The Journey of a White Rhinoceros: Sculpture Augmentation for Gallery Exhibition

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ABSTRACT

Rhinoceros are huge and strong but now almost extinct. "White Rhinoceros" is a sculpture that was exhibited in 1993 and now placed in storage. Twenty years after "White Rhinoceros" was first displayed, a team of animation artists and engineers revived this outdated sculpture endowing new meanings, stories, and technologies. "The Journey of a White Rhinoceros", using Augmented Reality technologies, delivered messages to the gallery visitors on the greed and blindness of human being, the ecosystem of the earth, and imminent crises of natural disasters. Two projectors projected videos and animated special effects on the sides of the White Rhinoceros, and one movable large display was employed to show the augmented views on the rhinoceros as a background. "The Journey of a White Rhinoceros" was displayed for four days at a gallery attracting interests of many visitors, especially of young generations.

Keywords: Exhibition, Gallery, Sculpture, Interaction

Index Terms: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems – Artificial, augmented, and virtual realities; [Arts and humanities]: Media arts

1 INTRODUCTION

In most cases, gallery and exhibition visitors may appreciate an artwork by looking at the artwork itself. However, some artworks may need supplementary materials such as text description, oral explanation, or augmentation in order to provide background stories or author's messages.

Augmented Reality (AR) technologies have a great potential for enriching display items through interactions and connections between real and virtual contents. Authors may even inspire stories and messages to gallery display items. Messages may be closely connected to a display item as if the display item may become a role player or a messenger by itself.

In this paper, we presented a sculpture augmentation for gallery exhibition titled "The Journey of a White Rhinoceros". The exhibition was based on "White Rhinoceros", a sculpture made by an artist and professor Kyoung-Ho Ko in 1991. White Rhinoceros represented old generations once powerful and popular but now outdated and obsolete. After two decades have passed, a team of animation artists and engineers revived this outdated sculpture endowing new meanings, stories, and technologies.

Author's message on the ecosystem of the earth and imminent crises of natural disasters were presented to the visitors using AR technologies. A projection based augmentation showed videos and animated effects as if the rhinoceros is a narrator of the story. Animated characters and various vehicles were superimposed on the rhinoceros showing human history as if the rhinoceros is the Earth.

"The Journey of a White Rhinoceros" was displayed for four days at a gallery located in Seoul, Korea. Visitors, especially of young generations, were attracted and showed interests on AR presentations and interactions. According to a preliminary user study, most subjects felt that AR augmentation and interfaces were useful and beneficial, and increased the feeling of immersion and interactivity to the sculpture.

2 RELATED RESEARCH

Traditionally, text descriptions are still popular in museums and exhibitions while aural descriptions support guidance of visitor's attention [1]. However, multimedia contents provide opportunities for enriching visitor's experience [2]. Virtual museum is one of the promising approaches for providing stories and messages for museums and galleries [3][4]. Although virtual museums allow users to interact with the contents using Virtual Reality technologies, 3D contents are often not connected to the real display items geometrically or spatially.

On the other hand, AR technologies may enhance artwork appreciation and museum guidance [5]. Sensors may be employed to trigger presentation of augmented information through visitors' interactions [6]. Information provided by interaction enabled visitors to understand messages more easily and deeply. Tillon et al. applied AR technologies to enrich fine-art museum visits and education [7]. Visitors were given a mission to help the virtual curator update the museum collections. Lee et al. used AR annotations in order to guide museum visitors to artworks of their interest for selective viewings [8].

In this paper, we presented AR based sculpture augmentation, where 2D and 3D multimedia information was projected or augmented on the sculpture. The sculpture was used as a communication mean that delivers messages regarding human's greed and resulting devastation of the Earth eco-system.

3 SCENARIO

3.1 Overview

The original sculpture "White Rhino" was first exhibited at InSa-dong art museum in Seoul in 1993, to great acclaim. It was created by a renowned Korean sculptor and professor, Kyung-Ho Ko, who taught art making for years at Hongik University. He used to say on a number of occasions that his inspiration for this sculptural piece was to express an alienated, old fashion human-being through the visual metaphor of White Rhinoceros, reticent to the species near extinction. Returning to his piece after two decades, Professor Ko wished to re-exhibit his White Rhinoceros piece. But, not as before, he wanted to recompose it via a multi-media format for the twenty-first century: Professor Ko wanted to show a digitized image of earth through his White Rhinoceros. As

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rhinoceros continue to be a threatening species living in the wild, dwindling in number as they inhabit protected areas in Africa, they remain in the endangered species list due to illegal poaching and urban development. Much like the ceaseless environmental degradation of our planet by the onslaught of industrial revolution, wars, and decades of nuclear testing, the White Rhinoceros became a symbol of fragility, majesty, and hope in our age of global warming and accelerated globalization. Professor Ko then believed the advent of newer technologies—digital animation, sound design, graphics rendering, and Augmented Reality—would appeal to younger, environmentally-concerned spectators, and were thus crucial to reconceiving this sculptural series to adjust to changing audiences tastes and their new media literacy.
The synopsis is as follows.

3.2 Act I: The Beginning (Creation of the Earth)

The interior exhibition hall is cloaked in darkness and quietude. Suddenly, thunder threatens the spectators with a crackling boom, accompanied seconds later by flashes of lightening which are projected on the surface of the white rhinoceros sculpture. From here, clouds gather and paint the surface of White Rhinoceros with hints of red hot boiling lava. At this moment, a performer appears and starts mimicking our creator: he reaches his hand to the surface and waves. Then the surface reacts like the real clouds which spread away and the hot red lava is revealed to onlookers in the space. This is followed by the performer who leads a child spectator to the surface of the rhinoceros and lets him touch its surface so that the child can be given the allusion of Biblical creation.

3.3 Act II: The Advent of Human-being

Animals like zebras, cows, rhinoceros, and hyenas are seen lingering around a dune (which is actually the ridge of the rhino's nose.) A lion lies down at the top of the dune (which is actually the brow of White Rhinoceros sculpture) looking at the animals. While a rhinoceros climbs up the dune, men suddenly appear and attract the rhinoceros. The lion is surprised and jumps up to the horn of rhinoceros sculpture, which means the lion lost its power and human-being starts to reign over the world. However, the men (two primitives) fight each other, which represents the beginning of human conflict and then modern wars.

3.4 Act III: The Wars

Human being wages wars. History is a testament to this fact. In this interactive portion of the installation we find biplanes flying around the sculpture, reminding audiences of the World Wars and its mechanical destruction. Many tanks run on the surface of the sculpture, firing artillery from their turrets. Later, long legged robots walk through the trees, which evoke the technological evolution of warfare we will undoubtedly soon face. (Industrial revolution and wars)

3.5 Act IV: The Future

In the future and in our actuality, human-being puts profit before natural environments, and capitalism before ethical responsibility. The ecosystem is in a state of ruin, so serious that many animals have disappeared completely from the planet. Only whales and fish swim in the polluted oceans. A polar bear anxiously sits on a small iceberg which is seen melting and splitting apart underneath his weight. (Global warming)

4 Design and Development

4.1 Modeling and Animation

Photographs were taken to measure the dimensions and create a 3D model of the rhinoceros sculpture (Fig. 1). Adobe Mocha was used for model creation. We had to do tedious modeling process several times so that the 3D model is close to the physical rhinoceros sculpture.
Using Maya, characters (two human primitives, a zebra, a lion, a cow, a rhinoceros, a hyena, a polar bear, a whale, etc.) and other

Figure 1 Rhinoceros Modeling

Figure 2 Character and Item Models

items (tanks, airplanes, a robot, etc.) were created along with their animations (Fig. 2). Animation trajectories of the most characters were created based on the rhinoceros model so that they may move on the surface of the rhinoceros.

4.2 Hardware Deployment

Two types of AR technologies have been employed to deliver the messages to the visitors: projection-based and large display based. Projectors were used to project videos and animated special effects on the sides of the rhinoceros. Depth cameras were installed with the projectors in order to detect user's hand motion and deliver special effect animations accordingly. A movable large display was used to present augmented animations on the rhinoceros sculpture. Fig. 3 shows the overview of the hardware deployment. Fig. 4 shows installed hardware components. White Rhinoceros was placed on a base so that average height visitors

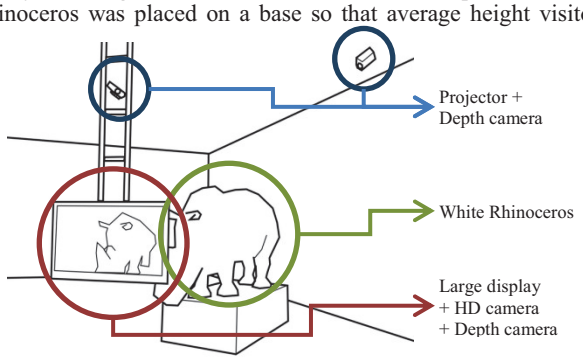

Figure 3 Overview of the Hardware System Installation

may observe through the large display comfortably.
For projection-based AR, low-end notebook computers were used to perform rendering and gesture interactions. However for large display based AR, two high-end desktop computers (GPU was GeForce GTX 580, 512 CUDA core, 797MHz graphic clock) were used: one for tracking and the other for rendering.

Figure 4 White Rhinoceros and the Hardware System in the gallery

4.3 Projection-based Augmentation

Two projectors, along with 3D depth cameras, were installed on the ceiling of the gallery. Through off-line calibration, the projector-camera relationship was estimated, and the distances to the White Rhinoceros from the depth camera were measured.

Figure 5 Projection based Augmentations: a video of wars

Figure 6 Projection based Augmentations: special effects triggered by hand gestures

Two types of contents were delivered: videos and the animated special effects. Videos showed the beginning of the earth and the wars that devastate the Earth (Fig. 5).
We had two intentions to project videos to the rhinoceros instead of the walls. By projecting on the rhinoceros sides, White Rhinoceros seemed to play as a narrator. Another point was that the rhinoceros played a role of the Earth itself. It looked like that the Earth (White Rhinoceros) was created in the midst of chaos (thunders and lightening).
The second type of contents was animated special effects. In order to allow visitors to interact with the display contents (in this case, the lava under the clouds), we enabled interactivity. When the visitors waved hands on the side of the rhinoceros, their hands were detected through blob detection. Then, another animated special effect was rendered on the side of the rhinoceros following the hand trajectory.
For animated effects, we used programming tool called Processing with 3D depth cameras (Microsoft Kinect, for hands detection and tracking). Processing is an open source programming language and environment for creating animations and interactions [9]. Originally developed for serving as a software sketchbook, Processing was designed to teach fundamentals of computer programming within a visual context. However, it now has evolved into a tool for generating finished professional work of prototyping and designs. Fig. 6 shows user's interaction to reveal red lava under the clouds (story of Act I). By performing gesture interactions, visitors may have a hands-on experience of participating in the creation of the Earth.

4.4 Large Display based Augmentation

A 42" display monitor was installed under a frame, which is connected on a ceiling rail. The rail was used in order to guide the display panning trajectory (in a half circle around the head of the rhinoceros). However, the display motion was unstable because the ceiling was very high. For stability of display movement, we extended display frame to the floor and installed wheels in order to support the display unit (Fig. 7).

Figure 7 Large Display based Augmentations

Figure 8 Large Display based Augmentations

On the backside of the display, two cameras were attached: a 3D depth camera (Microsoft Kinect) and an HD camera. 3D depth camera was used for AR tracking: we used Kinect Fusion algorithm [10] based on captured depth information. An HD camera was used for composing AR view of White Rhinoceros.
Using large display, animated scenes of the advent of human-being, wars between nations starting from fight between two men, and future of the earth which is devastated are shown (Fig. 8). In

the last scene, only whales and fish are left in the ocean. Animations were generated on the top or around White Rhinoceros head.

5 Exhibition

Usually in the exhibitions, visitors are not allowed to touch the sculptures. Furthermore, many modern artworks employ display devices, but visitors often have difficulties to interact with display monitors and projected contents. "The Journey of a White Rhinoceros" is a touchable and interactive artwork with various visual and audio contents.

"The Journey of a White Rhinoceros" was displayed for four days at an Art gallery located in Gangnam, Seoul, Korea. Because the story and interaction sequence was complex, visitors did not know what to do or how to perform interactions in the beginning. Therefore, a trained performer (guide) showed the sequence of interactions for appreciation.

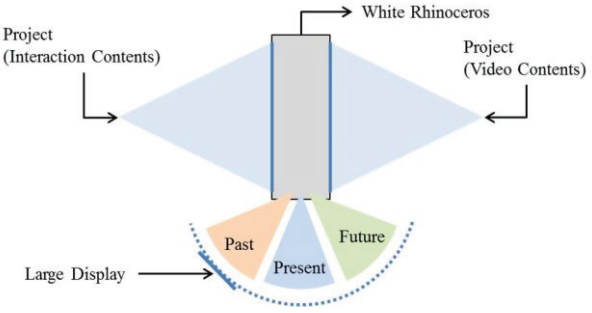

Figure 9 Contents Overview

Interaction was performed according to the scenario (from Act I to Act IV). Videos and special effect animations of Act I was played first on the left side of the rhinoceros. Right after Act I video was finished, the guide moved to the large display from the past position (left) to the present and to the future positions (Fig. 9). While animations were shown on the large display, videos of wars were played on the right side of the sculpture. After the guide's example, visitors could perform the interactions in no time, and were amused with interaction contents. Fig. 10 shows an overview of the scenario presentation.

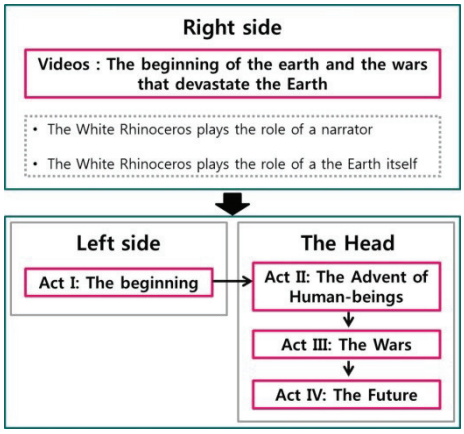

Figure 10 Presentation Overview

Illumination was an important factor for this exhibition. Under high intensity illumination conditions, the visitors could easily see sculptures, but most visitors had difficulty in perceiving augmented contents, especially projected contents. However, under low intensity illumination conditions, some visitors complained that they could not fully appreciate the sculpture itself.

6 Visitor Feedback

We have performed a preliminary user study in order to discover how this AR-based exhibition affected the visitors' experience and appreciation. The survey included questions to determine the degree of understanding of the overall story, convenience of the AR interface, correlation between interaction methods and the story, and the degree of immersion to the story and the multimedia contents. Visitors were instructed to evaluate AR-based interactions in 5-point Likert scale. Subjects were also asked to provide their opinions for open questions in order to obtain comments and suggestions. The tests were performed with nine exhibition participants and observers.

Six of the subjects felt that AR technologies helped understanding the story. They said that panning the display unit was useful, allowing them to observe the virtual contents in 3D. Seven subjects mentioned that interface itself was intuitive and convenient to manipulate. Only one subject indicated that she had difficulty in manipulating the AR interaction interfaces. She explained that the interaction sequence is complex and confusing. Although most subjects thought the interface was intuitive, three people mentioned that they could not find close connection between the interaction and the story. One of them stated that the exhibition was rather focused on introducing AR technologies than presenting the story. Another subject noted that the story was too complex and deep, thus it was difficult to understand the author's intention merely through some interactions. On the question asking the degree of immersion, five subjects answered positively. Six of the subjects liked the time shifts from the past to the present and to the future by moving the large display. One of the subjects added that time transition effect (as if riding a time machine) would increase the feeling of immersion. One subject indicated that the sound effect greatly increased the feeling of immersion especially for Act I.

As a summary, most subjects agreed on the benefits and usefulness of the AR augmentation and interfaces, which increased the feeling of immersion and interactivity to the sculpture. However, the manner that the technology was introduced was not closely associated with the story and multimedia contents. Intuitive and tightly artwork-related interaction methods need to be designed and developed so that visitors may access interaction interfaces without guidelines. For example, "Text Rain" was designed not to be accessed with a guide but to be intuitively addressed for pleasure and fun [11]. Another negative feedback was regarding the complexity of the story and interaction. It may be worth to evaluate whether simple interactions and fun stories are more suitable for AR interfaces than deep and complex ones.

7 Conclusion

In this paper, we presented a case study where AR technologies have been applied to a sculpture for a gallery exhibition. The sculpture "White Rhinoceros" was revived through AR and story inspiration after 20 years since it was first displayed. Author's message on the ecosystem of the earth and imminent crises of natural and artificial disasters were presented to the visitors through projection-based and large display-based augmentations. Although the rhinoceros itself was static and irresponsive, AR enabled interactivity and augmentation.

One of the biggest issues during the exhibition was the illumination condition. Bright illumination interfered observation of projection based contents, while dark illumination prohibited

appreciation of the sculpture itself. We learned a lesson that if scenario is planned to switch illumination conditions, visitors may fully appreciate both the sculpture and the augmentations.

Most visitors, especially young generation visitors, showed interests on AR presentations and interactions. We received many positive responses from the gallery visitors that AR technologies enhanced the understanding of the story and the feeling of immersion to the multimedia contents. However, some visitors indicated that the interactions and the contents were not closely related. Content-oriented interaction methods need to be designed and developed so that the technologies may be hidden behind the artworks. In the future exhibitions, we plan to design rich intuitive interactions so that the artwork may "speak for itself".

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