Enabling Interactive Interior Design through Virtual Reality

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Abstract

This report describes an interactive virtual reality application that enables professional and amateur interior designers to rapidly construct and iterate on a room design. The designer is able to explore the room in 3D through the ViewMaster and move around and manipulate furniture through the UI. This application was built in Unity.

1. Introduction

While public perception of virtual reality applications commonly revolve around video games, recent studies have demonstrated the efficacy of virtual reality for commercial and industrial applications such as design, data visualization, and communication [1]. For designers, a key benefit of VR is the ability to rapidly reconstruct and iterate on a 3D design compared to the unfaithful representation of a 2D screen or the slow iteration process of a physical model.

We built a VR application in Unity3D targeted towards both professional and amateur interior designers with the ultimate goal of enabling an interior designer to create and iterate on a room of his or her choosing. The application creates an interactive virtual environment which can be explored through the ViewMaster and manipulated via keyboard controls. Initially, the scene is a blank floor-plan of three rooms in the house: the bedroom, bathroom, and kitchen. Using the VRduino and IMU, the designer can look around a room as the camera tracks his/her head movement and move around using the keyboard. The designer is also allowed to place furniture in the room from a catalog of models and able to customize the position, rotation, and texture of models in the scene through the interactive UI.
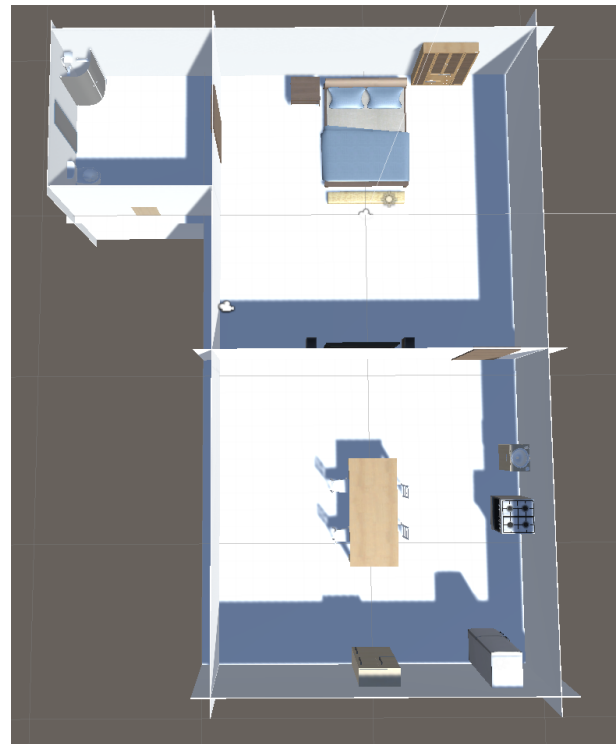

Figure 1: Top-down view of the apartment

2. Related Work

Traditionally, interior designers have relied on verbal descriptions, 2D renderings, or in-person tours of physical showrooms to communicate their vision to clients. These representations often lack critical details and are costly and slow to iterate upon. A VR interior design tool creates an opportunity to build higher fidelity representations that can give customers crucial spatial insight, such as depth perception or varying viewing perspectives.

The use of VR/AR is still nascent in the interior design

industry but has recently gained some traction. IKEA launched an AR app in 2017, allowing users to place furniture from the IKEA catalog into their rooms using an iPhone camera [2]. Several e-commerce retailers, including Wayfair and Chairish, have released similar products. Some professional architects have experimented with using VR in their design process [4]. Guise, a Swedish architectural firm, utilized Autodesk 3ds Max rendering and a VR engine to help design a contemporary photography museum in London [3].

Our aim was to build a VR tool for amateur and professional interior designers that does not currently exist. We wanted to create a more immersive 360° VR environment via a head-mounted display compared to the AR IKEA iPhone app. Furthermore, we wanted to balance giving interior designers the ability to construct more complex scenes and the autonomy to construct an entire room from scratch while also not requiring a professional CAD background in order to use the application.

3. Virtual Environment

As a proof-of-concept for our application, we created a scene in Unity from scratch consisting of a bedroom, bathroom, and kitchen. Each room is separated by a door allowing the user to move between rooms. The top down view of the scene is shown in Figure 1. Each room consists of around a dozen pieces of furniture. Furniture models were sourced from the Big Furniture asset pack [5]. For example, the bedroom contains a bed, bed-side table, cabinet, couch, TV, and multiple speakers. Each piece of furniture consists of multiple components (e.g. a bed is built from two pillows, a blanket, a frame, and a mattress).
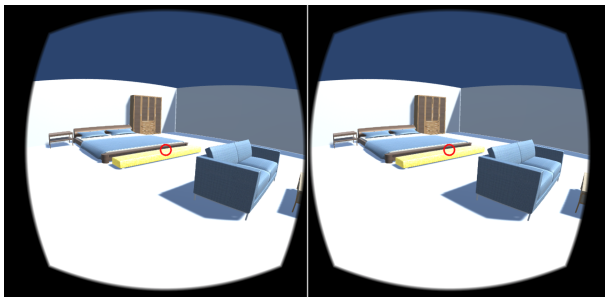

Figure 2: Stereo view of the bedroom

The user is able to walk through the scene in first-person, as shown in Figure 2. In real-time and in first-person, users can change the texture of each furniture component from a library of available textures, allowing for a plethora of

designs for one piece of furniture. An interactive UI (as discussed in Section 4) allows for the ability to arrange, duplicate, and add more furniture to create an endless array of configurations for the room. Additionally, designers can import more furniture models, or modify the configuration of the rooms, through Unity.

Next, we will describe in more detail the important object classes we created to build our scene.

3.1. Locations

Every room in the house is a Location object, which consists of the structure of the room (floor, walls, etc.) as well as all furniture objects that can be placed inside. All Locations have a Furniture Manager object. The user can navigate from one Location to the next by clicking on the door, which will freeze the furniture arrangement in the room, change the current Location, and move the camera position to the entry of the next room.

3.2. FurnitureManager

A FurnitureManager object controls all Furniture objects in a Location. It contains a list of all possible Furniture objects that can be placed in the room, a list of all active (visible) Furniture objects, and the current Furniture selected. Using the keyboard commands specified in Table 1, the user can translate, rotate, duplicate, set (in)active, or switch the current Furniture.

3.3. Furniture

A Furniture object is composed of one or multiple components, as described above using the example of the bed. Furniture objects keep track of their list of components, a list of texture materials that can be applied to each of their components, and the current component selected, which is highlighted in the viewer. The user can switch the current component and its material properties using the keyboard controls specified in Table 1.

4. User Interface

4.1. Headset

Interacting with furniture requires looking directly at the desired object with the red reticle in the center of the screen. Once the reticle is over an interactable object, it will grow into a circle and the object will then be able to be manipulated (e.g. moved around, duplicated, set to (in)active, etc.). If the reticle is over a furniture object with multiple components, the specific component of the furniture that is selected will be highlighted and its material properties can then be changed. If the reticle is over a door, the user can click the mouse to move to the next room.
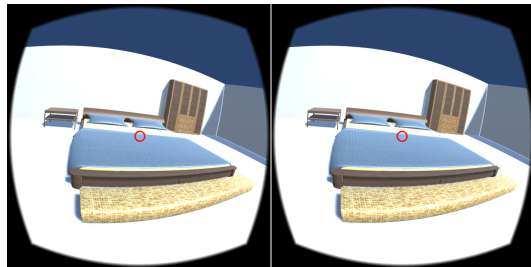
4.2. Keyboard Commands

Keyboard buttons are used to control camera movement and furniture management and movement. The keyboard commands are summarized in Table 1. The "w","a","s", and "d" keys move the camera around the room. Furniture movement is controlled via the "up", "down", "left", and "right" arrow keys for translation and "," or "." for rotation.

The current furniture is the object targeted by the red reticle and highlighted in the viewer. The user can set the current furniture to active with "p" and inactive with "h". To duplicate the current furniture, the user can press the "m" key and move the copy around. The user can also change the texture material of the selected component of the current furniture with "n" and switch the selected component with "b". Figure 3 shows the bed before and after changing the material of the blanket.
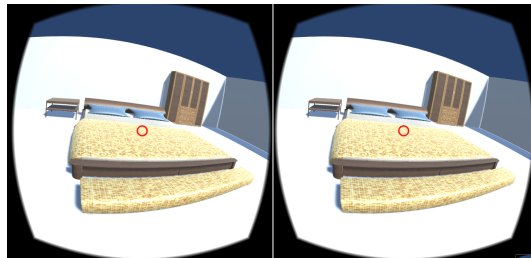
Pressing "c" will make a hidden furniture temporarily active and repeated presses will switch between hidden furniture objects. The keys "e" and "q" will set all furniture in the room to active or inactive.

Key	Action
w	Move forward
a	Move left
s	Move backwards
d	Move right
LMB	Move between rooms
↑	Move furniture forward
←	Move furniture left
↓	Move furniture backwards
→	Move furniture right
,	Rotate furniture clockwise
.	Rotate furniture counter-clockwise
m	Duplicate current furniture
p	Set current furniture to active
h	Set current furniture to inactive
c	Switch between hidden furniture
n	Switch material of selected component
b	Switch selected component
e	Make all furniture in the room active
q	Make all furniture in the room inactive

Table 1: Keyboard controls

with a small set of corresponding furniture. Furthermore, our framework allows designers to extend the scene with their creations or the layout of their client's house.

Looking forward, we can add additional features to our framework, such as windows, customizable light sources, etc. We could extend our furniture pack to a wider selection of furniture and also improve upon the low poly objects for more realistic rendering. We could even imagine extending our application to AR, allowing a designer to physically be in the room that they are designing. The application would map out the room and allow the designer to place models in the room in real-time.

(a) Bed before texture change

(b) Bed after texture change

Figure 3: Changing textures on furniture components

5. Conclusion

We were able to create a framework that enables interior designers to explore and modify the layout of an apartment or house in a real-time, first-person immersive 3D environment. We provide a sample scene that contains three rooms

References

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