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Photorealistic Rendering for LIve-Action Video Integration

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Photorealistic Rendering for Live-Action Video Integration

By

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An Undergraduate Thesis Submitted in Partial Fulfillment
of the Requirements for the
Fine and Performing Arts Honors Scholars Program
Honors College
East Tennessee State University

David E. Hirsh   5/4/2017
                                                  Date

Martin R Fitzgerald, Thesis Mentor   5/4/17
                                                  Date

James M Livingston, Reader   4 May 17
                                                  Date
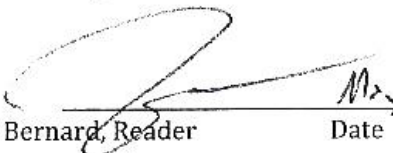
James M Bernard, Reader   May 2, 2017
                                                  Date

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Abstract

Exploring the creative and technical process of rendering realistic images for integration into live action footage.

Introduction

　　When everything in today's entertainment world is comprised of mostly visual effects, it only made sense to focus both my collegiate studies as well as my senior honors thesis on this field. In this paper, the reader will learn of the workflow needed to achieve realistic 3D rendering and its integration into live-action video. This paper is structured chronologically and explores my creation process and how this project has evolved, while providing image documentation from the many iterations it has undergone.
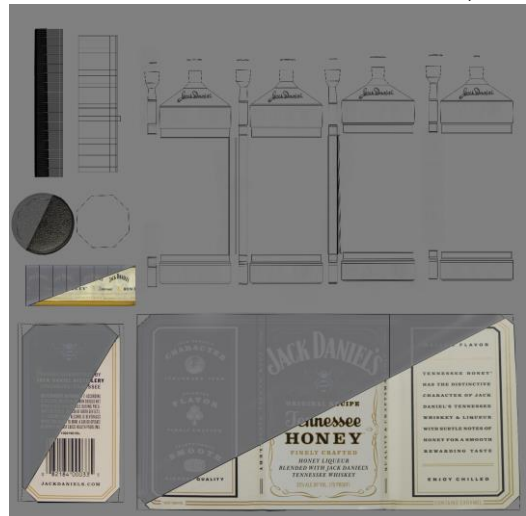
MentalRay

　　The work on this bottle initially began in 2015 for a Lighting and Rendering class my junior year. At the time, the main rendering system we used was an integrated renderer called MentalRay. By this point, I already had used it for 3 years or so, and was comfortable using it. However, I quickly encountered a few problems that would limit the realism of my final image. The first being that the glass in my scene was far too

Mental Ray test image: 9/1/15

perfect. In the real world, all surfaces have flaws. Each has its own imperfections, dust, scratches, or fingerprints that break up the surface even in ways that we may not expect. In the image on the right, you can see how clear the surface is. Aside from the refraction within the glass walls, it is a perfect surface; too perfect. Throughout my years here at ETSU, it has been stressed again and again that the most successful 3D content usually has a little bit of mess to it. With that in mind, I thought of ways to break up the surface and add some personality to the bottle.

　　The image on the right shows what is called a UV Map. These "maps" are 2D representations of 3D models that are used as templates to place textures and other shading attributes. UV maps are essential to obtaining photorealistic results, because it allows for seamless integration between 2D and 3D programs. In the professional production pipeline, UV maps allow a 3D modeler to give his model to a digital texture artist

Modified UV layout to show how both the bump map and color map utilize the same UV space

or painter, who can create the texture, then give the file back to the 3D artist.

RenderMan

Upon showing both professors and peers my initial render test, they urged me to learn a new renderer available called RenderMan. This renderer was, and is the main rendering system used by PIXAR, the famed animation studio that created Toy Story, the Incredibles, and many more, so naturally, I was excited to use it. I found that I could get a nice result quickly in RenderMan, as it was built for speed, and realism. Even though I had switched to RenderMan from MentalRay, I was still faced with the challenge of breaking up the surface.

To do so, I used what are called bump maps and displacement maps. These black and white images are used in texturing to give the object either the appearance of surface variation, or actual surface modification. The renderer would interpret these images as height maps, where the lighter parts of the image are peaks, and the darker parts are valleys. I tweaked the bump map in this scene constantly, because with each render I would notice something I didn't like.

Added Bump Maps to Object: 9/27/15

These maps gave the surface of the bottle a rougher look without changing the way the light refracted through the object. This was very important because our eyes can recognize even the most minor rendering mistake or overlooked detail. The first new render with the bump maps looked like this (9/27/15)! Even to the untrained eye, this bottle is much improved as compared to the first version. All of the other objects in this scene also use bump map, as especially visible both the flower pot and the table top. At this stage, I was challenged with providing better and more striking lighting that would bring out the surface of the glass. So at the start of the next semester, I updated the light setup I used, and decided, for the time being, I was satisfied with the result.
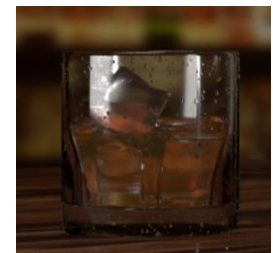

Lighting Update: 1/10/16

Arnold

During the summer of 2016, I interned at Zoic Studios, a visual effects studio in Culver City, California. I had the opportunity to work alongside and with Emmy nominated visual effects artists on commercial and television projects. While there, I learned the importance of staying up to date with the current trends and practices within the VFX industry. Any artist who fails to continually adapt and grow to the ever shifting industry, is at risk to falling behind, becoming less efficient, and potentially useless. This advice became immediately relevant as I was working at a studio that used a renderer called V-Ray, which acted differently than MentalRay or RenderMan. Unfortunately, because of various non-disclosure agreements I signed, I was unable to take updates to this scene back home with me when the internship ended. Although I couldn't keep the V-Ray version of the scene, the experience was invaluable to my development as a digital artist. I am now comfortable outside my own comfort zone, knowing that I can adapt to new workflows and programs quickly and efficiently. This new confidence and knowledge prepared me for my senior year in the Digital Media program because that fall, we were introduced to a renderer called Arnold.

Initially, I felt as though I could not control the Arnold renders like I wanted. I struggled for a few weeks as I learned more about this rendered, but as it goes when learning new programs, one day, everything just clicked. My other projects began taking shape as did this one, just in time for

our midterm presentation for the final digital media class. With one week until I was due to present my demo reel to a panel of professors, I realized that I had not finalized my bottle scene at all. While I was in LA, the comments I received the most were regarding the whiskey bottle, and how it should be full of liquid. With a deadline approaching, I made one of the biggest updates to my scene at that time as I changed the entire look and feel of the scene.

Frame from sequence shown at Midterm Presentation: 2/27/17

I admittedly did rush this update, and did not pay as much attention to the details as I should have. I received many constructive comments on the reflections, specular highlights, and overall color of the scene that made it appear computer generated. I realized that I had fallen short of the look I desired so I sought to improve it. One major way that I worked to improve my scene was to add water droplets to the tumbler, hoping to achieve the appearance of condensation. To do this, I used a

new feature in Maya called MASH. This procedural animation tool made creating randomly placed
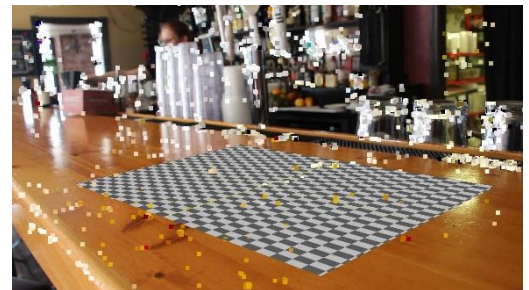
water droplets on a surface easy, and ultimately it added a lot to the scene. Up to this point, this bottle has been tested with three different rendering systems (Mental Ray, RenderMan, Arnold) each achieving varying degrees of success. While the ultimate goal has always been to achieve photorealism, I had not directly attempted it until it became my thesis. In previous projects, I had created scenes that were entirely 3D models in a 3D environment. During these iterations, I would tweak the textures, shaders, and lighting until I would achieve a desired result. However, no matter how realistic my scenes may have seemed at the time, the only threshold of

realism, was itself.

Test of MASH Droplets: 3/16/17

Nuke Tracking and Compositing

On April 1st, 2017, I decided that I wanted to try, for my first time, compositing a 3D object in a live action video. I knew that if I could pull this off successfully, it would truly push my work to that "next level". Not only is compositing used in entertainment everywhere, it would also allow me to truly test whether or not I could achieve the photo real quality I desired.   There are many steps involved in achieving a composited shot like the one I pursued for this thesis. The first step is the most obvious, and the most important. Film. This footage will act as the "plate" that the 3D

geometry will sit on when it is composited in later down the road. Shooting video for a track is slightly different that shooting for other uses. There are many pitfalls that a novice like myself may encounter when shooting these clips.   The first being, glossy surfaces and moving reflections, that make tracking the camera movement much harder, thus causing the geometry to appear to slip around on the surface. Simply changing the angle of the camera can eliminate some of these reflections. Glossy surfaces exasperate

An example of tracked footage, with the point cloud and card visible.

the issue because they pick up object reflections, lighting reflections and any refractive surfaces' caustics and will confuse the program when trying to record the movement data.   In this scene, I managed to find a location that not only had constantly changing lighting, a glossy surface, and numerous reflections but even worse, the footage itself was slightly blurry. These factors made getting a track to stick much harder and in some parts of the video impossible with the amount of time I had.

Tracking, or match moving, is the act of recording the movement of a real world camera in 3D space, as to replicate this movement with an identical 3D virtual camera that will be used in a digital scene. This is one of the most heavily used techniques in Hollywood today, as many films are

turning to visual effects to create the environments the actors are working in. In this project, I needed to track the movement of the hand held camera, so I could import the recorded movements into Maya.

When watching the original plate, one can see that there is a large yellow reflections traversing the bar as the cam pans left to right and back again. This reflection caused a great disconnect with allowing my geometry to "stick" in the scene. This light was cutting under the

models and making them look like they were not a part of the scene. To remedy this, I needed to cover up the reflections in the original plate, then create my own in a render pass. In Maya, I set up a plane that would match the height of the bar. From there I had to project a single image of the bar top that did not contain any reflections where the bottle was sitting. This technique worked really nicely and once the new bar top replacement images were combined with the plate and the geometry in Nuke, everything seemed to fall into place.
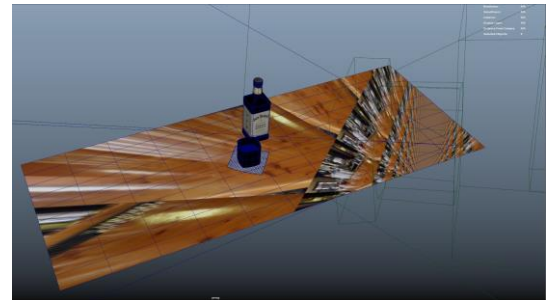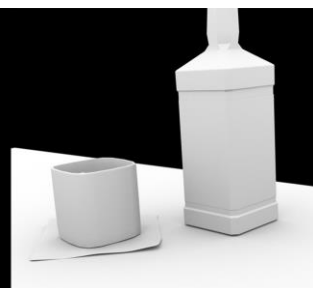

Now that I knew the scene was going to work, I focused my time on rendering "passes" that could be composited with the rest of the footage. These passes included beauty, reflections, ambient occlusion, and shadows. Each of these works in conjunction with one another to create a realistic looking 3D model.

Beauty   Reflections   Ambient Occlusion   Shadows
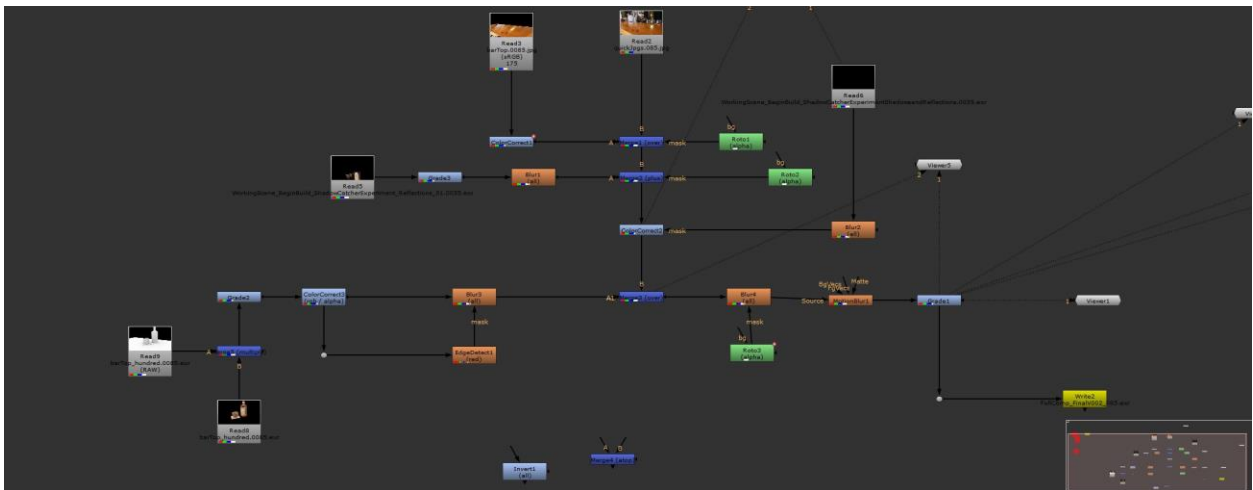
Rendered geometry: All Passes

Rendered Geometry: Final Composite

Compositing these passes together proved to be trickier than I had anticipated. As this was my first time compositing in Nuke, the web of nodes confused me at first. But I soon grew to really enjoy the visual feedback that they provided as it was easy to see what affected what within the graph.

The Node Tree within the Nuke Interface

Problem Solving

One major problem that I encountered during this project occurred near the end of the process. When I first imported all of my passes, footage, and geometry, nothing seemed to line up, everything was sliding around all over the place. After a couple of frustrating hours and some trouble shooting with Marty, we figured out the issue! In Maya, the default start frame on the time slider is 1, while in Nuke, the initial start frame is 0. This caused all of the renders that came from

Maya to be offset by one frame from the plate, so it appeared as though I did not have a good track. Once we figured this out, and fixed it, by moving all of the rendered sequences by one frame, everything stuck once again. This project had many small issues that had to be resolved in order to continue with the next phase, but thanks to the help of my advisors, and my classmates, none proved to stop production completely.

Conclusion

Although not continuous, the total time I have spent on this project encompasses just under two years. Within that time, I have grown as an artist and have revisited it whenever I learned of better techniques and workflows. Although this is the last time I will work with this scene, the skills I have picked up will be used in each and every new project that I work on. The development of this project alone has set me up for a newfound passion in match-moving and compositing that will truly allow me to pursue photo-real work within the visual effects industry.