
Aura Garden: Collective and Collaborative Aesthetics of Light Sculpting in Virtual Reality

Figure SEQ Figure * ARABIC 1. Screen shot of *Aura Garden* Virtual Reality Environment

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Abstract

Aura Garden is a Virtual Reality environment where participants can create their own light sculptures using a physical wand and customizable tools. They can also

create light sculptures by themselves or with a person in a networked virtual environment using various visual/temporal effects. In the *Aura Garden*, participants can experience light sculptures from different perspectives, in static or animation, and with different surface effects. Each sculpture will remain in the space and be part of the *Aura Garden* unless a participant decides to remove it. The real journey starts when a participant navigate around the space and discover other participants' creations. We use consumer virtual reality product, HTC VIVE: a head mounted display, a controller, and a motion tracker.

Author Keywords

Light Sculpture; Virtual reality; immersion.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction

Light has been a great inspiration to artists. Many artists utilize natural or artificial lights as the main medium of expression. Light travels through space and transforms space by illuminating. Artists plays with light exploring different aesthetic aspects including time, reflection, illumination and so on. Because of the natural characteristics of light, we only experience light arts in temporal and spatial constraints. We have been fascinated by the aesthetic and affective qualities of light and explored embodied qualities with physical materials in a virtual environment. In our project, *Aura Garden*, we have been inspired by light painting photography. Light painting is an experimental photographic technique in which exposures are made by moving a hand-held light source while taking a long exposure photograph, either to illuminate a subject or to shine a point of light directly at the camera, or by moving the camera itself during exposure [1].

Augmentation of Light Painting Experience

Light painting has inspired artists with the technique capturing kinesthetic qualities of light (Figure 2). Even though light paintings often create interesting results, it is quite limited experience. Light paintings can be appreciated only when it's finished. The artist team was curious about how we could expand the experience of light painting experience so that a participant could experience new things normally not possible during their creation or until they finished. We explored the different dimensions the light painting experience. Key components that makes light paintings unique are light source, environment, time, and movement. Recent virtual reality technology makes it possible to transform and deconstruct the multi-dimensional experience of light painting. Our project, *Aura Garden* explores collective and collaborative aesthetics in VR using physical and digital tools.

Embodied Immersion Through Creation

We conceive of immersion as any experience where integrated bodily, conscious and pre-conscious states thoroughly intertwine with the world. Immersion in interactive art contexts means that mind, body and environment interweave between environments/nature and the human. The mental and physical merge like the seashore and communicate with each other inside of technically-mediated, spatially enclosed, and sensuously-interactive computational environments. In immersive works, people's bodies become the main media triggering the creation of interactivity and immersion. Once the senses reach a sufficient belief that the digital environment is real, the user must then be able to interact with the environment in a natural, intuitive manner. Various immersive technologies such as gestural controls, motion tracking, and computer vision respond to the user's actions and movements [2].

Aura Garden explores embodied immersion in the virtual reality through art creation using a physical light

Figure SEQ Figure * ARABIC 2.
Light Painting Examples

sculpting wand. The tactile sense is significant to understand the world. Hands bring us knowledge of the world [3]. Embodied action works with other senses and creates synthesized experience. Also there is an experiential quality that is not just a sum of visual, tactile and audible senses. People perceive in a holistic way with their whole being [4].

Aura Garden

Concept

Figure . 360-degree night panoramic images used in *Aura Garden*

Aura Garden is a Virtual Reality environment where participants can create their own light sculptures using a physical wand and customizable tools. They can also create light sculptures by themselves or with a person in a networked virtual environment. *Aura Garden* provides a dozen built-in tools to get a participant started. Each tool has different visual/temporal effects and unique characteristics that suggest different ways of moving in the space to create various sculptural forms. In the *Aura Garden*, participants can experience light sculptures from different perspectives, in static or animation, and with different surface effects. Each sculpture will remain in the space and be part of the garden of light sculptures unless a participant decides to remove it. The real journey starts when a participant navigate around the space and discover other participants' creations.

Connected Spaces

Aura Garden has four connected spaces. A participant can navigate different spaces by teleporting themselves and creating artworks in any space. Each space was created using a 360-degree night panoramic image [Figure 3]. The spaces transition between each other as the participant explores and teleports to new locations. We believe that different environmental images will inspire participants to create their sculptures reflecting the aesthetics of each environment.

Hardware + Software

We use a consumer virtual reality product, HTC VIVE: a head mounted display, a controller, and a motion tracker. We implemented a motion tracker at the end of our wand design. A participant holds the wand in one hand to select effects and create sculptures and a VIVE controller to start/terminate a light sculpture and to pick different tools. The application has been developed using Unity3D.

Creation of Light and Kinetic Sculptures

Aura Garden virtual reality application provides a simple menu system for tools and effects. As soon as a user selects a material and effect, it visualizes in the middle of the menu. That helps a user visualize the final result of their creation.

Physical + Virtual Creation Tools

We developed a custom wand tool to allow participants greater range and freedom of motion in the creation of

their sculptures (Figure 4). The 3D printed prop matches the wand tool used in the VR space providing a physical, tactile connection to what the participant sees in the experience. The unique form and balance provide for patterns of motion special to our VR experience and different than what is typical of a Vive controller. This wand prototype is being iterated upon to find a design that is both visually and functionally appealing (Figure 5). Being two feet total in length, the staff was split into fourths and printed separately on three Ultimaker 2's.

Brushes + Materials + Effects

From the menu the participant can choose from different Brushes, Materials, and Effects. All of these properties change the sculptures that are created by the participant (Figure 6).

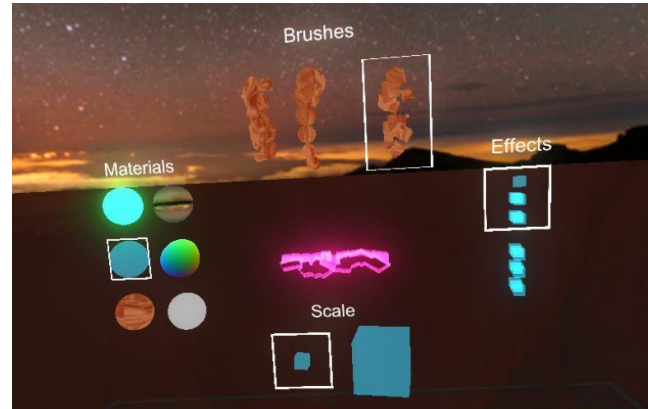


Figure 6. Interface for Brushes, Materials and Effects

The Brushes are displayed as 3D models in the menu to give the participant an idea of what a final sculpture will look like. When the participant actually uses a brush a cross section of the 3D model is used (Figure 7). This reduces how much geometry is being generated when a

participant makes a sculpture and creates cleaner geometry.

Figure 7. Left: The displayed menu 3D brush models, Right: The cross sections which generate the sculptures

Light Sculpture Park provides 6 different materials for the sculpting stick.

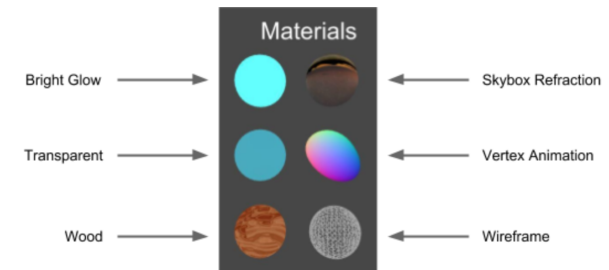


Figure 8. Materials for Sculpting

- Bright Glow: A glow shader that most resembles an actual light source.
- Transparent: A transparent shader that simulates a slightly emissive object
- Wood: A procedural wood shader
- Skybox Refraction: A refraction shader that uses the current skyboxes cube map.
- Vertex Animation: A animating vertex shader that is colored based on normal directions.

- Wireframe: A wireframe shader that uses the current brushes geometry.

The participant can modify the color of the shaders by touching the thumb pad of the Vive controller. This allows for a wide variety of possible material options. The participant can change the color dynamically as they are painting to create multicolored sculptures.

The last two options the participant has in the menu are Animation and Scale.

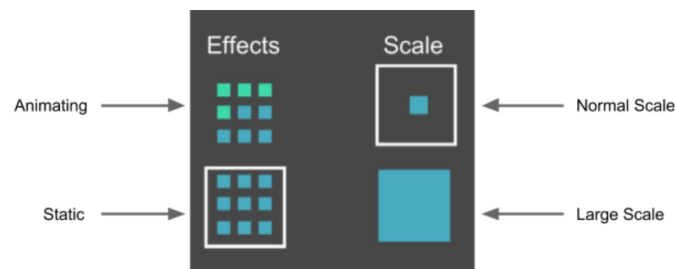


Figure 9. Effects for Light Sculpting

- Animating: When this option is chosen the length of time the participant uses to create each cross section is recorded and stored. When the sculpture is completed the motion is continuously looped. Since each cross section records how long it took to be created the motion of the participant is played back exactly as they created it. This allows participants to create kinetic sculptures that truly reflect their movement.
- Static: The sculpture is static and doesn't animate. Allows players to emphasize form over motion.
- Normal Scale: The scale of the brush is not modified. This option is good for making more precise paintings.

- Large Scale: The scale of the brush is increased by a factor of ten. This allows for participants to create sculptures that are on architectural scales.

Temporal + Kinetic Visualizations

To encourage participants to explore and move around the space the amount of sculptures that can be created in any one area is limited. This limit also helps to ensure that the frame rate of the application stays at high levels to avoid motion sickness. Once a participant has reached this limit they can either delete their creation or teleport to a new location.

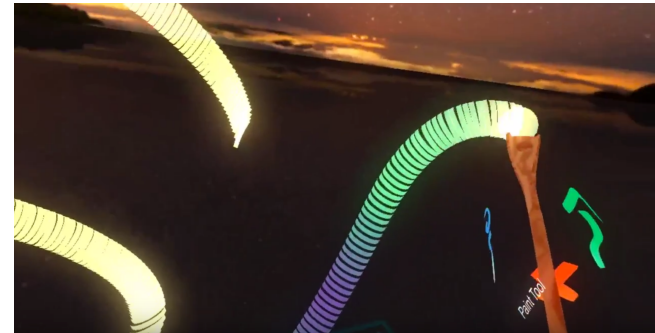


Figure 10. A participant is creating a light sculpture in the *Aura Garden*

A key feature of *Aura Garden* is allowing the participant to move around the space. This can be done through teleportation, the participant simply switches to the teleport tool and points in the direction they wish to travel. When a player teleports far enough away the sculpture is hidden and a beacon appears to mark its location. When this occurs the player is once again able to create more sculptures. Sculptures are persistent and can always be returned to.

Sculptures can also be locally saved and loaded. This allows for a participant to continually work on a scene and be able to work in the same space over multiple play sessions. Another benefit of being able to save is

having participants be able to experience other user's sculptures. When a scene is loaded participants will be able to see distant beacons that other users created. This encourages exploration and provides participants with inspiration for their own creations.



Figure 11. Navigating Aura Garden

Collaborative Sculpting

An extended version of Aura Garden allows for two participants to simultaneously work together in the same virtual space. The participants each have their own wand and Vive and can move independently of one another. Special beacons indicate where each participant is so that they can locate each other. Participants can synchronize and coordinate their movements to create otherwise impossible sculptures. Knowing that another person is actively working in the *Aura Garden* with you makes the whole experience feel more collaborative.

Discussion and Future Direction

From the local demos, we learned that *Aura Garden* becomes an aesthetic tool for *visualizing various motion*. Photographers who have done light painting photography before were very peculiar about creating detailed shapes with thin brushes. They enjoyed multiple perspectives of light sculpturing. They walked around their sculptures and focused on detail effects.

However, dancers have enjoyed visualizing their movements in the space and played with them.

Future designs will have various forms of the magic wand allowing wearable and different kinds of motion like spinning, rolling, swinging, etc.

Setting Up Aura Garden at CHI 2018 Art Exhibition

Aura Garden can be installed in a space with a typical HTC VIVE VR setup. If possible, we would like to setup a projection screen so that audience members who do not wear a VR headset can still explore the environment with a participant with a VR headset and controllers.

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