

AUGMENTED REALITY AND VISUAL ARTS

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Abstract

This research explores the use of augmented reality technologies in the field of visual arts, focusing on the way that visitors and artwork interact. The bibliographic research focuses on exploring the definitions of augmented reality and interaction. The historical overview defines the two above-mentioned fields and looks into their connection with art, via exploration of their visual characteristics. We present the implementation methodology for such enhanced artwork and the process of interaction with the observer. Our research extends beyond typical presentation and citation of augmented and interactive visual works as it sets two main objectives a) discuss the way the artistic work which use augmented reality technologies interacts with the visitor, as well as b) present how human senses are stimulated through visual art work when new interactive augmented reality technologies are employed.

Keywords: *Augmented reality, Interaction, Art - Technology, Multisensory Multimedia, New-Media Art.*

Introduction

In recent years there has been a rapid evolution of augmented reality technologies and applications that have found their way in various everyday fields. This has resulted applying those technologies into various fields such as education, medicine, gaming and art. Here with the term art we refer to the visual and interactive arts. Our research focuses on the application of augmented reality technologies to the visual arts.

In an artwork in which augmented reality technologies (AR) are applied, aesthetics and interaction play a key role (Pagoulatou, Lazou, & Ntourma, 2017). There are many studies that on on real-world technologies. These technologies are applied on many areas of everyday life such as gaming (Boulos, Lu, & Guerrero, 2017), theater and performance (Jaewoon, Yeonjin, Myeong-Hyeon, Dongho, & Byeong-Seok, 2015), and education (West, 2012). In recent years, as far as visual arts are concerned, artists have been employing systems, platforms and applications enabling them to realize their artistic creations. Those systems change with time as technologies evolve and reange from the

software named “ARART” to end-to-end solutions such as “HP Reveal” (formerly known as Aurasma) (List of augmented reality software, 2019). Our research questions moves beyond the technical elements of the software to the user-experience sector: 1) How is the interaction between visual art and augmented reality and the visitor implemented? 2) Which of the five senses are stimulated through the artwork? 3) How are those senses stimulated?

Augmented Reality

Augmented Reality AR is a way to link physical items from the environment to virtual content. The main difference between AR and VR lies in the fact that AR integrates the user into the physical environment in real time, offering the possibility of improving all the five senses even if AR applications usually use only the vision, while VR isolates the user from it. Augmented reality was created to enhance the view of the natural world and this is accomplished by using computers, sensors and image processing technologies (Kipper & Rampolla, 2012).

AR techniques appeared in 1962 when Morton Heilig designed a machine which immerse the user in a full range of sensory stimulation while watching short films. This machine – sensorama- is the first known multi sensory technology. Followed in the 1970s, by the establishment of Videoplac by Myron Krueger. Krueger created a virtual reality and interactive art environment in which by using augmented reality, users could interact with virtual objects (Kipper & Rampolla, 2012). These two events are what triggered the revolution in the development of AR technologies and applications. As technologies evolve, in 1994 Julie Martin created a theatrical production called “Dancing In Cyberspace”. During the show and while the dancers performed acrobatics on the stage, virtual objects appeared on them and around them (Dils & Cooper Albright, 2001). Today, such theater and performance productions are common and Projection-based AR techniques are used. In the field of art this technology is called “Projection Mapping” that covers a smaller field than Projection-based AR (Jaewoon et al., 2015). In recent years, researchers managed to develop techniques that these three-dimensional projections could applied not only to fixed objects but also to moving objects, as this technique requires automatic alignment of accurate moving image objects (Jaewoon, et al., 2015).

Interaction and Art

Active participation of the observer in the formation of an artwork and the need for his presence for the development or existence of the artwork itself is an embodiment of interaction. AR clearly enables this to be implemented as it provides a tool to interact with artwork. Of course this concept is not something new, as by researching art history, it emerges that during the period of the Futurism and Dadaism, there was a need from artists to physically and emotionally engage the public in their artwork.

Artists of that period (Futurism and Dadaism) sought the interaction, in other words the reaction of the public towards their artistic action. At this time, the Happenig’s predecessors could be identified along with the first at-

tempt to integrate the visitor into the artistic work. Then follows Allan Kaprow (Charalambidis, 1995), the father of Happening, who was the first to engage the visitors actively in his artwork. His idea was born when he noticed in the environments he was creating that each visitor was becoming part of his artwork. Based on this observation, he decided to give to every visitor the opportunity to be actively involved in shaping the project. This was led to Happening. Today, the interaction of a project with the observer can be achieved through the use of technology and can become more complex and multileveled than it could have happened with Happening.

Interaction and AR

For artists, how the observer feels or what he/she experience, is a key factor for their artwork. This goes beyond the logic of comparing one artwork item with the other or in other words “this piece sounds like or looks like”. Specifically, interactive digital art is purely about interactive experience (Edmonds, 2014). The way in which visual art interacts with the public is a critical part of the essence of the artist and his work. The reaction towards the project is the core of it and is more important than any other aspect in an artwork. The creative practice of the artist who chose this path is quite different from that of a painter. In the case of interactive art, the public’s response is the key element that will concern the artist, rather than the color or the perception of perspective. The public’s commitment to the project is based on what the public does, how it interacts with the project, and so forth (Edmonds, 2010). A basic part of the interactive arts is also part of the immersion of the visitor.

In the art of technology, observer’s immersion does not only function as a visual-spatial illusion but also as the sense of conscious immersion in a fake world and/or artistic processes. This is particularly true in the case of interactive art, which requires awareness of the things that are offered through interaction and focuses on the reactions of the observer who is actively involved. Here, the focus is not on escaping from everyday life, but on the emotional and mental intensity of the experience. In interactive art, the way that the participant-observer acts is important for him to perceive the artwork (Kwastek, 2015). The need to study the interaction between art and public has revealed the need to create a study model.

Zafer Bilda in 2011 developed a model for studying the connection of the public with the visual interactive artwork. This was the result of the research he conducted when he examined the interaction of art with the public. He found that, the observer’s engagement with the project shifted from involuntary actions to deliberate actions that led the observer into a sense of control. In some projects observer’s involvement continues through developing levels of exploration and uncertainty. It should be noted that Bilda has recognized four phases of interaction in an interactive visitor system: adaptation, learning, anticipation and deeper understanding (Edmonds, 2014).

Through the above research it is observed that a series of issues concerning the audience experience are important to the interactive artist and the research on these points is an important part for the creative process of an artwork. When creating an interactive visual artwork, artists should take into account the engagement processes and engagement types of the visitors involvement (Edmonds, 2010).

Aside from the above, which mainly concerns the artist and what needs to be taken into account in order to activate and engage the visitor with his interactive digital artwork. The key question remains how the visitor is affected when he/she receives the above information from an interactive artistic work that is connected with some real-time technology. Part of the answer to this question comes from the interactive artwork created by Diaa Ahmed Mohamed Ahmedien (2017) who created a neural interactive work of art in the form of a holographic puzzle in an attempt to expand the functional role of brain activity in interactive artistic processes.

The experiment connects the imaging system of the puzzle pieces with the electrical activities of the participant's brain by the means of an electroencephalography system. This experiment reveals the effect of the functional expansion of the participants' nerve responses and the ability to quantitatively analyze the interactive processes in an operational interpretation of the neural dimension in the interactive arts. If the brain is properly stimulated by the participant then the holographic tiles will appear and the participant can solve the puzzle. As a result, participants recognize how the system works and exercise self-observation and self-control in order to manipulate the holographic pieces of the puzzle. Finally, data from brain signals was summed up in comparative tables to reveal the reciprocal interaction processes between each participant's neurological response and performance. This technique is called "Neurofeedback" and is a technique that affects the nervous system of the brain, in which brain activity is recorded using electrodes and is presented visually so that the person can functionally know the state of his brain nerve signals and their performance.

Comparing Zafer Bilda's method of analyzing the interaction of the visual work and the steps that the visitor should take in order to engage with the interactive work, the way that Diaa Ahmed Mohamed Ahmedien analyzes in his research of the brain activity of each participant from his acquaintance with the system as the solution of the interactive holographic puzzle, we see an analogy of the steps and an increase in brain activity when the brain is in the final stage of solving the puzzle. As the author says, in order to solve the puzzle, the brain should produce Gamma waves that represent the state of hyper-brain activity (Ahmedien, 2017). In this case, intense brain activity is been produced by the person through his interaction with the AR artwork.

AR applications have been applied to language studies, social sciences, the arts and humanities, entertainment and recreation, as well as advertising and marketing. Many studies have found that AR offers visitors interesting, enter-

taining and exciting experiences as well as shocking sensations (Chang et al., 2014). As far as educational applications are concerned, it has been reported that both teachers and students believe that AR not only promotes participation and motivation but also creates a realistic and new learning environment by combining both the real and the virtual (Chang et al., 2014). Studies have shown the effectiveness of using AR in education. The findings seem to suggest that it has contributed to increased academic achievement and promoted positive emotional experiences compared to traditional teaching (Ibáñez, Di Serio, Villaran, & Kloos, 2014).

Artwork

Nowadays, artists in order to make the interaction between the visual work and the observer, make use of various technologies and, above all, AR technologies. A well-known artist working with AR is Masayuki Akamatsu, an example of his work from 2012 is the ‘‘Uroboros Torch’’ (Masayuki, 2012). This exhibition consists of eight paintings in which the augmented reality is achieved by the use of a mobile phone. That is, the visitor has the ability to see through his cell phone parts of the paintings come to life, also the tables are connected with speakers that augment the reality for the visitor through the sound. It is observed that through these technologies the visitor interacts with the project by activating in addition to his vision, touch and hearing.

Artist John Craig Freeman also deals with the visual arts and the combination of augmented and virtual reality unlike Akamatsu though, his works are large-scale outdoor installations One of his recent works is ‘‘Mexico Border Migration Stories’’ 2017 (Freeman, 2017). The artist through AR allows viewers to be in two different worlds simultaneously offering mostly visual stimuli.

Another artist who deals with the political form of art and the use of augmented reality is Patrick Lichty. In his ‘‘Love Bombers’’ (Lichty, 2012) project of 2012 made a visual art political statement against the NATO summit in a Chicago demonstration where, over the protesters mobbing a cell phone the observer could see virtual planes bombing the mob with virtual hearts. This project connects a historical event to a geographical environment (Lichty, 2014). And in this project AR technologies provide visual stimuli to the public. This is not the only artwork of this artist, he has made a series of works linking the natural surroundings of Alaska with the present and the past criticizing industries exploiting the mineral wealth and destroying the environment. As the artist himself mentions in his work ‘‘Into the Wild / Virtual Kenai’’ of 2014, he portrays another form of conquest in the Anthropocentric Age (Lichty, 2014). In this way, his work falls within a historical context while still having a critical position. In this work the artist also used a QR-code technology.

Similar political, social and environmental concerns produce the work of Nathan Shafer ‘‘Kenai Tapestry’’ of 2013-14. This artwork consists of a large-sized woolen tapestry that portrays the Kenai Fjords National Park in Alaska

and is connected with real-time augmentation techniques by providing information on the location through the forest site. This artwork reflects the artist's concerns about nature and its destruction (Lichty & Shafer, 2016).

Subsequently, a different form of AR is found in the artwork of Golan Levin and Zachary Lieberman "Footfalls" (Levin & Lieberman, 2006). In this interactive projection the sounds that produced by visitors' feet are detected by microphones under the floor and used to determine the size and number of virtual objects (bubbles) that fall from a height of six meters. The less number of visitors experience the stumbling blocks, the more virtual elements fall from the top by projection. Also, visitors using their silhouettes can "move" the projected bubbles around them. It is noticed that when the visitor joins in (with all his body within the artwork and) his movements and the way he walks, are those elements that influence and shape the artwork. The visitor literally becomes one with this artwork, as he physically becomes part of his evolution, mainly by visual stimuli.

In addition to the image and motion AR is also associated with sound. One such example is the artwork of Mene Savasta Alsina and Hernan Kerlleevich "Ahora" (Alsina & Kerllenevich, 2013) which is an interactive sound installation. This sonic artwork varies according to the movement of each visitor. In other words, the presence of the visitor and his movement in the space modifies each time the composition, in a sense re-writing each time this composition in a different spacetime. This way, the visitor is physically integrated into the artwork and remodels the project through its movement. The stimuli that a visitor receives are mainly acoustic.

Another work worth mentioned is the "water shapes" (Papadopoulou, 2018), which is an audiovisual - visual artwork that deals with the subject of water and creates a visual interactive environment that connects sound, image and augmented reality in order to help the audience interact and immerse. The project is divided into two parts. In the first part, nine photographs are presented in which the use of a mobile phone achieves the augmentation of reality, as the visitor has the opportunity to see via his mobile phone these photos come alive. In the same space (part) there is a video art that enhances the sound. In the second part of the project, as the visitor moves into space, he activates a sensor and a perfume diffusion mechanism. In this way the sense of smell of the visitor is activated. As the visitor enters the second space of the work, light diminishes and the only light sources at this point is a holographic projection which is projected inside an inverted pyramid and an interactive projection with a virtual rain in which when the visitor approaches, he sees himself inside and his body drips up with water drops. The water drops follow the movement of the visitor's body in a rainy environment. Through holographic projection, a stable rain sound is provided in the room. Through five distance sensors connected to an Arduino system, different rain and water sounds are activated depending on the visitor's movement, each time setting up a different sound depending on

the traffic and the crowd of visitors. It is important to notice that through this artwork an effort is made to activate the visual, tactile, acoustic and olfactory senses of the visitor.

The Royal Academy of Art (KABK) and the Delft University of Technology Foundation set up an AR workshop in which two related research projects were developed. The aim of the first was to research and apply the AR technique in the arts, design the technology and dissemination of the technology to the creative industry. The aim of the second project was to combine AR with the interaction and diffusion of technology into public institutes such as museums. Through this collaboration, they have emerged a series of works that combine art AR technologies interaction with the visitor and work (Caarls, Jonker, Kolstee, Rotteveel, & Eck, 2009). This research will only mention a 2007 artwork titled "Out of the Blue", which is an augmented reality audiovisual environment in which the exhibition area was transformed into a blue landscape where elliptical shapes were floating and creating the landscape. As the visitor was moving around, he could see and hear around him a various of flying objects (Caarls, et al., 2009).

Finally, it should be noted that art and AR technologies are not tools exclusively for visual artists. They can be tools of expression and artistic creation for students as well. An example (a prototype one) is the four students of 1st E.E.E.E.K. Pilea-Chortiatis (Greek secondary special education school) who they presented at the 10th Student Computer Science Conference of Central Macedonia (2018) their visual work which was connected with AR technologies. The students took their own photos and they edited them using various techniques such as collage, or coloring, and they linked them through AR application to their new artworks. In this way they recreated their natural environment. With the use of a mobile phone, the observer could see these works.

Conclusion

Beyond the purpose and research questions raised in this paper, small-scale historical references were sourced in order to connect the concepts of interaction, AR and the arts. Historically the incorporation of AR technologies into the visual artwork and the need for the artwork to interact with the visitor, a series of artworks have been presented and analyzed. The artists with their artworks attempt to incorporate the observer into them by activating his senses both physically and psychologically.

Through this brief research it is realized that the visitor ceases to be just a simple observer but acquires an active participation role in the project, by formulating through his choices the form of the project he is visiting. It is also observed that artists are trying to activate as much as possible the senses of each visitor and not just his vision.

Most of the aforementioned projects note the need for an observer to use

his/her mobile phone devices so that he/she can read the augmentation of reality in each project. In two of the examples, it is observed that through an interactive projection the observer takes an active part in shaping the project by acting with the projection through the motion of his body. A similar configuration of the artwork, referred to the two examples mentioned was the sound work that was presented using different forms, analogous to the crowd and movement of each observer. Apart from the visual, tactile and sonic stimuli that were reported as offered examples to the visitors, one of the projects offered olfactory instigation.

It is remarkable to see that artwork through AR technologies is also evolving as a tool of social and political criticism by offering artists a basic expression for their positions and the involvement of visitors in the political and visual work. It was also noticed that as technology evolves, art evolves as well. Technology offers solutions and art exploits them. As a natural continuation of this research a larger-scale research should follow that will deal with the collection of visual artworks making use of AR technologies and promote as much as possible the interaction between the visual work and the observer. Through this new research, safer conclusions can be drawn about the use of these technologies in interactive art environment.

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