Living the Past in the Future

Erkan BOSTANCI [a,1] and Adrian F. CLARK [a]

[a] *VASE Laboratory, University of Essex, Colchester, United Kingdom*

Abstract. This paper presents two fictional stories describing an augmented reality system that helps users learn history in an entertaining way. A complete impression of the surrounding environment is achieved by virtual human agents with sophisticated AI and thorough interaction with other users.

Keywords. Augmented Reality, Cultural Heritage, History, Games

1. Introduction

Augmented Reality (AR) is the process of blending real-world images with artificial objects or information generated by the computer, an extension of user's environment with synthetic content [1]. AR has been found to enrich human perception and facilitate the understanding of complex 3D scenarios [2,3]. Cultural heritage applications [4] were added to the list of application types given in [2] by [5]. Applications of this type include the reconstruction of ancient Olympia in Greece [6,7], Paestum in Italy [8] and the Gosbecks Archaeological site in Colchester [9]. AR is an interesting technology for archaeology as it facilitates display and interaction with ancient buildings in the form they had in antiquity; in particular, it allows tourists to explore archaeological sites without involving reconstructions that would disturb the original structures, so that they can remain for future generations [6]. Most excitingly, these computer-generated reconstructions can be made to overlay the ruins on the archaeological site.

The remainder of the paper is structured as follows: Section 2 presents the work carried out by the authors and show the outline of the prototype that is characterised in the fictional stories in Section 3. Finally, Section 4 summarises the prototype and shows how our research is inspired by these fictional stories.

2. Related Research

Tracking, the process of locating a user's position and orientation, is critical to AR as more realistic results are obtained when synthetic content is accurately registered with the real world. Generally, the user wears a head-mounted display (HMD) upon which the augmented images of the real world are displayed, so tracking it is paramount. Accurate tracking also prevents problems such as visual capture [2], in which inaccurate registra-

---

[1]Corresponding Author: Erkan Bostanci, VASE Laboratory, University of Essex, Colchester, United Kingdom; E-mail: gebost@essex.ac.uk.
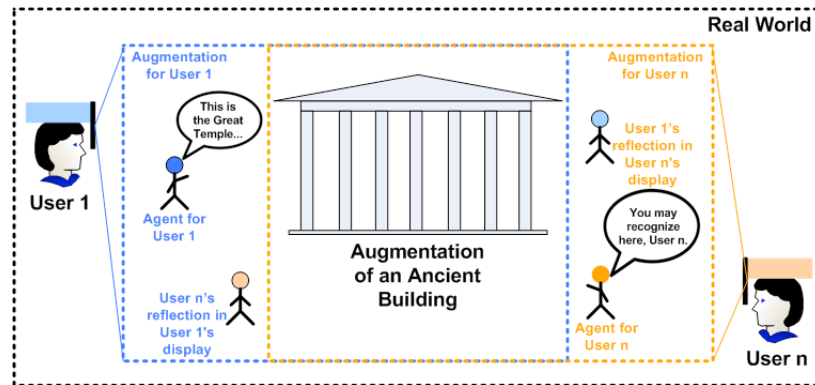
Figure 1. Planned AR system

tion causes augmentation to be displayed in, and the user to interact with, the wrong part of the real environment.

We have explained the difficulties in tracking for AR systems in [10]. Our research is directed towards marker-less tracking methods for AR and we are using algorithms based around SLAM (Simultaneous Localisation and Mapping) [11], developed in the robotics community for obtaining the position of the robot while it is exploring a new environment. In particular, we are interested in techniques derived from vision-based SLAM to perform the localisation of the user in the environment. The most important problem in SLAM is the data association problem, finding correspondences between real-world objects and their internal representations. When an incorrect data association is made, the Kalman filtering system that underlies SLAM cannot update its prediction robustly and this causes incorrect tracking results, leading to the false estimation of the user position and hence incorrect positions for rendering synthetic objects.

The performance requirements of vision-based tracking algorithms, as well as the rendering system required for large 3D models, is a problem of lesser priority as we believe that Moore's 'law,' which predicts ever-increasing computer system performance, will eventually deliver the performance required.

The two fictional stories below present a prototype for AR which extends current systems with more interaction. By doing so, a 'live' environment in which users can interact with each other and the agents in the system will be introduced, as shown in Figure 1.

The ultimate aim of our study is to create a cultural heritage application which can improve interaction with its users, perhaps not exactly as in the stories below but certainly with more interesting features then in a simple game such as the one depicted in Figure 2.

3. Fictional Stories

The last thing I can remember is falling asleep on my sofa reading the history magazine. In my dream, I was at home and everything was quite normal — the walls were their usual colour and the furniture in their usual places. Then everything started to transform: the textures of walls changed, becoming older and older. I was in the same place but the

Figure 2. Prototype AR game for a cultural heritage application

clock on the wall was spinning backwards very quickly until it slowed down and became barely visible within dark texture of the wall. . .

Medieval Ages.   I found myself in a room of a castle with stone walls and a large, old wooden table in the middle. Next to it was a large chair. Some swords and axes were hung on the wall. I looked at myself in the mirror: I was in my forties with mostly white hair, and I had a long scar on my face from my left eye to my chin. A young boy ran into the room: "My Lord! We are under attack!"

I looked around the silent room and saw no-one else. Me? Lord? Are you kidding? What kind of a dream was it like this? It was so real. After a few moments of hesitation and surprise, I made up my mind and asked the boy a sequence of questions which, I thought, would help me understand what was going on: "Who are you? Where are we? Who am I?"

"I am your humble servant, Sir," the boy answered quickly. He did not stop a moment and continued answering my questions. "We are at Tehlrog Castle. You are Lord Haringoth[2] of this castle and many others." He also gave me some information about my other castles and soldiers.

"Good," I replied, hopefully sounding as though I had understood everything and had complete control on the situation. The boy looked very frightened and repeated: "My Lord, our castle is besieged by Lord Naldera. He has a large army all around our castle. . ." As he continued to report, I understood that it would not be easy. I had no chance but to take this rôle and do whatever it took to save my castle!

"How many men in their army?" I asked.

"A Thousand man-at-arms, no cavalry."

"Hmm. . ." I responded, having no idea what this meant but trying to recall my previous gaming experiences.

"I counted about two hundred archers." Two hundred archers for my little castle? I did not have any military experience but I could see that this meant a rain of arrows on top of my head!

"Fetch my sword and shield," I commanded the boy as a real lord. He smiled: "My Lord, you already have your shield and sword with you." He was right. I found myself with a long sword and a heavy steel shield (Figure 3). I was wearing chain-mail armour

---

[2]Names of places and people are inspired from the computer game Mount&Blade, http://www.taleworlds.com/

too. Maybe that was why I felt heavier rather than the thick blanket my mum puts on me when I sleep.
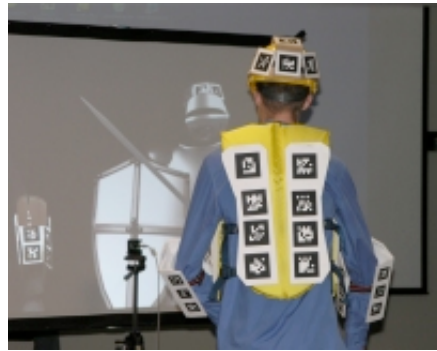

Figure 3. Magic mirror from ArTag (from [12])

I snatched up a crossbow and large quiver from a corner of the room and ran to the fighting platform on top of the tower. I realised how critical the situation was when I looked through the hole (Figure 4). As the commander of the castle, I ordered my generals to prepare their forces to defend the castle. I also told the boy to prepare hot oil to pour down the walls.

Figure 4. (a) Real image from the Tower of London. (b) The reflection of (a) in Mount&Blade.

Preparations for the forthcoming battle took about two hours — I knew because I could go and check the time on the clock which was ticking away quietly on the wall of the room where I had woken up in the medieval age. "Anyway, no more surprises," I thought to myself, "anything is possible in this world!"

It was then that the world around me started to change again, from the battle scene of the castle to the streets of some kind of ancient city. I no longer felt weighed down with armour and, looking down, saw myself in a toga. I was good to have lost the chain-mail but where had my sword and shield gone? More important, how have I come here from that castle? Sighing, perhaps with relief for I don't see myself particularly as a warrior, I accepted the change stoically and started walking. . .

Ancient Ephesus. I was in front of a large library (Figure 5a(a)) next to an old man. I saw that he was had a long beard and was wearing old clothes. *A philosopher?!* I asked him as before: "Where are we?"

He smiled and replied: "By now, you should have understood that you can be anywhere you wish to be, just as you were in the medieval ages." *How did he know that?* "Only remember that you can never step into the same river twice.[3]" He continued: "You are in front of one of the largest libraries in the world, the Celsus Library in the ancient city of Ephesus. I guess you also wonder who you are and who I am as well?"

"Well, yes." *He can predict what I will ask: good.*

"Your name here is Anaximander. I, Heraclitus, will be showing you around."

"Good. I would like to learn more about this city."

"That is why I am here. Let's proceed with the temple."

"This is amazing."

"Yes, indeed. This is the temple to Hadrian (Figure 5a(b)). It was built to honour one of the five good emperors." The temple was full of people lighting candles and praying for the emperor. It was the first time I had saw an emperor being worshipped as some kind of God. There were sculptures of gods and demi-gods around the temple; it was fascinating.
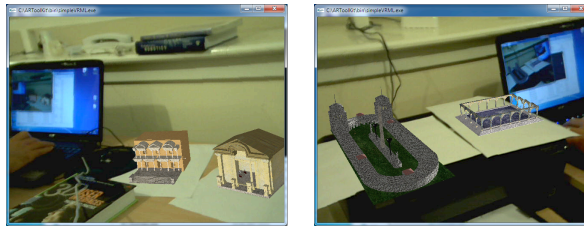
(a) Celsus Library and Temple to Hadrian

(b) Stadium and Baths

Figure 5. Buildings in the Ancient Ephesus [13]

Leaving the temple and walking past the old baths (Figure 5b(a)), we arrived at the stadium (Figure 5b(b)) where the chariot races were taking place. The stadium was just massive, bigger than anything I had seen in my life. I was starting to wonder where the wall clock was; looking around me, I spied it on the largest column in the middle of the stadium. "Not so much of a surprise this time," I thought to myself.

Thousands of spectators were shouting for their favourite racer while some people were collecting money for bets. Heraclitus started to explain: "These races are really very challenging. Do you see the blades on the sides of the chariots?"

"Yes, but they are only decorations and they are not sharp, aren't they?"

"As sharp as razors," he answered, a smile on his face again. We watched a few races; thankfully, no racers had to face those blades by falling out of their chariot.

Before the end of the final race that determined the overall winner on the day, the stadium started to vanish within the walls of my house. Everything faded away like a cloud of dust — except for the clock, of course. I woke up and saw my blanket on the floor...

---

[3]http://www.iep.utm.edu/heraclit/

4. Conclusion

This paper has presented fictional stories that illustrate an application which pushes the boundaries of what state-of-the-art AR systems can achieve. It moves from static augmentations of an environment to a 'total augmentation' paradigm in which the user will experience the worlds of past ages with animations of people (with their own AI), walking along the streets of a city, chatting in an *agora* or fighting in a battle — a living environment where different users will also be able to interact with each other.

The servant in the middle ages and the philosopher of the ancient city correspond to AI agents. AI agents help the user in an AR environment to learn the system better and become more comfortable with the system in less time [14]. The ability of the philosopher to predict what the user is going to ask is a depiction of 'evolving agents' which are able to learn the behaviour of the user over time. The clock on the wall represented the surprise and confusion between the real and the augmented objects in the environment as mentioned in [15]. Our current research is motivated by the wealth of application areas in which this kind of work can be applied.

References

[1] W. Broll, I. Lindt, I. Herbst, J. Ohlenburg, A. Braun, and R. Wetzel, "Toward next-gen mobile ar games," *IEEE Computer Graphics and Applications*, pp. 40–48, 2008.

[2] R. Azuma, "A survey of augmented reality," *Presence:Teleoperators and Virtual Environments*, vol. 6, pp. 355–385, 1997.

[3] M. Ribo, P. Lang, H. Ganster, M. Brandner, C. Stock, and A. Pinz, "Hybrid tracking for outdoor augmented reality applications," *IEEE Computer Graphics and Applications*, pp. 54–63, 2002.

[4] K. Yehuda, T. Kvan, and J. Affleck, *New Heritage: New Media and Cultural Heritage*. Routledge Publishing, 2007.

[5] G. Papagiannakis, G. Singh, and N. Magnenat-Thalmann, "A survey of mobile and wireless technologies for augmented reality systems," *Computer Animation and Virtual Worlds*, vol. 19, pp. 3–22, 2008.

[6] D. Stricker and T. Kettenbach, "Real-time and markerless vision-based tracking for outdoor augmented reality applications," in *International Symposium on Augmented Reality (*, 2001.

[7] P. Dahne and J. Karigiannis, "Archeoguide: System architecture of a mobile outdoor augmented reality system," in *IEEE International Symposium on Mixed and Augmented Reality*, 2002.

[8] R. Chiara, V. Santo, U. Erra, and V. Scanarano, "Real positioning in virtual environments using game engines," in *Eurographics Italian Chapter Conference*, 2006.

[9] P. D. Ritsos, *Architectures for Untethered Augmented Reality Using Wearable Computers*. PhD thesis, Department of Electronic systems Engineering, University of Essex, 2006.

[10] E. Bostanci, N. Kanwal, S. Ehsan, and A. F. Clark, "Tracking methods for augmented reality," in *The 3rd International Conference on Machine Vision*, (Hong Kong), 2010.

[11] J. Civera, O. G. Grasa, A. J. Davison, and J. M. M. Montiel, "1-point ransac for ekf filtering: Application to real-time structure from motion and visual odometry," *Journal of Field Robotics*, pp. 609–631, 2010.

[12] M. Fiala, B. Hetherington, and L. Burkett, "Artag array applications," in *ISMAR*, 2006.

[13] B. Koyuncu and E. Bostanci, "Virtual reconstruction of an ancient site: Ephesus," in *Proceedings of the XIth Symposium on Mediterranean Archaeology*, pp. 233–236, 2007.

[14] I. Barakonyi and D. Schmalstieg, "Augmented reality agents for user interface adaptation," *Computer Animation and Virtual Worlds*, vol. 19, pp. 23–35, 2008.

[15] G. Clarke and M. Lear, "We all wear dark glasses now," in *Creative Science'10*, 2010.