UT Martin Virtual Campus Tour

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Abstract— **Virtual Campus give prospective students a taste of the UT Martin experience. Using Google SketchUp, buildings from the campus are painstakingly recreated to allow the user to feel like they are actually there. The 3D models and their textures are exported from SketchUp in the .FBX format and imported into Unity. After importing the buildings into Unity the users can walk around the campus, entering individual buildings and explore individual rooms. Other models such as trees, sculptures are made using Blender. The virtual campus can be placed on the internet for anyone to view using WebGL or downloaded for offline use on Windows and OSX.**

A virtual model of a campus can have many practical uses. It may eventually be used to guide students to their classes or other points of interest around campus. It will also help some students to feel more comfortable as they go about their day by letting them feel like they have been to their classrooms before they have to actually physically step foot on campus. A 3D model may also be used by administration to allow them to visualize future building additions. Studies have shown that campus virtual tour have increased student interest by up to 80 percent.

I. Introduction

When the semester started we knew we wanted to do something with virtual reality. However, we began running into problems when it came to the hardware we needed to achieve what we wanted to do. While we were still deciding on a senior design project we were approached by an engineering professor and were given the suggestion to create a virtual campus tour for students to use. We decided to start on this project in hopes to one day be able to implement a virtual reality version of the campus further later.

A. Background

A virtual campus tour is a great way to increase the interest of prospective students. According to YouVisit, a company that makes virtual campus tours for colleges across the USA, a successful campus tour has seen an 80% increase in the number of inquiries about the campus from prospective students as well as 30% more in-person visits from prospective students to the campus [1].

B. Deciding the Scale

When we decided on the idea for a virtual campus tour we discussed for a few days what would be better having a large collection of exterior models for the campus buildings or having a small collection of really detailed models. We decided on the second option and also decided to model the interior of the Engineering and Physical Sciences building on campus to have a proof of concept that it is achievable. After we knew what section of the campus we wanted to model for our project we cut out the section of the sidewalk that didn't matter and focused on just building up that side with trees and outdoor objects.

II. Researching the Software

When we first began looking at software to use to create a virtual campus with detailed building models, Unity was a clear decision for us. Unity is a completely free game engine that gave us many features, including the ability to deploy our campus to a variety of platforms including Windows, OSX, and even WebGL. Using popular options for our software choices proved useful many times when it came to the amount of documentation we found on the web for the problems we were having.

A. Road Architect

After we created the 3D model of the sidewalk, we had some issues with getting it to fit well with the scale of the rest of the campus. It also looked incredibly blocky and not necessarily realistic. After a few weeks of trying to get things to work out between our 3D sidewalk model we began researching other options. After a few hours of research, we came across the free to use Unity plugin called Road Architect. Road Architect was designed to create actual roads with lanes and shoulders so we had to spend a few more hours tweaking the settings to make it resemble a sidewalk, but it looked great once we figured it out. Once we got the basics of Road Architect, we used our old 3D model of the sidewalk as a template. We could trace the old model to recreate the sidewalks in an accurate way so our original sidewalk model was still used for something.

B. Sculptris

Sculptris is a 3D modeling tool that excels in creating unique, realistic models of natural and biological entities. Sculptris comes equipped with a basic tool set that gives you abilities such as inflating, stretching, smoothing and rotating. As soon as you open the application you will be presented with a gray sphere, which acts like a virtual lump of clay that is able to be sculpted how ever you like. Creating the basic shape of the tree was accomplished by clicking and dragging to create a cylinder, and then all the branches were sculpted individually by clicking and dragging to the desired length and curvature. While this method produced unique and detailed models, it proved to be a very time consuming process because every branch had to be done by hand. We needed a more efficient way to produce lifelike models.

C. Blender and its add-ons

Blender is an open-source 3D modeling application that has a variety of uses in a professional environment ranging from animated films, to special effects and video games. Because if its open source nature, it comes equipped with a large variety of user created scripts, mods and add-ons that are created for efficiently carrying out specific tasks. The Sapling-curve add-on is what we used to create the majority of the trees you will find on the virtual campus tour. It starts you off with a wire-frame model of a generic tree. The option tab presents the user with many options to alter variables that let you change every aspect of the tree's appearance. For example, you can change how many times the limbs will multiply and branch off, which had to be balanced to reduce polygons while also maintaining a realistic look. After changing the settings to get the desired appearance, the add-on also comes equipped with a script that generates leaves automatically by rendering flat planes all over the branches, which a leaf texture can then be easily applied to.

D. Google Sketchup

Starting out one of the first concerns was how the buildings were going to be created in a timely and efficient manner. Google SketchUp provided all the tools needed to easily do this. First a building is imported from the AutoCAD file resulting in a flat outline of the building's outer walls. Then Sketchup's tracing tool is used to trace the outline. This tells SketchUp to make the outline a connected solid object. A stretching tool is then used to pull the buildings shape up out of the outline into a three dimensional model of the building. This gives the shape of the model to which details will be added.

III. Starting the Models

A. AutoCAD

The first step to creating the buildings was requesting an AutoCAD file from the university.

This file provided a layout of the campus with every object being its correct scale. From here all that was necessary was to copy the outline of a given building and paste it into Google SketchUp for modeling. This gives us a mostly accurate outline of a building's outer walls. Before we had the AutoCAD file we attempted to create buildings by free handing the walls with limited success. The AutoCAD file really got the ball rolling.

B. Adding Textures and Objects

The Next step is to add textures and details to bring the model alive out of the grey box it starts as. To get a brick wall texture a picture is taken of the real life building's exterior brick with an iPhone. This picture is then pasted on to the 3D model. It takes a bit of resizing and stretching of the texture to give it a realistic appearance. Most buildings will have some additional features that will needed to be modeled by hand. For example, the library required me to create columns and humanities required extra concrete work. Depending on what needs to be created this can be a time consuming process. The last step is to use the Google SketchUp warehouse to import models of doors and windows. The warehouse is a free to use marketplace where individuals upload their own models for others to use. It can take a significant amount of time to find a model that most closely matches a building's actual features to maximize accuracy.

C. Creating the Sidewalks

We knew recreating the sidewalks would be difficult due to the sharp turns and curvy pathways. The layer system was preserved when importing the campus AutoCAD file into sketchup, which made it possible to hide all the buildings, parking lots and everything else that was unneeded and made the sidewalk outline the only outline visible. Trial and error was used with many different methods in an attempt to derive a sidewalk model from the sketchup file, such as connecting tilted flat polygons and triangles roughly following the outline of the sidewalk. This method looked unattractive and had an un-optimized polygon count. We eventually used a flat plane under the outline of the sidewalk and traced out a large portion of the sidewalk from the campus quad.

We wanted to accurately elevate the sidewalk model to account for the hilly terrain on campus. To do this the flat model was sectioned into chunks and each piece of the sidewalk was elevated to an estimated height.

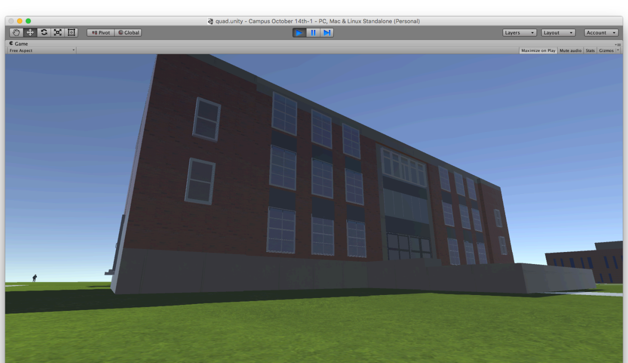

Figure 1 You can see here our final exterior model for the Engineering and Physical Science building.

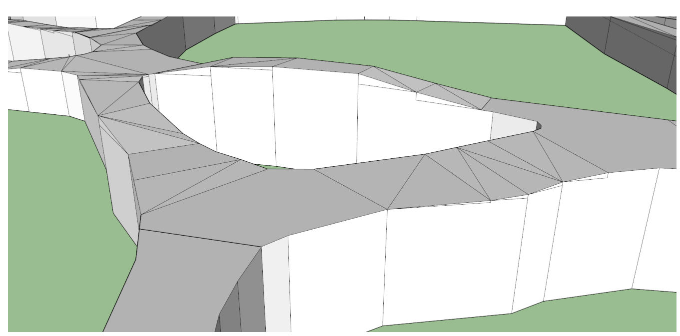

Figure 2 You can see here the version of the sidewalk once the rough blocky edges were fixed.

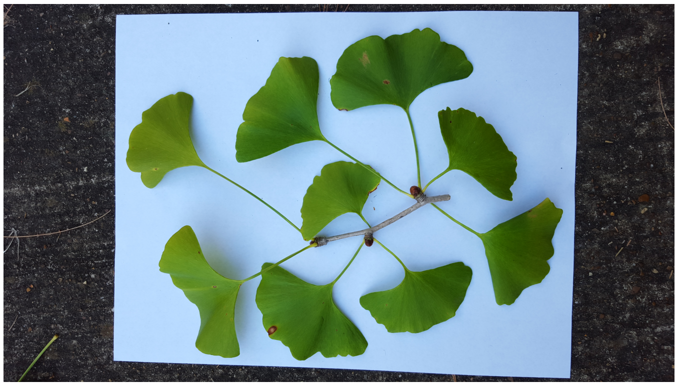

Figure 3 Here is the leaf texture without the backdrop. This texture was used for to add realism to the trees.

Then the elevation relief was added adding polygons that connected adjacent sidewalks chunks which made it look smoother and less blocky.

D. Modeling the Interior

Modeling a building's interior is a significantly more difficult and time consuming process than the exterior. EPS is the only building that was attempted so far. Luckily the university provided a floor plan of the building. Without it the modeling process would be very difficult. Using the building exterior model previously created we first strip off all of the outside decorations. The building interior will later be full of models which can be taxing on memory, so to optimize performance every thing not necessary must be removed. This is possible because the building interior is a separate scene than the outside of the campus. Originally it was envisioned for everything to be one scene but this later proved impossible. Now taking the blank model the roof is removed. This gives us a top down view of the hollowed out building. The floor plans are then used to draw in the rooms. Then the rooms are filled with models from the warehouse to make them feel like the real thing. Multiple floors are created by pasting a roof on this and restarting the process using the previous floor's ceiling as a floor. In our current state believable interior photo textures have not been achieved because of the natural lighting inside of a building. So for now a generic texture is used.

One advantage of setting building interiors in a separate scene from the exteriors is that liberties are able to be taken with the interior spacing. This allows for steps to be taken to make the interiors feel accurate as possible without worrying how changing spacing affects the appearance of the exterior of the model.

Figure 4 Here is a model of the interior of the Engineering and Physical Science building.

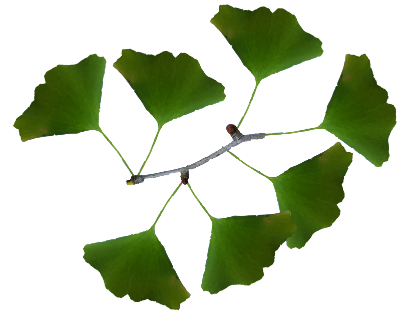

Figure 5 You can see here the final version of the leaf textures minus the background. This was used with Unity and Blender to add realism to the trees.

This is very helpful for things like staircases which can be difficult to fit in predetermined spaces.

Currently multiple floor exist in the same scene and are accessible by simply walking up stairs. In the future it may be easier and even necessary to split different floors into multiple scenes. This will be researched if the project is continued.

E. Trees

The UT Martin campus is a botanical garden, which implies that every tree species native to the state of Tennessee can be found on the campus. So this is a highlight of an actual tour so we felt the need to accurately recreate this in the virtual campus. So when choosing which software to use we considered the optimization of polygon count, time efficiency, and ability to render proportionate and accurate models. Leaves from the trees surrounding the EPS building were chosen, which include golden rain tree, Japanese maple, ginkgo tree, and willow oak.

F. Creating Leaf Textures use Gimp

Leaf samples from the trees surrounding the EPS building were collected with a Galaxy S6 camera phone and then imported into GIMP, which stands for Gnu Image Manipulation Program, which is an open source fully featured image editing application. A new layer was created using an alpha channel background, which is what makes the background transparent after exporting. The stem is copied over to the alpha layer and then few leaves that look the most intact are cropped out and pasted on the alpha channel layer with varied sizes. This creates a realistic texture despite reusing leaves, which saves a lot of time when creating multiple textures.

G. Leaf Shaders in Unity

A problem we encountered was that by default the standard texture in Unity didn't show transparency. This was fixed by using a basic diffuse transparency shader, this showed the alpha channel, however there was still a white line that remained on the edges of some of the leaves. This was unavoidable due to not having proper photography equipment. I researched that adjusting the feathered edge option with the crop tool in GIMP gives you the ability to smooth out and almost completely removes the rough white outlines.

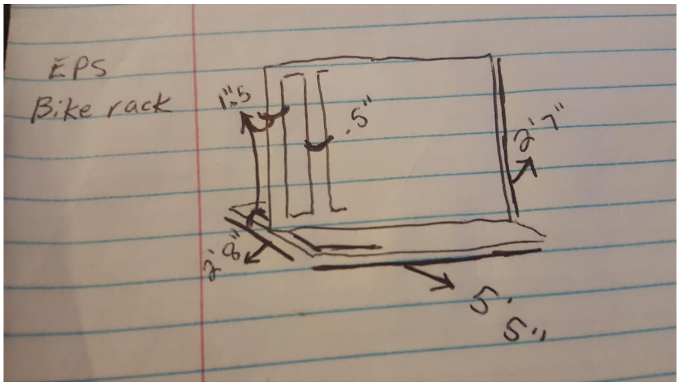

Figure 6 You can see here the rough sketches for our bicycle rack using the measurements for the laser measuring tape.

This almost removed the white outline but it still had remnants when applied to the transparency shader.

We researched better options for shaders and came across a cutout version of the transparent diffuse shader which has a slider that gives the ability to control how much of the edge shows.

H. *Creating Outdoor Objects*

We used an electric measuring tape that is accurate to one sixteenth of an inch and wrote down the measurements for many outdoors objects such as lamps posts, trashcans, bike racks and more. This method of acquiring measurements assured a 1 to 1 size ratio for all the objects we modeled. Sketching out pictures on graph of all the objects with labeled measurements was very helpful and reduced the mental work involved when modeling them. Sketchup was used to translate the 2D sketches to 3D models. Some of the models weren't as blocky as some models or the buildings that required learning some more advanced techniques to create smooth surfaces. This was done by connecting 2 different sized circular objects with triangle fan polygons which gives the illusion of a smooth curved surface.

IV. Problems Encountered

A. *Problems with Unity*

During the development of our virtual campus we ran into a few different issues with Unity and the way it imported our models and some roadblocks in regards to the way the terrain was designed.

B. *Building Issues*

When we first started getting basic building models, we quickly realized that something about the way we designed the models made some of the textures and even some walls simply not render correctly in Unity like they did in Google SketchUp. This was solved once we researched the correct file formats and method to use to import SketchUp models into Unity. We realized that while the models were getting correctly exported from SketchUp when we were importing them into Unity, we left out the texture folder that each model has that gives Unity the textures they need to use.

C. *FBX vs. Collada*

When we started our virtual campus, every model we created was exported from Google SketchUp using the .dae (Collada) format. This format worked well for every building until we started implementing the interior of the Engineering and Physical Sciences building. After implementation, we discovered that there were issues with the player falling through the building and the terrain and outside of the map. Using .dae also caused some problems with some of the interior textures not displaying correctly. After researching for a few hours online and talking to some people with experience online I discovered that as far as game development goes, .fbx is typically a better format to use. However, switching to .fbx caused some hiccups in terms of performance. When compared to .dae, .fbx files are much more intensive when it comes to importing and exporting them, sometimes taking up to 25 minutes to export and import on a 2011 Macbook Pro. Collada files did a much better job handling the scale of buildings when imported into Unity. We used a .07 scale on our original collada models but that had to change when we switched to .fbx. We ended up using the standard .fbx scale of 1 which meant it was the same size as the model in Google Sketchup.

D. *Terrain Issues*

Once we started getting the first few buildings implemented into our virtual campus, we quickly realized that things were too flat and adding elevation would make the experience more realistic. Unity has some really simple tools for adding hills and mountains to the world, but for some reason we had issues digging into the terrain to add holes and ditches. After doing some research, we learned that in order to fix the problem the entire terrain would have to be recreated and some basic settings changed. Starting fresh with a new project was our approach to this. We were finally able to add holes and ditches to our virtual campus, but it was difficult to make them look realistic compared to the actual campus with the tools that we had available. We based the height of the terrain off a three-dimensional model of the sidewalks that we created. Due to issues with the texture and scale, we ended up using a two-dimensional sidewalk that looked great due to the textures we created.

E. *Memory Optimization (Houston's EPS)*

One of the first hurdles we encountered when it came to the virtual campus and the performance was the implementation of the final interior model for the Engineering and Physical Science building. This model consisted of three separate floors, and each had their own classrooms modeled to look realistic. We learned pretty quickly that a normal implementation of this model would not suffice when we started having performance issues after we implemented it into our Unity scene. Fortunately, Unity is great when it comes to scripting. We wrote a couple scripts that would load the interior of EPS as a separate scene when you walked into a transparent square outside the door of our exterior EPS model.

F. Memory Optimization (WebGL edition)

One of the suggestions we got early in our project was that we should attempt to build our virtual campus for WebGL. Building it for WebGL allowed for people to try it without having to download any software just using a modern web browser like Google Chrome. For our first status report, demos this worked well, but once we started adding in some of our early models, Javascript began crashing before the world even loaded. We determined that this was related to amount of memory Unity was giving Javascript, but we continued on the project just demonstrating using standalone Windows and OSX versions. Once we built enough of the campus and had a good model of the campus we wanted to present, we began work on fixing the memory issue and successfully deployed our virtual campus to WebGL. However, we had mixed results with some computers having it work well while other computers still had issues with Javascript running out of memory. We have yet to determine a consistent solution for this issue.

V. Conclusion

In this paper we have shown how our research, time, and our ability to work as a team to learn new software have combined to create our Virtual Campus Tour. We have shown our reasoning for using certain programs to accomplish tasks as well as our reasoning for why we didn't use certain software to achieve some tasks.

References:

[1] YouVisit, College-Campus-Tour, https://www.youvisit.com/college-campus-tour, 12/01/2015