Istanbul Journal of Innovation in Education
Volume 3, Issue 1, January 2017

AN AUGMENTED REALITY INTERFACE FOR CHOREOGRAPHY GENERATION

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Abstract

Choreography is a creative process for crafting movement that has existed for many years. As digital technologies surge different means of generating choreography are being explored. Choreographers gain a lot from the use of digital tools in choreography generation. The aim of the project is to develop an Augmented Reality (AR) choreography generator interface and compare it with another interface for choreography generation, a Personal Computer (PC) based choreography generator. For that purpose, we develop an Android based augmented reality choreography generator and a PC based choreography generator. In the project we use the marker based tracking approach for augmented reality. Our research contributes to the study of how different interactive methods of the same application affect user experience. The results verify the effectiveness of augmented reality in developing training and design applications.

Keywords: Choreography, user experience, augmented reality

Introduction

Computers, tablets and mobile phones are vital tools in the modern century. Therefore, it is imperative to develop interfaces that can easily be used with these important devices. Augmented Reality (AR) presents an interesting approach to interface design. It takes three properties into consideration combining the real world with virtual worlds, providing interaction and presenting 3 Dimensional (3D) objects (Yilmaz, 2016). It gives the users the ability to interact with virtual world objects and the real world simultaneously. Bujak et al (2013) asserts that whenever 3D objects appear superimposed onto the real world a magical experience is created that adds pleasure and creates amazement and curiosity to the user.

Mobile AR is one of the fastest growing areas in AR applications (Craig, 2013). Nowadays mobile computing devices are getting popular as a platform for AR applications, there has been a sweeping shift from the bulky

AR hardware largely due to the increasing processing power of the smart phones (Lee et al., 2009). This trend is set to continue as mobile devices acquire more processing power.

The advent of digital technologies has seen various platforms being developed for choreography generation. Choreographers have been captivated by the use of technology in the compositional process. Therefore, development of applications for choreography generation is of major importance. According to Davcev et al, (2003), 3D animation is a preferred choice for dance learning. Hence the use of digital technology and software programs challenges choreographers to observe the creative problem space as new through confines alongside new possibilities (Alaoui, Carlson & Schiphorst, 2014). This research complements the existing choreography generators by adding AR. Several researchers have suggested that AR can aid reinforce motivation of students and trainees through improving their educational realism (Chang, Morreale & Medicherla, 2010). Lee (2012) also asserts that AR applications in mobile platforms provide a lot of promise with respect to training and planning.

The aim of our study is to develop an AR based mobile application interface for choreography generation. We design, implement and compare the mobile AR interface with the Personal Computer (PC) based choreography generator. The results of the experiments are important in understanding the impacts of different interactive techniques on user experience. As well as understanding the effects of augmented reality on training applications. In this study we provide an important contribution presenting a choreography application bridging the gap in the creativity technologically field.

In this paper, we first discuss the related work that has been done for choreography generation in the digital age. We then describe the interfaces we developed in detail and share the results that we obtained from the experiments. We conclude by discussing the results identifying challenges and future work.

Related Work

Choreography using computers dates back to the early 1960s. In 1967 a choreographing computer system that was prompted by the need to create dance annotation without having the physical dancers was developed (Noll, 1967). This article describes a two-dimensional interface, one of the first of its kind, it suggested a choreography application where stick figure representations of dancers are displayed on the computer screen. The choreographer controls the different movement aspects of the stick figures by manipulating the buttons and other controls to craft different dance annotations. The system was initially designed for ballet dancing and forms the basis of modern day choreography applications. The major weakness of the interface was the lack of dimensionality; it lacked an appeal of reality. Another deterrent in the early systems was the limited availability of input techniques and the low processing power of computers. However much has been done since then on designing rich interfaces.

Since its emergence, AR has been put to use by a number of organizations for teaching, visualization, training, and other applications (Lee, 2012). Different applications have been developed to enhance user experience using AR. The creativity sector has used AR for stage setup in mixed reality applications. Broll et al (2004) discusses an interactive mixed reality system for stage management and choreography. The mixed reality system combines AR and virtual reality in setting up a real stage and managing performers. The system is aimed at collective planning for stage shows and events. The generated environment is dependent on a miniature stage that has computer generated 3D props and characters. Using head mounted devices users can interact with the interface and complete their functions. A choreographer is responsible for setting up the stage the way and then play around with the choreography before implementing it on real dancers. Interior designers can also use this augmented reality stage to set up different props and view the scene before implementing it. However, this approach is dependent on expensive and bulky hardware.

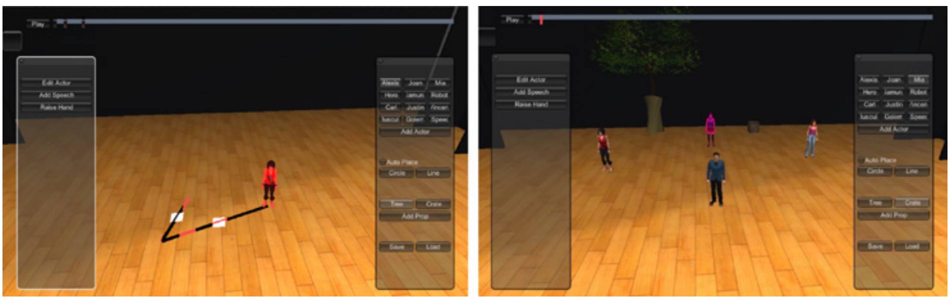
Davcev et al., (2003) describe another AR environment for dance learning. The web3D based environment described is an interactive method for dance animation relevant for training and education. This is basically an interactive technique for dance animation which facilitated for interactive dance steps observation, slow movement of fast steps and different angles of view. The Web3D environment allows the choreographer to compose different dance routines. A dancer can learn the movements by viewing from different angles and at different speeds. However, the interface is effective only on desktop browsers. A variety of digital choreography tools exists, which apply different types of interactive approaches and different ways of choreography generation. According to Alaoui et al (2014) as attempts to digitize choreography appear there still exists many open questions in relation to the support tools and consensus on the standards for choreography applications.

Desktop Interface for Choreography Generation

We first developed the PC version of the choreography generator. In the development process we interacted with choreographers and some individuals in the entertainment sector to get their views on how exactly the choreography process occurs. This assisted in crafting ways of controlling the characters in the scene.

On the interface the choreographer is presented with a 3D dance stage for choreographing. The interface has controls for adding a dancer, drawing the path, adding props to decorate scene, controlling speed of the characters and resetting the scene. The user can select the “add dancer” button and choose the type of dancer to add into the scene. To define the path the character follows, the user uses the “draw path” button and then drags the dancer using the mouse along the path they must follow. The Line Render component of Unity is used to set a line trail to show the user the path being defined. Once the path is defined the user can play the choreography. Whilst playing the scene the user can use the speed slider to change the speed of the character just like choreographers can change paces of the dancers on the stage. To further enhance functionality the user can add different props like trees and boxes. The user can zoom into and out of the scene using a mouse, and also rotate the scene to view it from different angles. Other animations include a bubble to keep track of any commands that a dancer must say on the scene, and the ability to raise hands as a sign for different signals. The PC based choreography generator is shown in Figure 1.

Figure 1: Snapshots taken from the PC choreography generator interface



Augmented Reality (AR) Interface for Choreography Generation

For the AR application we limited choreography to define only the movement of a dancer from a certain point to another. The other forms of dance choreographies are set aside for the extension of the system at a later stage. The mobile based application allows the choreographer to add dancers into an augmented reality view seen from the phone. The application uses marker-based augmented reality approach. The marker is the stage set up required to initiate the interface. The marker used for this application is shown in Figure 2. The user utilizes his/her phone camera to view the marker and initiate the interface. Once the marker is detected the user is presented with application's interface. The interface has controls for adding a dancer, drawing the path, adding props to decorate scene, controlling speed of the characters and resetting the scene. For zooming in and out the user moves the camera close to the marker or away from the marker. This functionality can also be achieved by moving the marker closer to the mobile phone camera. Furthermore, to view the scene from all angles the user moves the camera around the marker or rotates the marker whilst holding the mobile phone. Figure 3 shows the final implementation of the AR interface with 2 trees and 3 dance characters added.

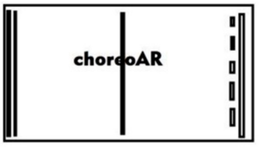


Figure 1: Augmented reality marker

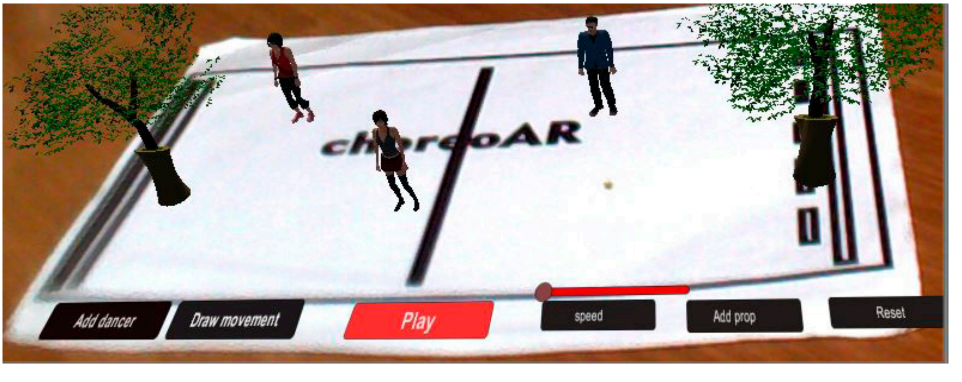


Figure 3: A snapshot taken from the augmented reality interface with props and dancers

Experiments and Results

Experiments were conducted to evaluate the performance of users on the two developed interfaces, the PC based version and the AR based version.

Software and hardware

The PC based application was developed using Unity3D. The application is available as a standalone desktop application or as a web based application for a web browser that supports the Unity web plugin. The AR application is android based. Implementation was done using Vuforia and Unity3D. Unity3D is a cross-platform game engine used to develop video games for computers, consoles, mobile devices and websites[1]. Vuforia is an AR Software Development Kit for mobile devices that enables the creation of AR applications[2]. It uses Computer Vision technology to recognize and track planar images and simple 3D objects in real-time. Unity3D and Vuforia combine to produce portable applications. The PC based application was tested on the Mozilla Firefox web browser whilst the AR interface was installed in a LG G4 and a Samsung Galaxy S4 during the experiments.

Experimental Setup

In the experiments we used a total of ten test subjects, 4 females and 6 males all of them university students with a mean age is 24 years. The test subjects were selected based on their knowledge with computers. The experiments were carried out primarily to evaluate the usability of the applications therefore the use of non-professional test subjects, this is a preliminary study. From the 10 users 6 of them were aware of AR

Users were given four tasks to perform on the two interfaces. During the experiments the users used the interfaces in a random order to avoid task adaptation. For the experiments we selected these simple tasks that were easier to handle for users because all of them were first time users of a choreographing application. In addition to the tasks the users were asked zoom in and out, and increase speed of characters. This allowed users to explore the interfaces further. The four tasks that were completed by the test subjects are the following in sequence:

Task 1) Add dancer to the left and right of the scene
Task 2) Add prop to the left and right of the scene
Task 3) Draw a simple path from the back to the front
Task 4) Play the choreography (free play time)

Objective test results were attained by recording the time required to complete given tasks on either interface. To obtain subjective analysis after the experiments the users gave feedback about the system. The users were required to fill the post-test user satisfaction questionnaire. During the testing phase users were encouraged to think aloud and give any feedback from their observations. The user experience test conducted on the interfaces investigated the following issues:

- Users' awareness and experience with AR technology
- Users' preference on touch based or pointer based interactive technique
- Users' reaction to the different zooming approaches
- How the users interact with the two interfaces.
- Time taken to complete tasks

We used a scale 1 to 10 to measure different usability experience measures. For mental stress and physical stress 1 represents a low stress level whilst 10 represents high level. Satisfaction from completing the tasks and the level of difficulty of completing the tasks were also attained using the same scale. The users were also required to highlight how difficult it was to understand the interfaces and give a measure of how easy it is to learn the basic functionality.

Results

Table 1 and 2 show the results from the experiments. In the tables we present the average time taken to carry out the tasks and the average scores for mental stress, physical stress, level of satisfaction and pleasure in performing tasks.

Table 1: PC based Interface results

	Time(s)	Mental Stress	Physical Stress	Satisfaction	Pleasure
Task 1	10.10±1.20	4.90±1.73	3.10±1.61	6.20±1.78	7.10±1.45
Task 2	11.40±1.13	3.60±1.58	4.20±0.40	6.50±1.18	7.60±1.10
Task 3	16.20±2.10	7.00±2.01	3.10±1.10	5.30±0.67	5.10±0.50
Task 4	Free time	3.10±1.51	2.00±0.50	6.00±0.49	6.90±0.14

Table 2: AR interface results

	Time(s)	Mental Stress	Physical Stress	Satisfaction	Pleasure
Task 1	8.50±1.90	3.10±0.15	6.01±0.45	7.10±1.10	8.20±1.01
Task 2	16.30±1.91	3.20±0.12	6.20±0.65	7.10±1.75	7.10±1.14
Task 3	6.30±1.51	3.10±0.13	7.10±0.14	8.00±0.82	8.00±0.67
Task 4	Free time	2.00±0.10	7.10±0.02	8.20±1.10	8.10±0.54

The results indicate that completing the tasks was generally faster on the touch based approach of the AR interface as compared to the PC based interface. The total average time for completing the first three tasks in sequence is 30.7 seconds for the AR interface and 37.7 seconds for the PC based application, demonstrating that on average the users completed the tasks faster on the AR interface. Task 3 is performed faster in the AR interface as compared to the desktop interface, the mean value for completing the task is 6.20 seconds on the AR interface compared to 16.30 seconds for the PC based interface. This significant difference is due to the different interactive approaches for drawing path employed on the two interfaces. Drawing the path on the touch based approach using a finger was simpler and faster as compared to using the mouse on the PC based interface.

Users were generally comfortable using both interfaces despite the fact that most of them had never used a choreographing application before. The tasks assigned to users were fairly simple to understand as shown by the mental stress scores. However, completing them on the different interfaces gave interesting results. Task 3 on the PC application shows a high level of mental stress with a mean value of 7.0 as compared to 3.10 for the AR interface, this is largely due to the approach that requires more time to grasp. Most users pointed out that drawing the path confused them in the PC based interface. The PC based application exhibited less physical stress on users as compared to the AR interface. This is because on the AR interface the user has to hold the mobile phone looking at the marker, this causes strain on the hands with time. The desktop based interface is therefore more user-friendly when it comes to the physical stress on the user. In the AR interface users expressed satisfaction by being able to move around the dancer in the scene by only moving the mobile phone around the marker. Controlling the speed of the moving dancer was another interesting aspect for the users. However, users were continuously making errors by dragging the camera's view when they wanted to move the dancer. The overall mean scores for usability of the interfaces obtained are 6.50 for the PC based interface and 8.05 for the AR interface. In comparing the two interfaces we found out that the augmented reality interface brings a sense of curiosity and amazement to the user and enhances user experience, however the physical stress exerted on the user is a major concern. The rates of errors are however higher in the touch based interface for adding dancers and adding props as compared to the pointer based approach of the PC application. Both interfaces showed a good visual quality with mean scores of 7.90 and 8.10 for PC based and AR respectively. The AR interface has few visual buttons and results show that users would learn it faster that the PC based with a scored of 6.90 as compared to 4.40 on how easy it is to learn the functionalities.

Discussion

Experiments were carried out to complete the same task on two different interfaces using different interactive techniques: 1) The mobile based AR application that uses touch based interactive approach and 2) the PC based application that uses pointer based interactive approach using a mouse. The results showed that when adding the dancer and the props into the scene the rate of errors was high in the AR interface as compared to its desktop counterpart. This result is influenced by the changing position of the interface as the phone tilts or is held in an unstable manner. The touch based interactive approach of the AR interface showed faster time scores using the finger to draw path demonstrating the power of interfaces that provide a natural way of interaction to the users.

The results of the experiments show that AR has an important part to play in crafting training tools as mentioned by Lee (2012). It gives a compelling effect to the users and excitement through the curiosity it creates. The AR interface affords users the ability to interact with the characters by only moving the phone around the marker. The ability to move closer to the dancers on the scene and easily shift the viewing angle provided pleasure to the users. However, mobile AR for handheld devices presents high levels of physical stress on the hands of the user and also a high error rate when interacting with the touch screen as the mobile device tilts and shifts positions on the hand of the user. Therefore, wearable glasses can prove more effective for AR in training applications, which is a study area we leave for future work. We will continue working on extending the PC based interface and Android based interface so that we have same approaches especially with respect to drawing paths. Furthermore, we intend to extend the interactive approach for the AR interface by allowing the choreographer to use virtual buttons on the marker and draw on the marker. In this approach the mobile phone screen becomes a merely viewing screen but no longer the means of interaction. The AR interface can also be extended to include voice interaction.

Conclusion

In the study we implemented a PC based and AR based choreography generator interfaces which we compared the performance of users with in terms of user experience. The interfaces allow a choreographer to define choreographs and make the choreographer in charge of the dancers just like in the real world. The results of the experiment showed that AR has big part to play in training and educational applications. Another aspect we tried to implement was virtual buttons and virtual drawing of paths where the user only interacts with the marker and not the mobile device screen. In this approach the mobile device screen becomes just a screen to view the real world but the user only interacts with the marker. However, they were challenges with this approach which we set aside for future work. The addition of other forms of movement and special animation for choreography generation is another important topic for the future.

Acknowledgements

The authors would like to thank Güneş Karababa, Çağatay Koç and Ege Sarıoğlu for the fruitful discussion and their invaluable ideas.

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