CZU: 371.3:004.9-028.25

ENHANCING PRINT MEDIA IN E-LEARNING BY USING AUGMENTED REALITY

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Abstract. With emerging tech like augmented reality, the interaction between print and digital media have been possible. In this paper, we explore augmented reality techniques and their implementation in educational field. Moreover, we augmented this article as an example of enhancement of visual learning process. We created an AR application that add another dimension to previously 2D articles, in such way it is possible to provide not only interactive experiences but also giving new ways of comprehending the knowledge.

Rezumat. Cu tehnologia emergentă, cum ar fi realitatea augmentată, interacțiunea dintre presa scrisă și cea digitală sunt posibile. În această lucrare, explorăm tehnicile de realitate augmentată și implementarea lor în domeniul educațional. Mai mult, am augmentat acest articol, ca exemplu de îmbunătățire a procesului de învățare vizuală. Am creat o aplicație de RA care adaugă o altă dimensiune articolelor 2D anterioare, astfel fiind posibilă furnizarea nu doar de experiențe interactive, ci și oferirea de noi modalități de înțelegere a cunoștințelor.

Key words: augmented reality, intelligent AR interfaces, print media, e-learning.
Cuvinte cheie: realitate augmentată, interfețe inteligente de RA, media tipărită, e-learning.

1. Introduction

With emerging tech like augmented reality (AR), E-learning can leverage a new way to connect with students. AR has the potential to revolutionize education as a whole in the next few years. By creating contents that will be exciting to learners, developing learning environments with unforgettable experiences, sure will get students engaged in learning process, because when physical and digital worlds collide, it changes everything. Literally, AR is changing the way we see the world. In order to get a good idea of where AR tech is headed, have to look back on where it is been. For this purpose, we studied the history and evolution of AR and the result of our study we compiled and presented in section 2. Augmented reality made a leap into public spaces a few decades ago, but the real explosion of AR is in recent years, because of the processing power in today's smart devices. Thus, appeared various approaches of developing and implementing AR. In section 3, we described the methodology of creating augmented article based on PIP Framework [1]. Moreover, we presented few examples of how we created our app in Unity, Vuforia environments. In the last section, we presented some of our idea and our future works.

2. Emergence of Augmented reality

Over the last 50 years, AR technology has reshaped the way we interact with the real world. Augmented reality is the technology that expands our physical world, adding layers of digital information on it. AR is often mistaken for virtual reality (VR). While they do share pieces of development history, the two are not the same. Unlike VR, augmented reality does not create the completely artificial environments to replace real world with virtual one, it blends technology with the real world. It appears in direct view of an existing environment

and adds multimedia elements to it, such as: video, sounds, graphics etc. AR leaves a little to science and a lot to the imagination.

According to [1] augmented reality is not a specific device or program; it is a type of human-computer interaction, that occurs through a combination of technologies that superimpose computer-generated content over a real-world environment. Augmented reality tech was invented in 1968, with Ivan Sutherland's development of the first head-mounted display system called "The Sword of Damocles", see Figure 1[1] - year 1968. However, researcher Thomas Caudell coined the term "augmented reality" in 1990 [2].

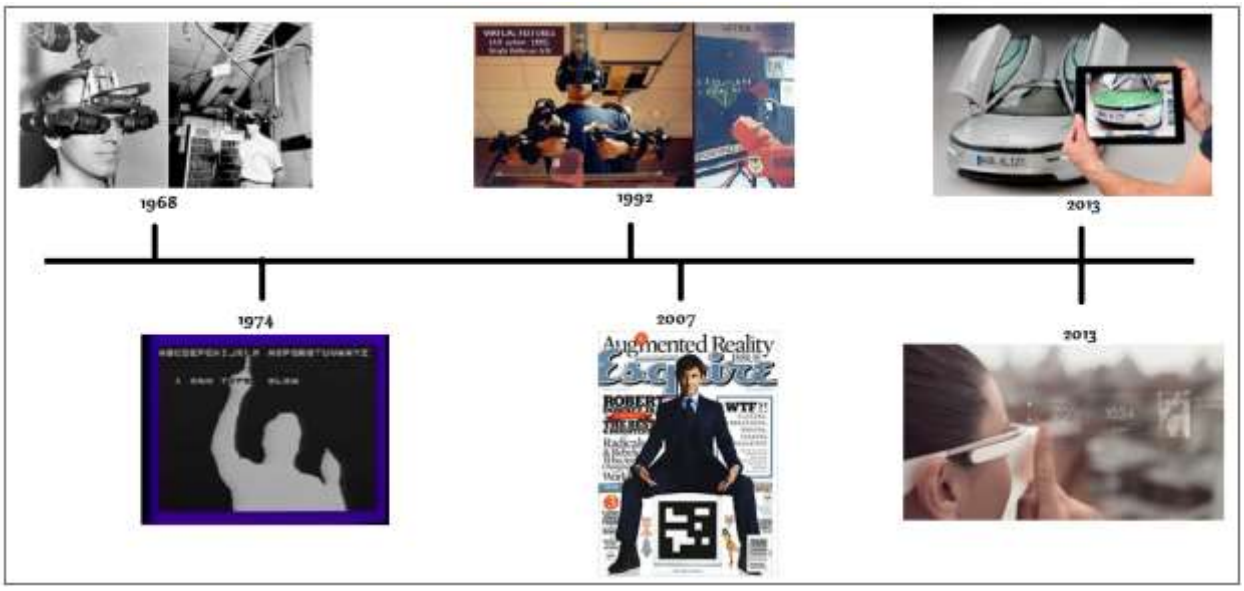

Figure 1. (1968) Ivan Sutherland and the first head-mounted display system called "The Sword of Damocles"; (1974) Myron Kruger's Videoplace; (1992) Louis Rosenberg testing Virtual Fixtures; (2007) Esquire Magazine, AR issue, December 2009; (2013-upper marker) Volkswagen's MARTA application; (2013-lower marker) Google Glass – a brand of smart glasses

Note[1]: In our article each figure are more than typically normal figure, it represent a marker, an anchor for our AR application. Therefore, when we make a reference to any Figure, we make reference to the animation that it triggers.

In 1974, Myron Kruger, a computer researcher built a laboratory at the University of Connecticut called *"Videoplace*" and developed the first *"virtual reality"* interface, which allowed its users to manipulate and interact with virtual objects in real-time, see Figure 1 – year 1974.

In the early 1990s AR transitioned out of the lab. Louis Rosenberg developed the first fully functional augmented reality system called *"Virtual Fixtures"* in 1992, at the USAF Armstrong Labs. The system allowed military personnel to virtually control and guide machinery to perform tasks like training their US Air Force pilots on safer flying practice, see Figure 1 – year 1992.

One of big step of AR in being more popularized was when Hirokazu Kato developed an open-source software library called the ARToolKit, in 2000. This package helped other developers to build AR software programs. Taking in account that we become increasingly dependent on our mobile devices, more of AR software raised.

Surprisingly, in 2009, Esquire Magazine come up with idea to adapt augmented reality in print media in order to make pages to come alive. When readers scanned the cover, the AR equipped magazine featured Robert Downey Jr. speaking to readers, see Figure 1 – year 2009.

Another impressed adaptation of AR tech was Volkswagen's MARTA application, an acronym for Mobile Augmented Reality Technical Assistance, which assists technicians by visually walking them through the steps to be taken during a repair.

The MARTA app, outlines and labels parts overlaid on a real time images of the vehicle and provides helpful contextually relevant information like which tools are required for a specific step, see Figure 1 – year 2013 upper marker.

In addition, in 2013 Google unveiled its Glass devices, a pair of augmented reality glasses that provide some relevant information for its users by using visual, audio and location, based inputs, see Figure 1 – year 2013 lower marker. For instance, upon entering an airport, a user could automatically receive flight status information.

In the last ten years, the field of augmented reality has been recognized as one of the most promising areas of computer graphics. During this time, a variety of innovative applications has been developed, stressing the importance of augmented reality in everyday life. AR was built from the ground up and now is the perfect time for it to take off and soar to new heights.

3. Developing AR application for Print Media

In this section, we will describe the principle behind of our application that makes possible the interaction between print and digital media. In our research, we intent to add another dimension to previously 2D articles, in such way creating an augmented article that will provide not only interactive experiences but also giving new ways of comprehending the knowledge. We believe that for proceedings print and digital media does not have to be mutually exclusive, on the contrary, it should be an intertextuality between them.

As we already mentioned the current article has embedded with marker-based augmented reality. Thus, all images presented in this article were converted into markers (*also called targets*). For all our targets, we created a database on ***Vuforia Engine.*** Additionally, Vuforia Engine helps in analyzing the target's features by giving ratings from 0-5 stars, see Figure 2. Smartphone cameras harder recognize the target image with few features, than target image with five stars ratings. For testing purpose, we kept the target with zero value and added targets with two, three, and four value.

Figure 2. A - example of target with 0 rating; B – example of target with 5 rating

4. Intelligent AR interfaces

According to [1] an intelligent interface is one that learns about users and can adapt to serve them better through a minimally invasive presentation. We believe that augmented reality is part of the input/output side of an intelligent user interface, because any type of augmented reality firstly should recognize markers, objects, spaces; secondly it needs to respond wisely to users' intentions and lastly to overlay digital content on to the perceptive field of the user. In other words, an intelligent augmented reality interface requires the combination of detecting and tracking input with displaying output in meaningful way to support the user interaction with real-virtual world.

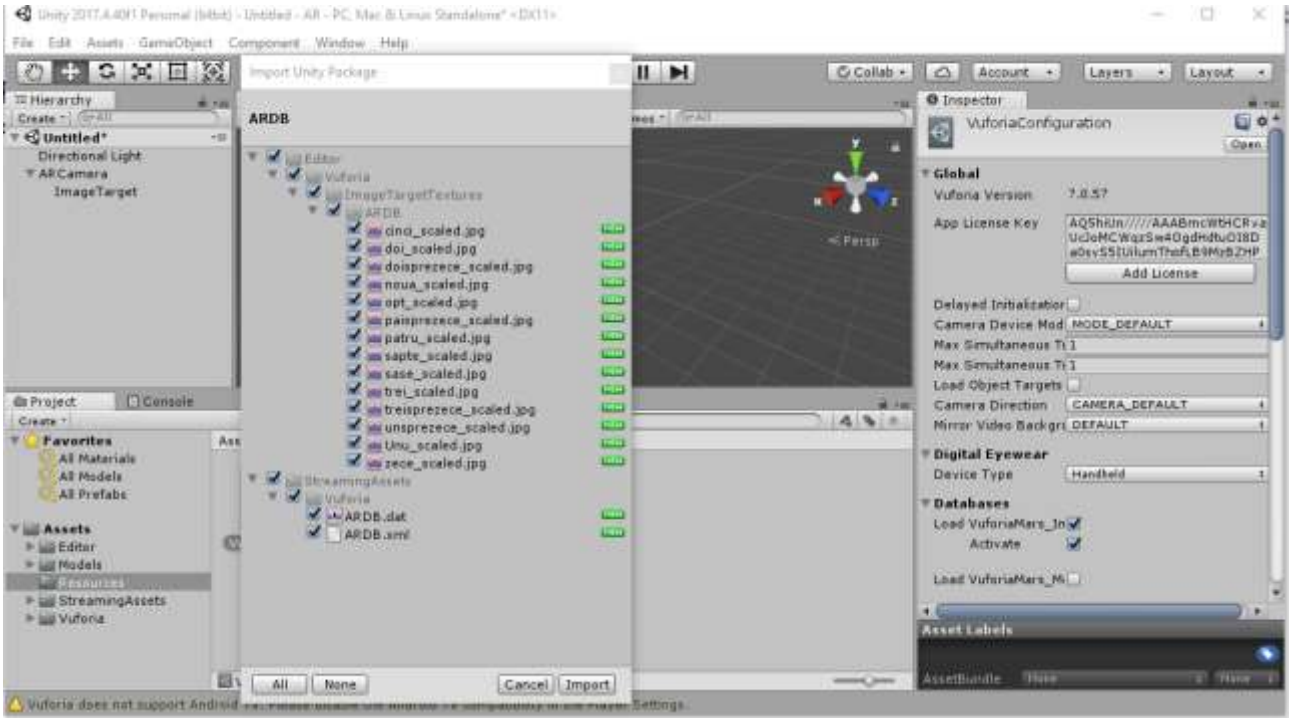

Figure 3. Vuforia configuration and imported ARBD package in Unity

Therefore, we created our AR application in Unity (version 2017.4.40f1) according PIP Framework (Pose-Interfaced-Presentation):

- ***Pose*** – stands for accurately tracking user's location and orientation in space in general;
- ***Interfaced*** – the program responds to a user's intention and actions in an intelligent way; and
- ***Presentation*** – displaying the added multimedia elements to an existing environment that affect the perceptive field of the user.

Regarding ***pose step***, we firstly generated App License Key app and added in *VuforiaConfigurations*, see right side of Figure 3. Secondly, we downloaded AR database from Vuforia Engline and imported into Unity app, see the left side of Figure 3.

Regarding ***interfaced step***, we created scenario and added targets to it, see Figure 4 zone 1. For each target, we configured the output display see Figure 4 zone 3. Next, we created 3D quad for each target and added multimedia component that were imported in Resources directory see Figure 4 zone 2.

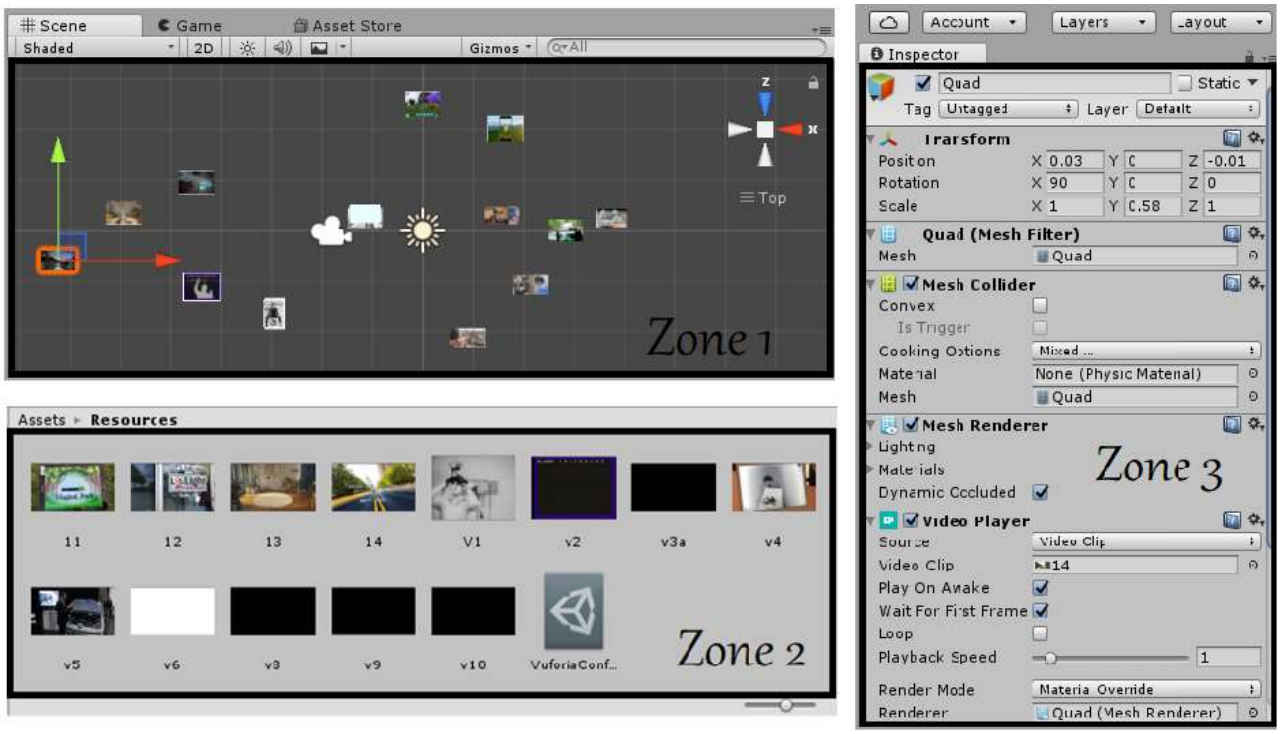

Figure 4. Zone 1 – Scene zone with triggers; Zone 2 – Imported multimedia resources; Zone 3 – target's configuration and trigger's components

Regarding ***presentation step***, we configured quad zone to be on top on target image with 45° rotation on X position, see Figure 5. In addition, we indicated to display simulations only one trigger. The digital content will be sticky to print so if we move paper the digital content will follow it. If printer will be moved out of smartphone's camera, the media will be put in pause zone. Thus, if print will be brought back, then digital content will continue from where it stopped.

Figure 5. Example of 3D quad configuration with display on 45º and 90º

Note: In Figure 5, we presented an example where the marker a saved on smartphones display and it is shown in real time to notebook's web camera.

5. Conclusion and Future works

The main purpose of our research was to design and create an augmented article, as demonstration of possibility of combining print with digital content. Another objective of this research is to explore the augmented reality and their contribution in educational field.

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