Applying Augmented Reality Technology to Book Publication Business

ANDY S.Y. LAI¹, CHRIS Y.K. WONG², OSCAR C.H. LO³

Department of Information and Communications Technology
Hong Kong Institute of Vocational Education

HONG KONG

¹andylai@vtc.edu.hk, ²chris@hkchris.com, ³oscarlochihang@hotmail.com

Abstract—Augmented Reality is an emerging technology and the applications of technology are still not fully unveiled. This paper explores a new application of augmented reality for a new direction in educational book publishing, which aims to bring interactive learning experience to life. The project takes printed images on book to the next level by applying Augmented Reality technology to provide a unique fascinating experience to its readers on mobile devices. Augmented Reality (AR) technology composing with animation brings new digital entertainment experience to the reader of books. The key feature of this paper uses the technology presents auxiliary information in the field of view of an object printed on book automatically without human intervention. The project uses the technology with iPad mobile device to display 3D models, 3D animations, video splaying, websites and web server connectivity for children education. The results and evaluation of the project shows the interactive 3D animation and self-assessment functions significantly support students to improve their learning experience and performance. The software product of this project, from the business perspective, creates a new business marketing dimension in digital publishing and increases the selling profits in the book publication business.

Keywords- Augmented Reality, Mobile Computing, Multimedia Services, E-Learning

I. INTRODUCTION

All Augmented Reality is a variation of Virtual Reality and is used with visual object tracking devices. Augmented Reality allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. However, Virtual Reality completely engages a user inside a synthetic environment. While engaged, the user cannot see the real world surrounding. Therefore, Augmented Reality supplements reality, rather than completely replacing it. In an application, you can expect that it would appear to the user that the virtual and real objects coexisted in the same screen on device. Augmented Reality (AR) is a multi-discipline research area. The two main technological tasks of Augmented Reality are to keep track of video objects with their movement and position accurately [1][2] and to render a virtual image seamlessly with shadow and color of real time background environment [3] [4]. We engage the innovative application of Augmented

Reality technology for digital entertainment with educational book publishing.

Augmented Reality enhances a user's perception of and interaction with the real world. The virtual objects display information conveyed by the virtual objects could help a user to perform real-world tasks or provide auxiliary information for training and learning environment [5].

This paper illustrates Augmented Reality (AR) technology composing with animation brings new digital entertainment experience to the reader of books. The key feature of this paper uses the technology presents auxiliary information in the field of view of an object printed on book automatically without human intervention.

II. PUBLISHING WITH AUGMENTED REALITY

The paper explores a new application of augmented reality for a new direction in educational book publishing, which aims to bring interactive learning experience to life.

A. E-Learning and Augmented Reality

Pushing e-learning becomes a trend in most countries, which, from environmental point of view, can reduce the use of tons of papers in printing, and, from physical health, cut down the weight of children's school bag. Another critical reason is that, from educational aspect, e-learning can improve the experience, quality and efficiency of learning of students. This paper aims to apply the Augmented Reality (AR) Technology to educational book publishing, which can not only improve the learning quality through e-learning approach, but also provide related extra content of the textbook, such as 3D models 3D animations, audios, videos and websites for reference. They can increase the student's interest in learning and build the independence of self-learning skills.

B. Continual Updates Learning Platform

Educational Publishing with Augmented Reality is not only bringing the knowledge to life with the help of augmented reality technology, but also providing more number of up to date information, adding a unique and innovative track to this revolutionary technology. We consider one good example in applying augmented reality

features on teaching the topic in stars and constellations in science subject by providing a galaxy model of with 3D animation which pulls out from the web site server. The web server is the platform provides continual updates from the professional and amateur astronomers who share what they learnt and expressed in words or video format to best describe they found. This feature allowed the readers to see the latest information in real time by using the Augmented Reality app via their smartphones or tablets.

III. SYSTEM DESIGN AND IMPLEMENTATION

This project has chosen Qualcomm's Vuforia Engine to develop the application. Qualcomm is a chipset manufacturer who focuses on mobile devices and lots of smart phones are using Qualcomm's chipsets. Vuforia Engine is an outstanding product of Qualcomm. It has an AR software development kit (SDK) that supports Unity 3D, XCode and Eclipse and truly integrates and seamlessly work with them. Vuforia is free to developers and keeps adding remarkable features which help developers to implement interactive gaming applications. Compared with other toolkits, Vuforia Engine provides detailed development documentations and examples and resources which have thus far not been found in other engines. One most favorable feature is that the output of Vuforia Engine can be installed on iOS environment and android as well, which definitely reduces the development costs, time, and recourses in projects if the applications are required to provide software versions on both iOS and Android environments [6][10]. Our project employs Vuforia which is one of best choices to develop AR application to meet two mobile business worlds [9].

The system architecture of the software has been divided into three major components they are: Target Management System, Vuforia Engine, and Rendering Engine [8].

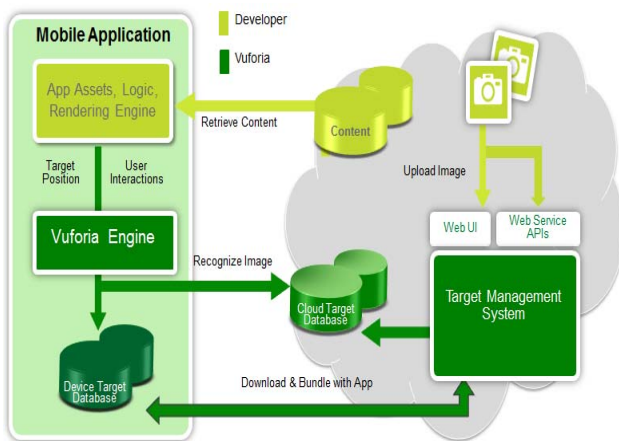


Figure 1. System Architecture

A. Target Management System

Target tracking performing is important in any Augmented Reality system. The tracking is to identify the object with the database. A good object tracking

performance means the tracking process takes a short instance of time for identification in database. A long tracking process means it needs longer time for tracking while user playing the AR functions. For a worst scenario, that is no object could be found for display from database if the target pattern cannot be recognized. Figures 2a and 2b below show the tracking performance of an ancient bowl in a museum.



Figure 2a. Target Tracking Management System (Original Color)



Figure 2b. Target Tracking Management System (Contrast Added)

This management system gives a rating to every target and represents the features: sharp, chiseled details and spiked in yellow crosses as shown on the Figures 2a and 2b. The contrast added can create more chiseled details and spiked a better tracking with yellow crosses as shown in Figure 2b. It has been observed not every objects can be tracked by the application. The target tracking performance affects the download rates and, as an end result, it slows down the performance of the applications. Those targets would be sent to the web-based Target Managements System to evaluate the tracking outputs and their performance before stored into the database of the system.

B. Vuforia Engine

As previously stated, Vuforia Engine consists of an AR software development kit (SDK) that has to work with Unity 3D, XCode and Eclipse. Vuforia has libraries that provides software components for augmented reality (AR) software developers in programming interactive 3D animation on mobile devices.

Target management is the database in Augmented Reality. After the database created, the augmented reality applications can use Vuforia Engine to control the mobile visual devices operations such as start the camera, read the image from the camera, and compare and identify object with the AR database which stores the tracking objects information. This engine is the heart in the application in Augmented Reality technology. The functions provided in engine form the core and technical parts of our software system.

C. Rendering Engine

Rendering Engine lets developers to integrate the programming scripts, assets and coding logic to form an application. The design and implementation of the project is fully based on the object oriented approach with the functions provided in engine to construct the core and technical parts of the software system.

The Vuforia Engine tracks the objects and searches on the database; and the rendering engine renders the virtual object placed in. Furthermore, the virtual objects allow to code with different programming scripts producing the 3D motions of the targeting object, and let users to control motions of the objects, such as rotating, playing the sound and audio and video. Hence, this rendering engine focuses on the implementation of the interface and interaction of the application developed by programmers.

D. System Implementation

This project is using Qualcomm's Vuforia SDK to develop an iOS application. The AR application is applied to display some resources such as video when the camera is focusing on the book's content in a textbook.

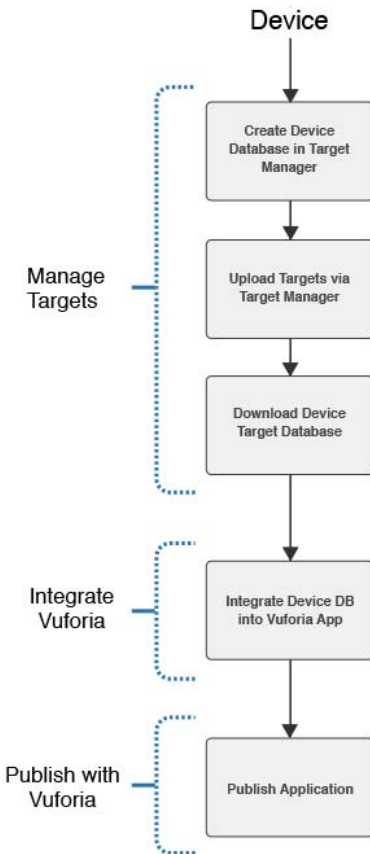


Figure 3. Software Implementation Flow with Vuforia Engine [6]

Firstly, developer should scan selected content and, in our case, is to prepare the target image from the textbook.

Secondly, developer is required to create the device database in Vuforia Engine and upload the target images in Vuforia's target management system. After the Vuforia's target management system analyzed the target images, it will provide the device target database. Developer could download the device database and import it into Unity 3D.

Next thing is to integrate Vuforia with Unity 3D. In Unity 3D, developer can design the 3D models and 3D animations with special effects. After the resources in 3D Unity are ready to be used, developer can link the related resources with image targets in Vuforia. Developer is allowed to write programming scripts to control the Vuforia application's movement actions once the target image stored in Vuforia Engine is detected.

Final step is to publish the Vuforia application with Unity 3D after design of the application is finished in Unity 3D. The AR application is ready for publishing mobile iOS devices via Apple's XCode.

IV. AUGMENTED REALITY AND TEXTBOOK PUBLICATION

It has been found that the benefits of having Augmented Reality (AR) Technology integrated with educational textbook publication in comparison with current traditional textbook provide additional entertainment and interaction to the readers, which will make the book contents interesting and attractive, and improve reading and learning experience of the readers. Nowadays, e-Learning has increasingly played a more and more important role and the way of delivering traditional education materials may be replaced soon. In the classroom or at home, children may need to study with their tablets. Augmented Reality (AR) Technology could increase the content and improve the traditional learning environment and offer a lot of new features that the traditional books cannot achieve, such as playing audio and video, displaying 3D model and other interactive elements including online assessment [7].

A. AR with 3D Animation Contents

After the mobile application has been published with Vuforia, user may start it and the mobile device will enter into the camera mode. At that time, it is ready to be used in AR mode. Reader can use the mobile to focus on an object on the textbook with camera embedded in the device and the 3D motion object will be retrieved from a web server and dynamically pop up on the mobile screen. Figure 4 shows the AR effect that when the camera is focusing on the textbook's content a satellite galaxy photo, a 3D orbiting galaxy pops up, which consists of a solar system with 3D animation. The audio digital sound effect is explaining how the objects in solar system, stars and planets, which have a center of mass and are not connected to each other and they have orbits and are moving around in space. With the animation, students can easily understand the abstract concepts of satellite galaxy that are printed and illustrated in the textbook's contents.

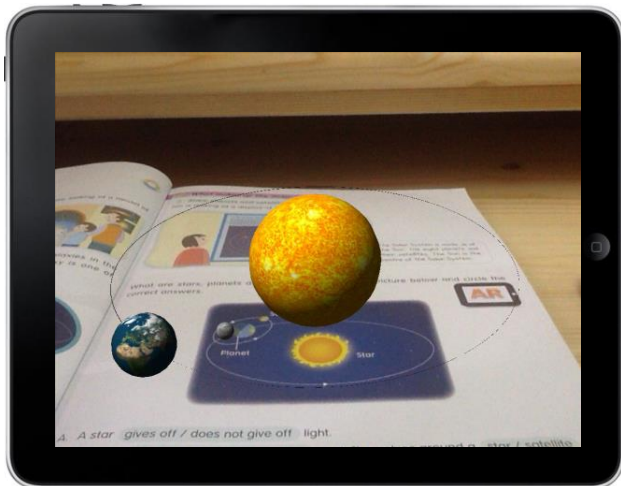


Figure 4. AR Solar System with 3D Animation shown on Textbook

Figure 4 presents an excellent and typical example that an AR app in a tablet is showing a relevant 3D animation on top of the related book content. The 3D animation is downloaded real time from a destined web server of the mobile app system. There is an AR Sticker printed on the top right corner of the page on the textbook is to remind the readers that there is an AR resource provided.

B. AR with Audio and Video Contents

Augmented Reality supports Audio and Video Contents. Figure 5 illustrates a reader with tablet device focusing on a glossary/summary page of a textbook and, after the audio and/or video file retrieved from web server, the mark “Play” icon button will be shown on the screen besides the each item on the page.

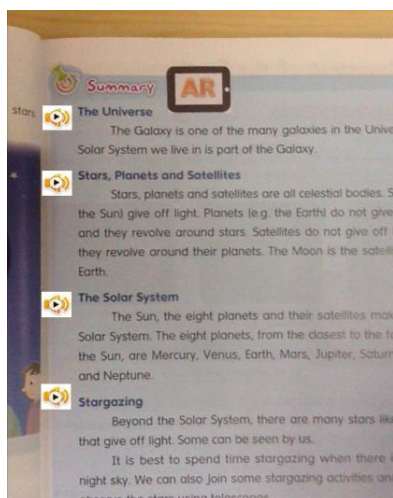


Figure 5. AR Audio Contents on Textbook

The content will be read to the audiences once the user touches the mark “Play” icon button displayed on the mobile tablet device. In such a way, the students of English as

Second Language can listen the book’s content and learn and read the words and sentences. It can benefit the student in reducing the time to look for words from dictionary and upgrade the listening ability at the aspects of pronunciation.



Figure 6. AR Video Contents on Textbook

Figure 6 illustrates a reader uses the mobile tablet with AR application focusing on a cartoon story book, a video player will pop up, which allows the reader to play the video of the story, whereas the contents of the video could be more vivid and interactive in illustration of the story for children.

C. AR Contents with Simulation Feature

AR technology provides 3D model to support the simulation for real situation. Figure 7 illustrates a good example in which the AR application could pop up a 3D model of moon and sun on tablet.

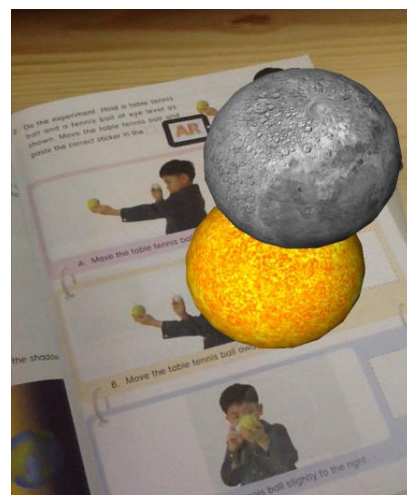


Figure 7. AR Simulation Contents on Textbook

Following the textbook's instruction, reader can simulate the orbit moving tracks and have a try to simulate the eclipse phenomena without setting up two physical balls at home.

D. AR Textbook Contents for Internet Self-Assessment

AR technology provides online web-based self-assessment. Figure 8 illustrates an example in which, when the mobile tablet camera is managed by reader to focus on the self-assessment form of a textbook, the "Submit the Form Online" label button will be instantly shown on the top right corner of the mobile tablet.

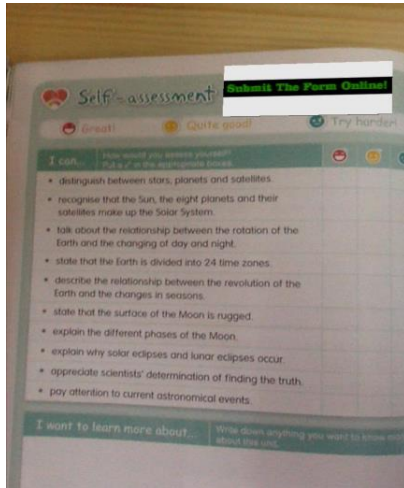


Figure 8. AR for Self-Assessment on Textbook

Reader touches the label button, the AR application will show a page of questions similar as it printed on the page of textbook, which allows reader to fill in the answers and, at the time of finishing the answers, submit them through internet to the teacher account on web server. As for teacher, he can mark the answers and give the scores on internet web page. Eventually the server stores the scores and process them to form a summary report of the class to the teacher.

V. TRAIL TEST AND EVALUATION – AR IN PUBLICATION

The project has invited 37 primary school students in a class in Hong Kong to try the application on mobile tablets.

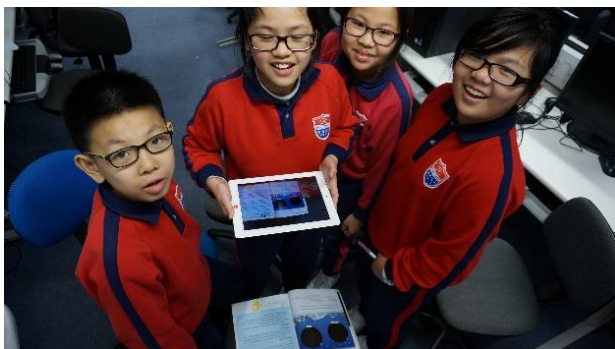


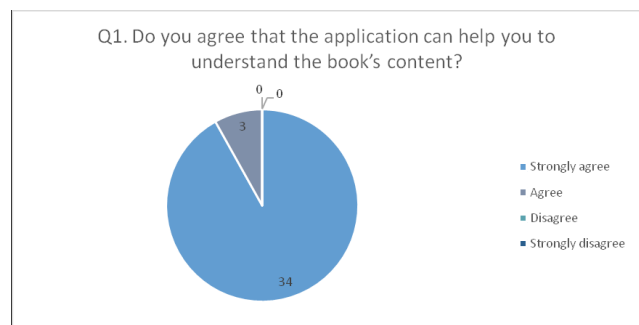
Figure 9a. Trail Test on AR Application on Textbook

The students already have employed a lot of experiences on using Android tablet to learn their lessons. During the trial process, students felt very excited and enjoyed the satellite galaxy lesson very much in the classroom. They explained that AR application could deliver the concepts and teaching materials interactively with innovation and looked for more textbook publishers and schools implementing such AR technology in teaching and learning process in foreseeable future,



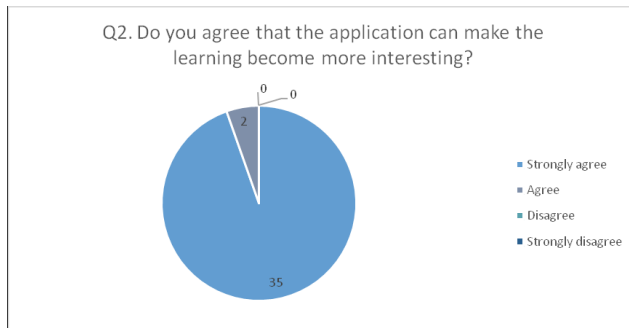
Figure 9b. Trail Test on AR Application on Textbook

In understanding the students' feedbacks on the AR technology with the textbook, especially for the primary school students, a questionnaire survey was conducted on the primary school students.



Among the 37 responses, more than 34 (92%) agreed that the application can help them to understand the book's content clearly and 35 (95%) agreed that the application can make the learning become more interesting in comparison

with the traditional learning setting in classroom. Mostly importantly, about 100% of them agreed that the application is not boring but motivate them to enjoy the learning. Furthermore, the application is easy to use.



It has been found that the AR application in textbook publication can help students increase their learning performance and make the lessons in classroom more interesting.

VI. CONCLUSION

Augmented Reality (AR) is an emerging technology area. The applications of AR technology are still not fully unveiled. AR technology enhances a user's perception of and interaction with the real world. The virtual objects display information that the user cannot directly detect with user's own sense. The information conveyed by the virtual objects helps the user to perform real-world tasks. This new form of human-computer interaction can be applied to different industry areas including digital book publishing.

We foresee that Augmented Reality (AR) technology would be one of the major technologies to revitalize the digital composition of animation with real scenes and to bring new digital entertainment experience to the viewers. We propose to apply Augmented Reality technology for digital entertainment by building an enabling environment to support the development of Augmented Reality entertainment applications for digital book publishing. We will bring in the new business opportunity enabled by Augmented Reality technology for education and entertainment sectors. We believe the project can make new services possible for book publication business with cost effective technology for daily use in content creations, and generate innovative, brand new entertainment experience for the readers.

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