Remnance of Form: Interactive Narratives through Unexpected Behaviors of a Shadow

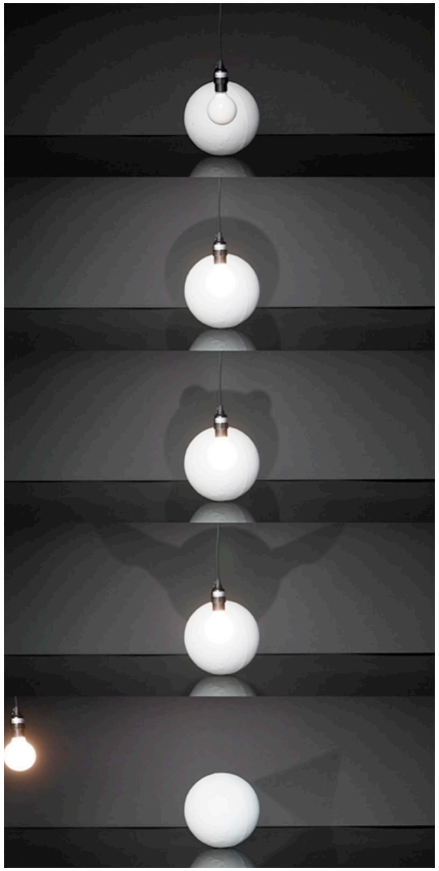

Figure 1. A digitally controlled shadow allows the alteration of reality, in a form of a visual augmentation in a subtle, yet, compelling way

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Abstract
Remnance of Form is an interactive installation that explores the dynamic tension between an object and its shadow. By fusing light, projection, and motion technologies, the shadow can now detach itself from its former role. This creates a new narrative that challenges our perception of reality, what's real and what's not. Through several playful vignettes, the shadow interacts with viewers' presence, body posture, and their manipulation of the light source creating the shadow.

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Human Factors; Design

Introduction
We are now in an age where technology has seeped into every corner of our existence, and myriad forms of mediated reality have become increasingly accessible, sophisticated, and robust. As a result, we expect to see a correlating evolution in our perception and experience of reality as we examine and challenge long-standing concepts surrounding our relationship to space, time, light, shadow, and physical objects.

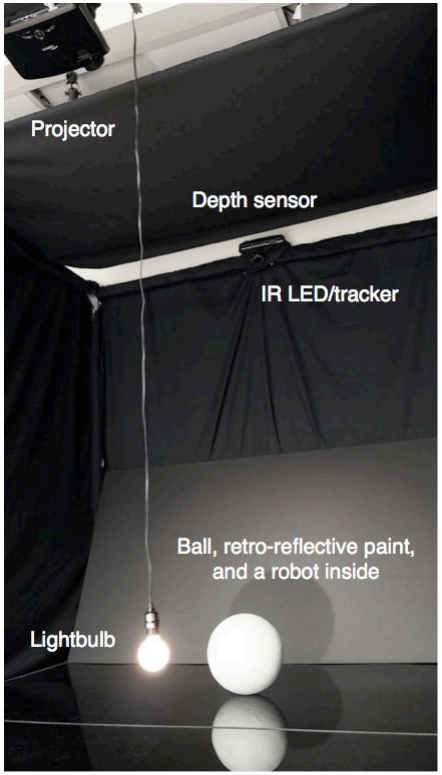

Figure 2. The setup of our installation

In this work, *Remnance of Form*, we modulate and distort the relationship between simple, mundane objects and their shadows in order to shift and extend the perceived nature of the object as well as our own generally accepted notion of what's real and what's not. By presenting a series of interactive vignettes, we hoped to create an art piece that examines the fundamental human perception of reality on one level while fostering a deeper connection between viewer and the object/shadow relationship.

On a technological note, we instrumented a highly calibrated augmented reality system to imitate and simulate the reality in a form that is indiscernible from the pure reality. The presented installation deliberately demonstrates the notion that augmented reality systems are not merely to provide additional layers of information but are capable of making active alteration to the reality – letting the digital world more seamlessly and tightly seep into reality.

Related Work

Shadows are direct and dimension-reduced projection of the physical world, and this fact lets artists utilize shadows as media for creative expression. Artists have created light/object sculptures to explore the tension between an object and its shadow [4, 7]. More interactive pieces include *Treachery and Sanctuary* [3], *Shadow Bag* [6], and *Shadow Inverted* [5]. They used cameras to capture the viewers' body silhouette to programmatically create and tweak the shadows of the viewers. The metaphor of shadow was also adopted in interactive tabletop systems [2, 10]. The most relevant work to ours is *Parade* [1], where the artists tracked the fake light source's motion to create seemingly impossible shadow animation when the light source moves. Our work takes a step forward, technically, by tracking both the light source and objects to create a more realistic experience, and philosophically, by distorting the relationship between the viewers and a mundane object through direct and embodied interaction between them. In addition to that, in one of the presented vignettes, we incorporate robotic technology to control the ball programmatically, pushing the experience beyond visual augmentation.

Figure 3. Openframeworks software tracks the positions of light bulb, the ball, and the viewers of the installation.

Setup

The entire installation was set up in a cubic structure of 8 feet x 8 feet x 8 feet, with black fabric wrapped around to reduce the interference of natural light with our tracking system. Three entities (a white ball, a light bulb, and a shadow) are presented to the viewers. Using Kinect v1, we track the positions and body postures of the viewers. The shadow's position is computed based on tracked positions of the ball and the light bulb; therefore, moving either of them will change the size and position of the shadow. For the ball

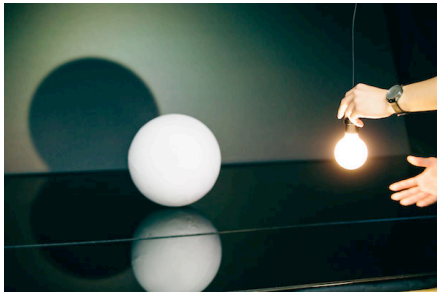

Figure 4. The setup allows manipulating the light source to change the position and size of the shadow

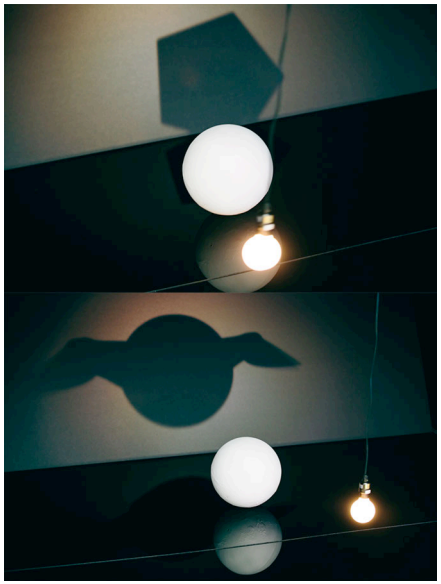

Figure 5. The shadow can be shaped programmatically, into any shapes.

tracking, we put retro-reflective paint layer on the ball and captured it using a Pointgrey camera and infrared (IR) LED array. In this way, reliable tracking of the ball could be achieved.

Shadow Effects
We used an Optoma HD131 3D projector to create lighting and shadow effects. The high lumen and the imperceptibly low latency of the projector allow successfully overriding the natural shadow of the ball. A computer generated Gaussian Blur effect in addition to out-focusing of the projector let the blurry boundary of the computer-generated shadow look even more realistic with light-scattering effect. The shadow created by the light bulb is removed by covering the floor with reflective acrylic layer and by using a white-coated bulb to diffuse the light.

Robot
A Sphero 2.0 robot controls the ball movement by rolling inside the ball. As the 2D position of the ball is tracked in real time, the system can control the ball to move to a certain position within the setup.

Interactive Exhibit

The proposed setup allows direct manipulation of the light bulb. It is notable that, as the light bulb starts to swing like a pendulum, the computer-generated shadow becomes much more realistic because our mind automatically picks up the synchronized motions of the light bulb and the shadow. This, combined with the viewers' presences and body postures, allows the interaction between the viewers and the ball with its shadow to become more playful and perceptively appealing. In totally, we present five unique vignettes.

Disappearing
The shadow disappears on a viewer's approach. This vignette is designed to experiment with the most subtle shadow effect; as we typically don't pay much attention to shadows due to their ubiquity, this experience requires some degree of attention to recognize the shadow's absence.

Showing Fear
The shadow shows spikes growing out of itself on the viewer's approach, much like hackles on the back of an animal. The more people approach the setup, the bigger the shadow's spikes get – showing a degree of escalation from alarm to hostility. Viewers can learn by experimentation that they can disarm Shadow; for example, if the viewer lowers body posture, the spikes disappear. Through this animal-like behavior of the shadow, viewers start thinking of the inanimate ball as an animate and spiritual entity.

Changing Shape
This vignette experiments with the unexpected behavior of the shadow that is only discoverable through direct manipulation of the light bulb. As the viewer moves the light bulb around, the shadow will change its shape creating a surreal experience (Figure 5 top).

Dream of Flying
This is a unique mode only triggered when the system is inactive for a long time. When there are no people approaching the installation for a long time (~40s, configurable), the shadow turns into a flying ball trying to attract people's attention. The shadow returns to its original behavior as soon as someone approaches the setup (Figure 5 bottom).

Figure 6. Interacting with the installation.

Possessing the Ball
In this mode, the shadow takes control over the ball and invites a viewer to play with it. As the viewer approaches the ball, the ball rolls to the opposite side from the viewer. This mode demonstrates an idea one-further step towards digitally altered reality. Beyond subtle visual effects, a sufficiently mature augmented reality system would be capable of changing the real physical world.

Conclusion

We presented *Remnance of Form*, an interactive art installation designed to give a distorted perception of a simple mundane object through visual augmentation of a shadow combined with actuation of the object. The installation comprises multiple vignettes demonstrating various degree of alteration of perceived reality and interaction models. More importantly, through this work, we tried to fuse concepts across different paradigms including Tangible User Interfaces [9], Augmented Reality [8], and Ubiquitous Computing [11]. We hope the installation stimulates more discussion about the fine boundaries among the paradigms and their potential collective integration into the real world as a single media.

Acknowledgements

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