HARRAN ÜNİVERSİTESİ MÜHENDİSLİK DERGİSİ

HARRAN UNIVERSITY JOURNAL of ENGINEERING

e-ISSN: 2528-8733 (ONLINE)
URL: http://dergipark.gov.tr/humder

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Bu makaleye şu şekilde atıfta bulunabilirsiniz (To cite to this article): Memduhoğlu A., Şenol H.İ., Akdağ S., Ulukavak M., "3D Map Experience with Virtual/Augmented Reality Applications", ***Harran Üniversitesi Mühendislik Dergisi***, 5(3): 175-182, (2020).

Erişim linki (To link to this article): http://dergipark.gov.tr/humder/archive

HRU Muh Der, 5(3): 175-182 (2020)

Harran Üniversitesi

Mühendislik Dergisi

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Araştırma Makalesi

3D Map Experience with Virtual/Augmented Reality Applications

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Makale Bilgisi

Başvuru: 24/07/2020
Yayın: 25/12/2020

Keywords

Virtual Reality,
Augmented Reality,
3D City Modeling,
Map Education

Anahtar Kelimeler

Sanal Gerçeklik,
Arttırılmış Gerçeklik,
3B Şehir Modelleme,
Harita Eğitimi

Abstract

Human beings have started using maps since prehistoric times. The first man has made maps to the cave walls but nowadays the maps are being used with virtual/augmented reality (VR/AR) applications. With the use of 3D VR/AR applications, traditional map education can be given to the youth explicitly. With this technology, students can learn the maps enthusiastically and develop their spatial abilities. In this study, a 3D model of the Harran University Osmanbey Campus was created and prepared for the use of VR/AR applications. This model was then transferred to the Unity Game Engine Software for augmented reality applications that students can see on tablets and smartphones. The resulting application was presented in a science festival where students experienced these technologies. It has been observed that students approached more enthusiastically to these technologies as a learning material because of the interactive nature of these technologies.

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Öz

İnsanlar tarafından tarih öncesinden mağara duvarlarına çizilen haritalar günümüzde sanal/arttırılmış gerçeklik (VR/AR) uygulamalarıyla yapılarak kullanılmaktadırlar. Haritaların üretimi ve kullanılmasında bu yeni teknolojilerin kullanılmasıyla okullardaki harita eğitimi de değişime uğramıştır. Harita eğitiminde 3 boyutlu dünyanın 2 boyutlu klasik kağıt veya duvar haritalarından nispeten zor olan öğretimi, VR/AR uygulamaları kullanarak kolaylaştırmak gençlerde mekansal algıyı erken yaşlarda güçlendirmektedir. Bu çalışmada Harran Üniversitesi Osmanbey Kampüsü'nün 3 boyutlu bir modeli oluşturulmuş ve VR/AR uygulamalarında kullanmak üzere hazırlanmıştır. Ardında bu model Unity oyun motoru yazılımı kullanılarak öğrencilerin kullanımı için arttırılmış gerçeklik uygulaması şeklinde tablet ve akıllı telefonlara aktarılmıştır. Ortaya çıkan bu uygulama, bu tür teknolojilerin farklı yaş gruplarından öğrencilerin deneyimleyebildiği bir bilim festivalinde kullanıcılara sunulmuştur. Öğrencilerin, bu teknolojilerin etkileşimli ve eğlenmeye yönelik doğası nedeniyle bir öğrenme materyali olarak daha hevesle yaklaştıkları gözlenmiştir.

1. INTRODUCTION

Maps were used as a tool to answer the questions What? Where? and How? by human beings since prehistoric times. These maps have been used in the past on the cave walls, animal skins, parchments and recently on papers. Nowadays, maps are benefiting from developing technologies such as computers and virtual/augmented reality (VR/AR) applications. VR is defined by [1] as 'the ability of the user of a constructed view of a limited digitally- encoded information domain to change their view in three-dimension causing update of the view presented to any viewer (the user)'. In addition to this definition, it can be said that VR is the use of glasses, motion sensors, computer, and 3D projection systems to create a virtual environment for the user's perception. On the other hand, AR integrates visual objects to the actual environment of the user. Although immersive technologies such as VR have been used for educational purposes since the past years, they have been used frequently in recent times since their prices have become cheaper [2]. AR technology has been defined as a next-generation media that will improve the quality of learning by researchers due to its ability to integrate virtual objects into real environments [3]. VR/AR technology can explain educational

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content better than text and this makes VR/AR unique for education [4]. It is also possible that VR/AR can be used to bring textbook content to life [5].

VR/AR technology has entered our lives for entertainment purposes and then evolved to serve other sectors such as education. Students can use the advantages of this technology since it offers to learn by doing virtually in almost all domains. Learning our world from maps is one of these domains.

The psychological effects of map education on young students have been an ongoing research topic. The fact that children perceive objects around them because they can establish their location and the connection between them suggested that children's perceptions of the maps are a congenital ability [6]. Geography education starts at an early age in schools. Classically young students learn the earth from 2D school atlases and wall maps. Since it is hard to perceive 3D objects from these 2D products, students can struggle to understand the earth and other spatial phenomena. As a result of not perceiving the maps and geographical phenomenon, it was determined that there were difficulties in the use of maps in older ages.

Learning the portion of the earth and spatial phenomena through VR/AR technologies, which are memorable and stimulating senses, will save students from this challenge. In this context, experiencing the 3D earth by using VR/AR technology instead of the traditional 2D paper, will make a great contribution to students learning and spatial perception skills.

This study shows an example of how maps and spatial models can be used in conjunction with VR/AR technologies. A 3D model of Harran University Osmanbey Campus was created and used as a 3D map in the VR/AR environment to present it to the young students.

2. RELATED WORK

A literature review will be presented in this part about VR/AR applications related to maps and using them in geography education.

[7] argued that spatial coordinates have a very important role in map education at school. In the study, children were asked to draw two lines based on two specific coordinates and show at which point these two lines will meet. As a result of the study, it was determined that young children (4-6 years old) could find a position in the space by using two spatial coordinates, and it was stated that they could solve complex problems as they progressed. In [8], a questionnaire study on the spatial relationships and perception of the environment of 93 children between the ages of 7 and 12 was evaluated. As a result, it was determined that the spatial ability was higher in older children in three of the four studies, however, this was not related to the main variables (gender, age, etc.).

In a study by [9], participants were asked on a printed World map, for example, which route an airplane departing from point A should follow. At the end of the study, it was revealed that most of the participants in the application did not consider the curvature of the world while planning a route on the map [10]. investigated the appeal of children and young people by integrating the joysticks into the online version of the Swiss World Atlas. Participants in the study learned the use of maps with joysticks and children who previously used the joysticks perceived the map more easily. As a result, their mastery of mapping and understanding has increased.

In the study conducted by [11], the appropriateness of maps produced for child education was investigated and maps for various levels of complexity were used for this purpose. It is recommended that map designers should prioritize simplicity and usability when designing maps for children. [12] mentioned that the people who made the atlases for children were thought to approach these maps from an intellectual point of view, but in reality, this was not the case. A small group of atlases was collected, and comments were made. It was emphasized that the maps used in the atlases are inadequate for the development of children and the necessity for future studies in this area.

[13] carried out an application using pattern-recognition techniques where a topographic map of a region and a digital terrain model can be displayed in 3D in the study. [14] discussed the implementation of augmented reality in the field of cartography and maps. In this study, two applications are presented: a map that is projected to the top of a desk with the help of a projector and used interactively with PDA devices and showing various virtual signs in the real environment by using the portable smartphone's camera and screen. [15], developed

an application by using location-based augmented reality maps for tourists. In this way, map-based additional information could be given to tourists coming to the city for the first time. [16] pointed out that visualization of geographic analyzes based on static models restricts visual analysis, and in this study, he aimed to give a 3D perspective to these models by using VR technologies. In this context, the author draws attention to the importance of transferring geographic data from a paper medium to a visually highly capable environment, such as VR. [17] developed a location-based mobile game, MapLens, using augmented reality technology. The authors also stated that the use of augmented reality maps as a collaborative tool has great potential. [2] conducted a study on how VR technology can be used in geography education. In this study, a broad literature review of using VR technology in education is also presented.

[18] argued how mobile AR can contribute to students learning and conclude that this technology can be a valuable teaching tool. [19] stated that the development of technology has accelerated the augmented reality-supported mobile learning and the notion of concept-mapped AR was revealed to develop the applications that would attract students' interest. [20] stated that augmented reality technology is an increasingly popular educational material for young users. In his study, he examined 26 publications in which education with augmented reality was compared with classical education and revealed the good and bad aspects of this technology. [21] developed an augmented reality-based sphere to make astronomical observations easy and understandable for students. Also, this method has been found to increase the interest of students in astronomical observations. [22] investigated the effect of AR technology on students. An experimental chemistry lesson was prepared for use in the research. The results of the study indicated that the use of AR provided a beneficial and fun environment. [23] reviewed publications based on VR technology in education between 2013 and 2014. The study revealed that most of the publications were aimed at students at university and high school levels. It is also stated that there are some studies on adult education.

In most of the studies examined here, it has been revealed that VR/AR applications are useful for students as a learning material which is easier to understand than classical methods.

3. METHODS

Data accuracy and precision are important for any study. The geographical accuracy and the visual accuracy of the data to be used are important in VR/AR applications where reality is tried to be presented. For this reason, some preliminary preparations should be made to reveal the resident area of the university campus, which is the area to be applied. In order to create a 3D campus model, firstly an UAV flight has been conducted on the campus area. Secondly, pictures of building facades have been taken for the detailed models. Then detailed 3D campus model created in the CityEngine software. This model transferred to the Unity software for creating VR/AR applications (Figure 1).

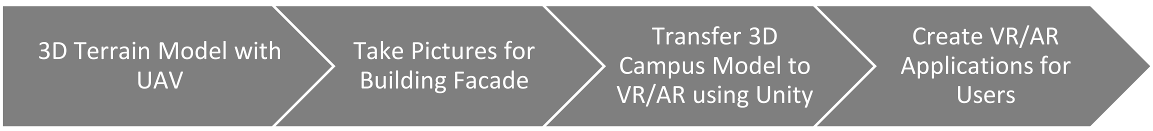

Figure 1. *Workflow of the applied methodology to create VR/AR applications*

4. FIELD WORK

Although the data obtained by unmanned aerial vehicles (UAV) are modeled, we can obtain a visually consistent model, some land applications should be done to increase the accuracy and geographical sensitivity of the model. In this direction, it is planned to establish ground control points (GCP), which are primarily distributed in the region to be flying.

To be used in VR/AR applications, firstly 3D model of Harran University Osmanbey Campus was prepared. For this purpose, flights were made on the campus with GPS assisted unmanned aerial vehicles. To increase the sensitivity of the data obtained by the photogrammetric method, evenly distributed ground control points (GCP) have been laid on the land. 10 separate flights were made in the campus area and Orthophoto, Digital Surface Model and 3D point cloud were obtained from the photographs of the campus (Figure 2).

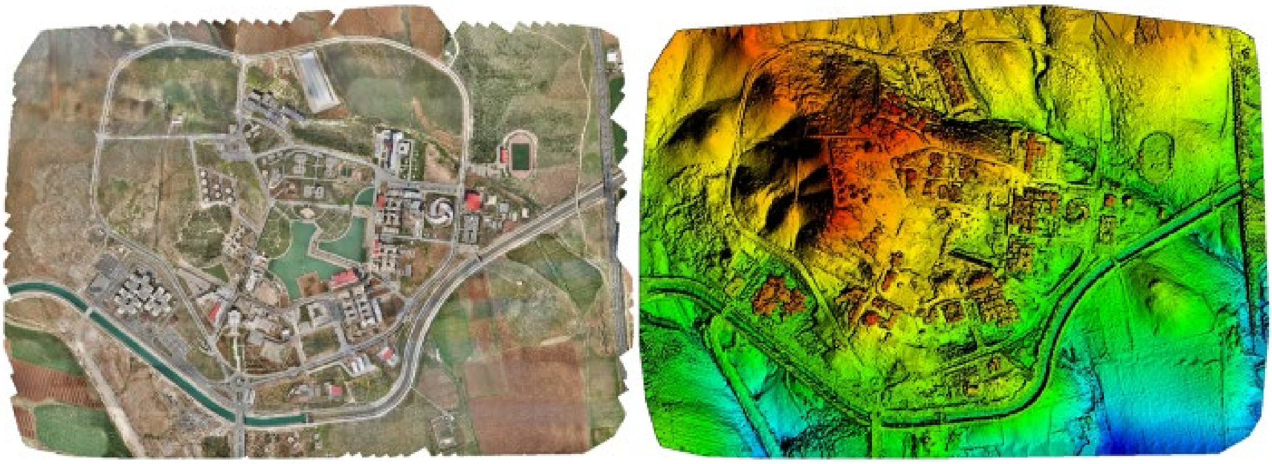

Figure 2. *Orthophoto (left) and Digital Surface Model (right) of the Osmanbey Campus*

Infrastructure data was obtained during model creation and these data were arranged through GIS software for use in the CityEngine environment. Then the facade photographs of the campus buildings were taken by fieldwork. These photographs were used to produce the building models at the LOD2 (Level of Detail 2). To take advantage of the procedural modeling technique of the CityEngine software, .cga files were prepared by writing proper codes in the software for the creation models. With these codes, the buildings belonging to the campus area were modeled according to their characteristics (Figure 3). The surfaces of the modeled buildings are covered according to the building types. The windows, doors, etc. that are not in the correct position during this process are arranged in "cga" codes. To ensure that the model is suitable for VR/AR applications, the model is prevented from being in a multi-part structure. Finally, this model is ready for use in VR/AR applications.

Figure 3. *Some modelled buildings and their facades of the Osmanbey Campus*

5. VR/AR APPLICATIONS FOR STUDENTS

The 3D model of the Harran University Osmanbey Campus was prepared for use in VR/AR applications. The 3D model of the campus was created by using ESRI CityEngine software from the photographs obtained using an unmanned aerial vehicle (Figure 4).

Figure 4. *A general view of 3D model of the Osmanbey Campus*

All of the prepared building models were exported as one model file and made ready for the Unity 3D environment and then transferred to the Unity 3D -game engine software- and rendered on the tablet screen using the Vuforia platform. When the pre-defined visual target (paper and cardboard) is detected by the tablet's camera, this target is displayed as a 3D model of the campus on the tablet screen and the details can be shown (Figure 5). The user can explore different parts of the model by rotating the tablet's camera around the visual target.

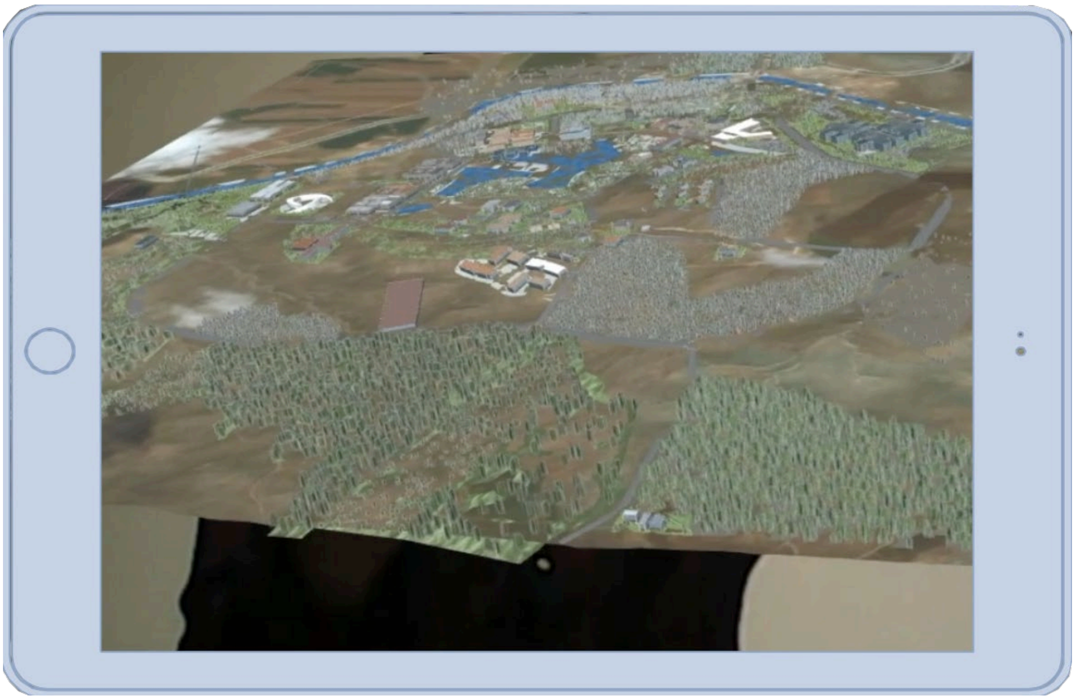

Figure 5. *An example view of AR application from tablet screen*

As a second application, the campus model was transferred to the VR environment using Unity and Mixed Reality Toolkit and ready for use with VR glasses. Thus, the user can navigate in the model using VR glasses and explore the campus in 3D (Figure 6).

Figure 6. *An example view of VR application which user see from the VR glass*

AR application was presented to young students in the high school and their equivalent age groups as a workshop in the Sanliurfa Science Festival organized within the scope of a project funded by The Scientific and Technological Research Council of Turkey (Tubitak No: 4007). Within the scope of the workshop, students from different high schools discovered the 3D campus model of Harran University with the application of augmented reality. The students were able to examine the Osmanbey Campus, which is 25 km away from the center of the city, in an interactive way on the tablet screen.

6. CONCLUSIONS

In this study, a 3D model of the Harran University Osmanbey Campus was prepared using an unmanned aerial vehicle and used in the VR/AR application to present it to students. This practice enabled children to understand the use of maps in 2D and 3D environments. It is important to use this product to make it easier for young children to understand a complex product, such as a map. As some students were familiar with such augmented reality applications from the games, they easily get used to the application and explored the campus virtually. These spatial models, which are presented in 3D with new technologies, have been carefully and enthusiastically studied by young students who participated in workshops. In this context, teaching maps with new technologies such as VR/AR will contribute positively to the development of spatial perception and map skills in young students. The produced model was also shared on the internet and students who were curious about the campus were provided with information about the university from here. Future studies will focus on creating VR/AR games that will provide fun map learning for students of different ages.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] P. Fisher and D. Unwin, Virtual reality in geography, CRC Press, 2001.

[2] I. Stojšić, A. I. Džigurski, O. Maričić, L. I. Bibić, S. Đ. Vučković, Possible application of virtual reality in geography teaching, J. Subj. Didact., 1:2 (2016) 83–96.

[3] C. Dede, Theoretical perspectives influencing the use of information technology in teaching and learning, in International handbook of information technology in primary and secondary education, Springer, (2008) 43–62.

[4] M. Hussein, C. Nätterdal, The benefits of virtual reality in education-A comparision Study, Chalmers University of Technology University of Gothenburg, 2015.

[5] T. J. Bastiaens, L. C. Wood, T. Reiners, New Landscapes and New Eyes: The Role of Virtual World Design for Supply Chain Education, Ubiquitous Learn. An Int. J., 6:1 (2014) 37–49.

[6] J. Piaget, B. Inhelder, The child's conception of space. London, Routledge & Kegan Paul, 1956.

[7] S. C. Somerville, P. E. Bryant, Young children's use of spatial coordinates, Child Dev., (1985) 604–613.

[8] M. S. Joshi, M. MacLean, W. Carter, Children's journey to school: Spatial skills, knowledge and perceptions of the environment, Br. J. Dev. Psychol., 17:1 (1999) 125–139.

[9] P. Hennerdal, Beyond the periphery: Child and adult understanding of world map continuity, Ann. Assoc. Am. Geogr., 105:4 (2015) 773–790.

[10] A. Weber, B. Jenny, M. Wanner, J. Cron, P. Marty, L. Hurni, Cartography meets gaming: navigating globes, block diagrams and 2D maps with gamepads and joysticks, Cartogr. J., 47:1 (2010) 92–100.

[11] R. Gerber, Map design for children, Cartogr. J., 30:2 (1993) 154–158.

[12] B. B. PETCHENIK, Fundamental considerations about atlases for children, Cartogr. Int. J. Geogr. Inf. Geovisualization, 24:1 (1987) 16–23.

[13] J. Bobrich, S. Otto, Augmented maps, Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci., 34:4 (2002) 502–505.

[14] D. Schmalstieg, G. Reitmayr, Augmented reality as a medium for cartography, in Multimedia Cartography, Springer, (2007) 267–281.

[15] Z. Yovcheva, D. Buhalis, C. Gatzidis, Smartphone augmented reality applications for tourism, E-review Tour. Res., 10:2 (2012) 63–66.

[16] J. A. Quaye-Ballard, Virtual Reality: A Tool for Cartographic Visualization, J. Sci. Technol., 28:1 (2008) 136–145.

[17] A. Morrison et al., Like bees around the hive: a comparative study of a mobile augmented reality map, in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, (2009) 1889–1898.

[18] M. Billinghurst, A. Duenser, Augmented reality in the classroom, Computer (Long. Beach. Calif)., 45:7 (2012) 56–63.

[19] C.-H. Chen, Y.-Y. Chou, C.-Y. Huang, An augmented-reality-based concept map to support mobile learning for science, Asia-Pacific Educ. Res., 25:4 (2016) 567–578.

[20] I. Radu, Augmented reality in education: a meta-review and cross-media analysis, Pers. Ubiquitous Comput., 18:6 (2014) 1533–1543.

[21] J. Zhang, Y.-T. Sung, H.-T. Hou, K.-E. Chang, The development and evaluation of an augmented reality-based armillary sphere for astronomical observation instruction, Comput. Educ., 73 (2014) 178–188.

[22] R. Wojciechowski, W. Cellary, Evaluation of learners' attitude toward learning in ARIES augmented reality environments, Comput. Educ., 68 (2013) 570–585.

[23] L. Freina, M. Ott, A literature review on immersive virtual reality in education: state of the art and perspectives, in The international scientific conference elearning and software for education, 1:133 (2015) 10–1007.