Robotically Augmented Imaging (RAI Alpha)

Spatial Experience Customization Using Robotic Imaging as a Design Tool

ABSTRACT

This paper presents a project-based research study in the design studio context, highlighting the use of robotic technology as a “perspective-machine” to create custom spatial readings/experiences through predetermined and controlled static/dynamic views. The early studies of this method—in this paper referred to as Robotically Augmented Imaging (RAI Alpha), enables architects, designers, and students to micro-direct the “spatial experience” and atmospheric effects of the project through visual story-telling and in multiscale set-ups ranging from architectural to product and object scale.

Demonstrating the contemporary opportunities of imaging and perspective—as an architectural tool to investigate/define the space—RAI Alpha studies the potentials of robotically controlled/manipulated views as a possible new medium for interacting with form, space, architecture, atmosphere, and performance in a scale-free seamless experience and as both a design tool and a product.
INTRODUCTION
Two-dimensional static graphical drawings have always been one of the primary methods of visual communication about form, space, composition, and proportions, as tools for both representation and simulation, and to document existing conditions or propose possible ones. Perspective drawings became the primary media to think about architecture, volume, and space. Development of tools such as forced perspective in architecture or hierarchical perspective in painting was followed by the invention of other tools, such as perspective-machines that enabled designers to use perspective to go beyond representation by introducing multiple political, social, volumetric, and spatial layers to their perspectives.

With the rapid growth of digital design in the past three decades, digital design tools now have become the primary platforms to document and propose a design, especially in the field of architecture. 3D modeling software platforms as new generations of “perspective-machines” produce hundred thousands of perspectives in real-time, enabling the designer to study and understand the design from almost every possible view through a virtual camera. Although this possibility has tremendously affected the design and fabrication process, it has not affected the user’s spatial experience in a compatible way. In other words, although digital platforms enable the designer—regardless of the scale of design—to design and study qualities of a project in its full capacity using different digital views and perspective, s/he is not able to communicate those qualities with the final user because it is not possible to “translate” the virtual camera into a physical experience.

In his article “Postarchitecture,” Güvenç Özel calls for a combination of virtual and actual, and argues that our surrounding “space” is a hybrid of both physical materials and electronic bits (Özel 2016). Considering these issues and ideas, RAI Alpha suggests a new generation of “perspective-machines” to connect the worlds of digital design and tangible/physical experience in a hybridized way. The designer not only can communicate the design—spatially and three-dimensionally—but also can walk the user through as custom perspectival “atmosphere” using curated perspective views and providing an experience using a perspective-machine that “thinks” digitally and “acts” in a physical world: a Robotic Camera (Figure 2).

Robotics as a Design and UX Medium
From the public introduction of robots in the 1950s, there has always been an interest to think about them as extensions of our body, mind, imagination, and even space. However, as Greg Lynn points out in his article “Robots,” the construction industry is decades ahead of the design industry when it comes to using robotic technology. In the late 80s Lynn called for revisiting architectural communication methods—mainly drawings—as they are not efficient for talking to machines (Lynn 2008). Later by increasing the use of computer numerical control (CNC) machines and robot arms as fabrication tools, the dialogue between design platforms and machines started to reform and immediately after, many creators and designers began to think about creative approaches to use this newly bridged hybrid cyber-physical world. Projects such as “Robotic Softness” (Brugnaro et al. 2016); Bartlett RC4 and multiple “chair” projects (Soler, Retsin, and Jimenez Garcia 2017); and ICD/ITKE Research Pavilions—2013-14 research pavilion for instance (Yunis et al. 2014)—to name a few, challenged the conventional ways of thinking about robots in the realm of fabrication through new means of communication or fabrication.

Although novel robotic fabrication and making methods are always welcome in the field of digital design and fabrication, and are crucial for the creative design world, there is a missed opportunity to use the performative aspects of robots as a vehicle for design/special experience and as active agents, where the motion itself can be designed. In other words, in some of the mentioned projects and similar ones, although the process is tremendously innovative, the performance/agency of the robot follows conventional thinking methods of “engineered” efficiency in finding the optimized “path” to perform a task or avoid any accidental
collisions. These optimizations are the result of default robotic controlling/programming platforms and mindsets that are industry-native.

Later as a response to the mentioned controlling needs, some professions, academic set-ups, and creative platforms started to develop new methods for interacting with robots through design software platforms with a focus on designing the motion of the robot as well as its functional operation. The Esperant.O platform at Sci-Arc by Kruysman-Proto, BDMove at Bot and Dolly and UCLA, by Bot and Dolly, and RobotAnimator by Andy Flessas are some examples of these intuitive controlling platforms. As a result during the past decade, robots have been used profoundly as creative design tools in multiple different design-related categories, such as material exploration, interaction design, motion simulation, experimental fabrication, and light drawing/printing to name a few.

As part of these non-productional robotics approaches, one of the creative/design-oriented uses of robotic technology, on which RAI Alpha focuses, is robotic videography as a take on machine vision. In his book *Robot House*, Peter Testa explains how through these techniques image is not limited to be a representation but becomes a design tool itself as part of Sci-Arc robot house (Testa 2017). The “Impossible Objects” design series by Kruysman-Proto and Curime Batliner (Kruysman-Proto 2011), and the “Aether Project” by the Güvenç Özel studio at University of California Los Angeles ( Özel 2013), are some other examples of similar thinking about spatial qualities of imaging (Figures 3, 4). Another familiar example of the use of robotic videography to curate an atmospheric spatial effect is the work of Bot and Dolly—the creative robotic studio behind designing and shooting special effects for the film *Gravity*.

METHODS | ROBOTICALLY AUGMENTED PERSPECTIVE (RAI ALPHA)

The primary goal of this research—in this paper referred to as RAI Alpha—is to examine the potential of robotic imaging and videography as a design tool to not only represent the design/built architectural artifacts but also to add another layer of design/experience inputs through the videography process. As a project-based research study, and to analyze the potentials, limitations, and delimitations of RAI Alpha method, we study two projects: *4D Graphics* and *Hetero[Animo]Geneous*.

This article intends to question—rather than answer—as a way to emphasize design possibilities of robotically controlled imaging. Both from visual/conceptual and applied point of views, RAI Alpha and the two proposed projects, have developed around two central research themes: (a) using robotic videography as a tool—or even
possibly a medium with some agency, to produce design feedback during the design process, and (b) investigating on the potential of RAI as a medium for experiencing the outcome of the design.

4D Graphics | UCLA IDEAS Campus, 2014

The 4D Graphics project is a study on how RAI Alpha method can enhance the potential of an "architectural" advertising package as a branding method through curated camera views. Using robotically animated camera as viewers' point of view, 4D Graphics takes the viewer on a spatial/atmospheric experience through a three-dimensional advertising poster for the UCLA SUPRASTUDIO program.

The initial core of 4D Graphics is an object: a volumetric infographic piece as a three-dimensional "poster," fabricated and wrapped with UCLA SUPRASTUDIO program information (Figure 5).

Since the "poster" is a three-dimensional object, to interact with it, it is necessary for the viewer to know how to move around the piece pricelessly to receive the information cohesively. Using RAI Alpha method, we hired a combination of two robots to both animate the object and the viewer’s “point of view”. Using BDMove—Bot and Dolly’s custom plug-in for Autodesk Maya to animate the robots, and through a choreographed curated motion of the robots, we were able to translate digital views and camera into
physical ones. This setup enabled us to walk the audience through a customized spatial advertising/branding story highlighting the technological and educational atmosphere and the design culture of the UCLA IDEAS campus (Figure 6, 7 and 8).

As part of the branding package and using the combination of 360-degree recording camera and VR headsets, the audience could also experience the designed camera motion in a more holistic way (Figure 8), where the “eyes” of the robot could potentially be the eyes of the viewer in a curated fly-through.

Hetero[Animo]Geneous | Kent State University, Robotically Augmented Design (RAD) Lab 2019

The Hetero[Animo]Geneous project, as part of the third year undergraduate design studio at the College of Architecture
and Environmental Design at Kent State University, studies the possibilities of RAI Alpha as a medium to advance representation and development.

As part of the promises of studio to hybridize the digital and physical experience in both design process and its outcome, students have been asked to produce conceptual models looking at Tom Wiscombe’s “super-component” idea borrowed from flat ontology of the OOO conversation (Wiscombe 2014). Using Oriole—a custom-made robotic videography plug-in for Grasshopper 3D—each student developed a robotic camera path to be executed physically (Poustinchi 2019). Using multiple camera settings, lighting, and physical set-ups, students studied their physical models through the lens of the robot arm as a feedback method to inform their design decisions (Figure 8, 9, and 10). This hybridized “camera” enabled students to revisit their physical models—as the tangible result of their initial design process, with the precision of digital camera and through a curated lens/experience (Figure 12).

As the result of this process, students were able to augment their design projects, and design back and forth in a hybrid digital-physical setting, exploring the tangible design possibilities of the projects in a physical yet curated journey, through and around their physical models. Combining the “imperfections” of the real world and the precision of digital platforms, students used the existing gap as a creative design tool to re-inform their designs.

The result started to illustrate/target some of the conceptual and theoretical interests of the on-going post-digital conversation through learning from the materiality, imperfection, and imprecision of the physical model (Figure 13).

RESULTS

One of the unique aspects of RAI Alpha—in comparison to other robotic videography projects—is that RAI Alpha seeks a design application for an emerging tool. Looking at the projects mentioned above, RAI Alpha begins to move beyond the conventions of representation, where representation and the “architecture” are separate, and tries to blur the boundaries of representation, experience, scale, and even digital/physical resolution through augmented
imaging. Different from most of the “productional” robotic projects in the field, RAI Alpha is an attempt to use robotics not as a tool to “finish” a project, but as a medium through which to design the project.

Following this interest, as part of the Hetero[Animo]Geneous projects, students are currently working on studying and ultimately revisiting their designs, in their physical stage—at the desktop scale, from the perspective/views that are not possible though conventional interactions with physical models.

CONCLUSION
The research presented in this paper is the very first step of a series of upcoming research proposals/projects with an interest for revisiting the use of robot in—and possibly as an active agent of—the design process. Existing in the realm of non-productional robotics, RAI Alpha questions the potential of robotic imaging as an architectural/representational aspect of machine-vision and as a design medium. It is, however, very difficult to evaluate its potential impact as it is still a very young developing inquiry. This paper is a short exploration on how RAI Alpha can be seen as a potential medium/platform for architectural explorations.

One of the main limitations of this research is the limited number of projects and students/designers involved in using this method. As a creative platform, RAI Alpha—and robotic imaging in general—can significantly benefit from multiple/diverse visions with different approaches in employing this method of thinking as a tool/medium. One of the restrictions that limits the number of designers using robotic imaging is that most of the robotic videography platforms are either not available to the public or need professional technical programming knowledge to operate.

As part of the RAI Alpha platform, we are currently developing the final stages of our custom robotic videography plug-in for Grasshopper 3D called Oriole-Gama. By making Oriole available to the public in the near future, and expanding the community of creative thinkers and designers using robotic videography, we hope to be able to amplify the possibilities of robotic imaging and design-oriented machine vision.

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NOTES
1. Forced perspective techniques were heavily used in Greek and Roman architecture to create controlled illusion of form, depth, and space.
2. Hierarchical perspective was used in Persian miniature as a way to represent importance through scale and perspective.

REFERENCES

Özel, Güvenç. 2016 “Toward a Postarchitecture.” Log 38: 99-105


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