

“3D Scanning”

Kevin Fuentes, Kyron Donaldson
San Jacinto North Campus
5800 Uvalde Road
Houston, TX 77049

Faculty Advisors: Professor Nathaniel Wiggins

Abstract

The project involves researching the manipulation of a 3D model to better understand the overall process that is required for a 3D scan to be processed and received by a 3D scanner. The goal of the project is to create tangible objects by converting STL and CAD files to develop these models. This has been achieved by understanding and working with the programs Skanect, Autodesk Memento, MeshLab, and Solid Works. With these programs, it is possible for a scan to be rendered of ourselves, modified, and then printed with moveable pieces that are also interchangeable. The research exemplifies the endless possibilities of 3D scanning made palpable by 3D printing.

Keywords: 3D Scanner, 3D Printer, Busk, Skanect, Memento, Solid Works, MeshLab

1. Introduction

The initial goal of this project was to better understand the methods and overall process of 3D scanning. A 3D scanner allows for the formation of an object in a 3D space that can be edited to the desired design. Some of the objects that can be produced from a scan include 3D prints and a cut-out from a plasma cutter from a two dimensional perspective. A 3D scan is a rendered CAD (Computer Aided Design) or STL (STereoLithography) file that can be viewed in the three dimensional or the two dimensional perspective. Additionally, a 3D scan can be modified using AutoCAD, Solid Works, or similar programs. The requirements for the project are to obtain the ability to scan an object and create a .STL file from the scans of the objects.

3-Dimensional scanning and printing has created new ways for procedures to be orchestrated. The contributions of 3D scanning are limitless, and include the creation of form-fitted masks for severe burn victims, prosthetics for amputees, and the creation of braces and retainers by dentists. The main goal was to create an action figure in order to determine how detailed a 3D print could be of an object that size. Through this process, busts were created of the upper body, followed by a full body bust, and completed with the creation of functioning arms that moved. Lastly, an item was scanned and combined with another STL file.

2. Methodology

Materials included an X-Box 360 Kinect, Robo 3D Printer, PLA – Filament, CPU, Skanect (Software), Mesh Lab (Software), Solid Works (Software), Autodesk Memento (Software), Matter Control (Software), Lazy Susan, Go-Pro, NXT Board, and Lego Parts.

2.1 Skanect

The Kinect **must** be connected to the computer and a power source before launching the Skanect application. Once the application is loaded, set the parameters for the bounding box, scene, and aspect ratio on the “Prepare” tab and click the “Record” tab. Make sure the object is in the bounding box before hitting the record button. Once the record button is on, a green hue is formed around the figure (on the computer screen) that represents the area captured by the software.



Figure 1 The white trace around the figure is the path followed by the person scanner

The figure should not be moved at any time during the recording session, or the Kinect should remain stationary while the object is allowed to be turned at a constant rate (turning on a chair while the Kinect is not moving should work). Be sure to move slowly. Make sure all the perspectives of the object are captured before stopping the recording. Click on “Reconstruct” and the software will interpolate the images into a 3D model. Click on the “Process” tab to edit the model. Preference Setting for Human Body Modeling (suggested settings: Fill Holes > Strategy> Closed Hull; Smoothing> Medium).

Once finished editing, click on the “Share” tab. To export the model, click on the “Export Model,” set “number of faces” to max (the “free version [is] limited to 5,000 faces”) and format it to “STL.” 3D printers model, and find a place to save. To revisit a model on Skanect, go to the “Prepare” tab and click on “Load”. Select the desired model (has to be found using “Path”) and the program should redirect the user to the “Reconstruct” tab. Run “Fusion.” The software will re-interpolate the images into a 3D model.

2.2 Meshlab

Meshlab is software that allows the edit of .STL files. Parts of the model can be removed but cannot be drawn back on this software. Components can be added to the model if additional STL's files are added.

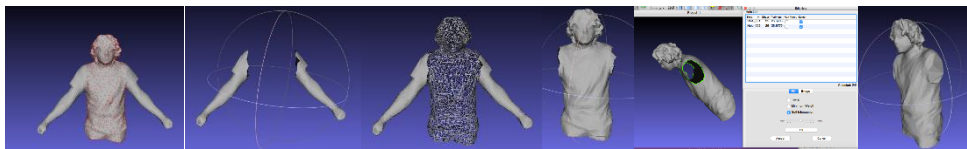


Figure 2. Meshlab software that allows the edit of SLT files.


The removal of the arms includes importing the body as a .STL file into Meshlab. By using the “Select Vertexes” tool



, highlight the body region. Once satisfied, delete that portion of the body by using the icon indicated to the right.



The arms should remain; at this point the file can be exported as a .STL file. Import the same .STL file from the beginning and it should appear as nothing has been cropped. Change the texture of the recently uploaded .STL file to “wireframe.” This time instead of highlighting the body, highlight the arms (do one at a time) and follow the same processes as depicted for the body. At this point, export the body as a .STL file. It is recommended to have two different files of the same figure (two for the body and two for the arms): one where the holes are filled and one where

they are not. Use the “Fill Hole” tool , to fill the desired holes.

2.3 Memento

Memento is a software that compiles captured photos and generates them into a 3D model that can be exported into several configurations. The proper way to operate inside Memento is to first gather a compilation of photos using any camera. Be sure to take multiple pictures of the same angle and transfer to a storage device. Open Memento and select the photo box under the “Create 3D” section. Select the box on the left labeled “Local Drive” as shown in Fig. 3. It will open another box leading to the files located on a computer. Select the photos for the 3D scan. Be sure they are not blurry or distorted. Click the “Create Model” button. This will display another box; make sure to name the 3D scan, making sure the quality is set at “best” and not “draft.” Once these parameters have been met, hit start. While the 3D scan is being rendered, the process can be viewed in the “A 360 Drive” tab; it will be the photo farthest to the left (all previous scans will also be accessible for re-download in this section as shown in Fig. 4.)

Once the scan is done, download the completed file by clicking on the blue circle that appears once the cursor is over the designated image and save the 3D scan. It can be viewed in the “Open” section.

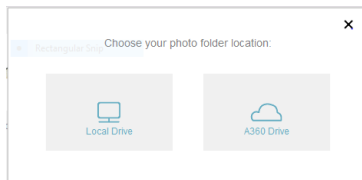


Figure 3 Here is the section where you find your pictures. You can either select a local drive or cloud storage.

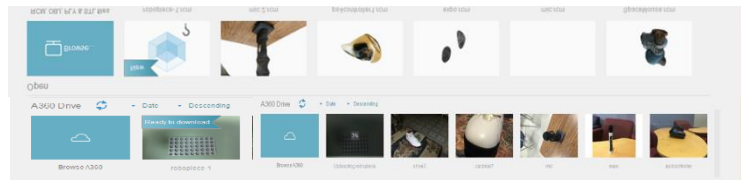


Figure 4 Here is how the 360 Drive will look

3. Data and Discussion of Results

3.1 Skanect/Meshlab/Mesh Mixer

With the first initial scan, it was undetermined whether the software could export .STL files from the model. With the second scan, it was determined that it was possible to edit the “capture” box by increasing the “capture” box. In the third and fourth images, detail was the priority in order to know how complicated a model could be. Since it was possible to create .STL files from a scan, it was necessary to test if the images could be printed into 3D objects. The object could not be too large, since the size of the model would determine the amount of detail shown on the figure. Increasing the scaling of the model allowed for more detail, but there were still missing elements due to the size of the model. The scan below demonstrates the degree of complexity that a model can have as long as the object can be captured properly. It was printed with difficulty since raft support was not known about. The images above represent the evolution of the 3D print since it involves stacking a layer on top of another layer of material. They are a compilation of scans and prints that were made in minutes. Figures were added to preexisting scans.



Figure 5 Notice the loss of detail in the smaller print compared to the 3D scan

By increasing the capture box in Skanect, a full body scan of the human figure was done. When reprinting the model in a larger scale, the 3D printer had issues reaching the abdominal of the figure. To combat this issue, the object was printed laying on its front side. A reprint with an increase to the scale was also necessary due to the fact that the initial print was fragile from the ankle-knee area.

3.2 Action Figure

Since it was already possible to make 3D silhouettes of people with 3D scanning, the next step was to create a figure with moveable limbs. A ball and socket had to be attached to make the arms move on the figure. The requirements for the figure included arms that could be attached to the body, arms that were able to move while connected to the body, and arms that were removable from the body. Meshlab is the software that allows for the edit of .STL files. Parts of the model can be removed; components cannot be drawn back on this software. Components can be added to the model if additional STL's files are added.

3.3 Prototype 1

For the first model, the balls on the arms were uneven and the arms were not scaled proportionally relative to the body as shown in Fig. 5. In order to attach the arms to the body, a cavity had to be created on the arms.

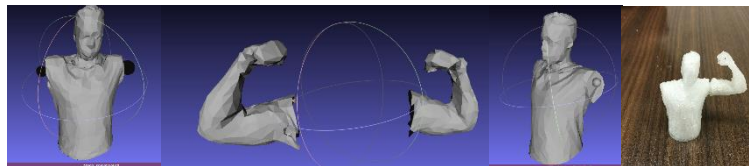


Figure 6 Shows the process of Prototype 1

3.4 Prototype 2

In this version of the model everything is scaled proportionally, but in order to attach the arms to the body a cavity would have to be made. The arm was able to be attached to the body and the arm was semi-movable. Placing the ball in the man-made socket is difficult due to the force needed; in the processes one of the arms broke due to the force. Additionally, the ball altered into a cone when it was placed it in the arm.

3.5 Prototype 3&4

Prototype 3 & 4 are essentially the same model with the only difference being the ball and socket design and its placement, as seen in Fig. 6. Prototype 4 worked to an extent and all the requirements were reached. However, the downfall with this particular model was that the socket expanded and cracked.



Figure 7 shows the process for design 3 and 4

3.6 Prototype 5

The last prototype was inspired by the Lego brick design, where the arms were attachable and movable (in one plane). The action figure was a success in the sense that the arms could move without the arms falling off the body. Not only was a working model made, but the idea was reproduced with a different model and scale for the figure to be bigger. There was one slight issue with the pink arm (the right arm) as can be seen in Fig. 7. Unlike the pink arm, the clear arm works and rotates without a without a noticeable gap in between.

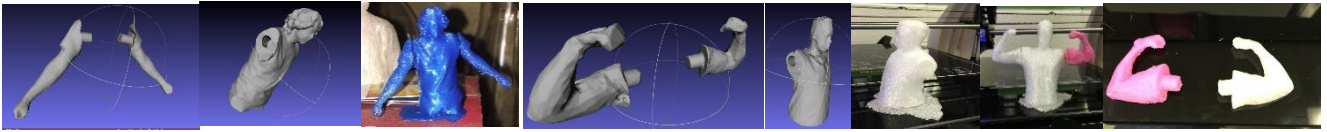


Figure 8 shows the process and assembly of prototype 5.

4. Memento

4.1 Microphone

Using Memento, the objective was to scan objects by taking numerous pictures and then render them to be viewed in a three dimensional perspective. One of the trials using this program was an attempt to scan a microphone. The first step was to compile photos of the object from every possible position. As shown below, the microphone was captured with the surroundings of the room where the photos were taken as shown in Fig. 8. Using the editing tools in Memento, it is possible to erase majority of the unwanted areas using the lasso tool. The image below in Fig.9 has a deformed look to it as well as some discoloration within the handle. These discolorations are actually objects that were in the room when the pictures were taken. It seems that an object with a reflective surface like the microphone can and will have images on the exterior of the object.

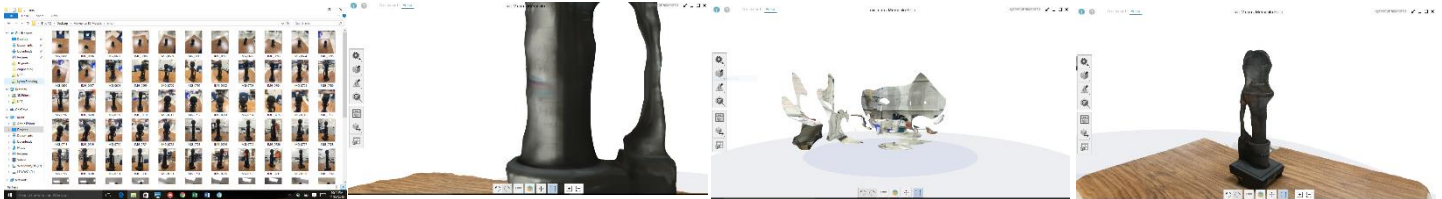


Figure 9 here is how the rendering of the microphone came out. Notice the amount of the surroundings around the microphone that was captured.

4.2 Tennis Shoes

With a pair of tennis shoes, a total of 104 photos from different angles were captured, compiled, and rendered by the Autodesk Memento servers. Once the file was completely rendered, the image received can be seen in Fig. 10. The image is deformed. Some quality was picked up, but not in a consistent manner. Luckily, the image can be cleaned up by clicking the 3D print button. A box appears that allows to fully compile the defects as particles, holes or intersections as shown in Fig 11. Click the “Detect Issues” box. Particles, holes, or intersections can be fixed by selecting the issue and hitting “next.” The final product was an improvement but not a design worth printing.



Figure 10 The images shown are different angles of the rendered scan from the Jordan 7 tennis shoe

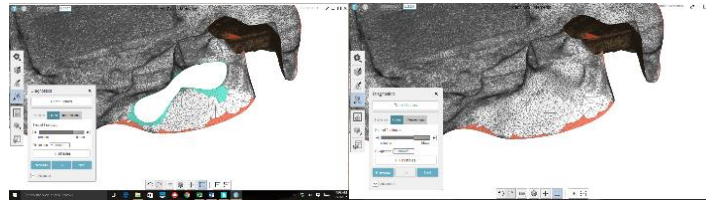


Figure 11 This image shows the Memento software filling a hole with its diagnostics feature

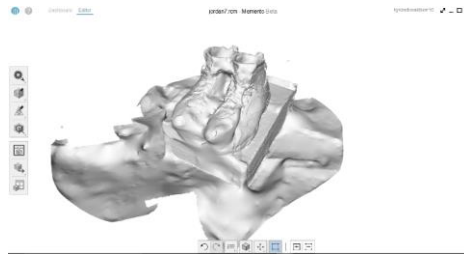


Figure12 This image shows a cleaned up rendered scan but still lacks desired quality

5. SolidWorks/AutoCAD & the Plasma Cutter

In order to create a 2D rendering of a 3D model, import the model into Solid Works and export the model as a .dwg or a .dxf file. (NOTE: Before exporting the model adjust the position of the model to the desired perspective. The program takes a snap of the lines and vertices of the 3D model at a particular position and scales the image into a 2D plane.) The .dwg and .dxf file type allows for editing on AutoCAD. The images on the left of Fig. 12 and Fig. 13 represent the 2D rendering of a 3D model and the images to the right are the outline of the previous renderings. Save the model as a .dxf. Import the desired file on Plasmacam, scale the model to the desired size and initialize the cut path (NOTE: Make sure the outline of the model is linked before cutting). Once satisfied with the setting, test the cut path on the plasma cutter without actually cutting anything. Place the sheet of metal on the plasma cutter and run the cut. (CAUTION: Do not look directly at the light emitted from the plasma cutter and stay clear of the cutter). Continuing with a design that was more complicated, more lines were exposed within the silhouette. The end result allowed for a more detailed figure cut. If one looks at Fig. 13 at the farthest right, one of the detail lines is missing from the body. Remember to initialize all the cuts, otherwise the plasma cutter will not cut the path. The images below depict the evolution of design: begin with a 3D model on Solid Works and transform the 3D model into a 2D plane. By removing a few lines from the 2D image, what is left is an outline of the figure and a few detailed lines. The image above represents the cut path; purple represents the outline of the figure, while the yellow is the trace-path, followed by the extruder, and red represents the actual cut path. Once again, the plasma cutter follows the cut path and creates the design.

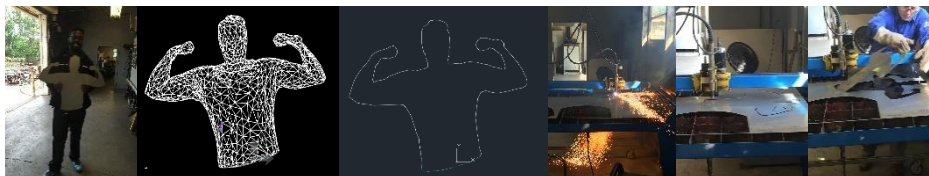


Figure 13 This panel of pictures illustrates the process to creating a cut out on a plasma cutter from a 3D scanner

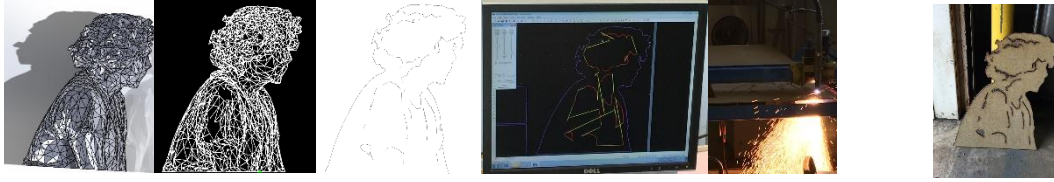


Figure 14 Here is the same process as we used on Fig. 12 but a thicker piece of metal was used

5.1 Lazy Susan

Another idea for this project was to create a 3D scanner; the image above represents a conceptual idea for our self-built scanner that utilized the Lego NXT as a board and a tire and motor to rotate “Lazy Susan.” The base was created with extruding ‘pillars’ so Susan would not leave the designated area when rotating. The NXT motor rotates when the sound sensor picks up sound. The creation of a program that did require the sound sensor for the motor to rotate could have been made, but because it was a test design, only the pre-programs on the NXT were used.



Figure 15 The lazy Susan was meant to present a method of scanning an object that will rotate the object around

6. Conclusion and Acknowledgments

6.1 Potential Ideas

Using Meshmixer, a bobble head figure was created. This side project fell into “Potential Ideas” because it was never printed. During the process, it discovered that increasing the scan box made it possible to scan rooms. In the next semester, an attempt will be made to use the oculus rift to view our 3D scanned environments.

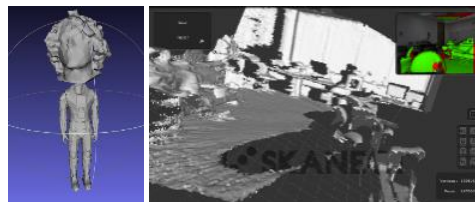


Figure 16 here are several potential ideas for further studying

6.2 Outreach and Collaboration

Friday, November 20, 2015, the group presented at C. E. King High School. Over 200 students were present and an additional presentation is scheduled for UBMS at San Jacinto College, which would include another seventy students. Additionally, the team collaborated with the Welding Department and people from the engineering lab.



Figure 17 Kevin and Kyron present their research to the students of C. E. King

6.3 Raw Data and Explanation

With enough images of different perspectives, a 3D model can be made for almost any figure. Memento is a hit and miss, since the program is in BETA not all the kinks from the program have been resolved. Skanect allows for an average quality scan since it limits the procedure to only using the Kinect. Using programs like Meshmixer and Meshlab, .STL can be edited to the desired needs. Solid Works can transform a 3D model to a 2D plane. In a 2D plane, the same rendering can create different products. For one of the subprojects, a plasma cutter was used to create metal silhouettes. Using a similar method with an embroidery machine, a custom “self” logo could also be made. Ultimately, there are different outlets to produce products using 3D scanning. With further investigation, using 3D scanning



Figure 18. Kyron Donaldson on the left and Kevin Fuentes on the right.

6.4 Research to Hypo Comparison

At the beginning of this project, 3D scanning was not well understood, but through experimentation, knowledge was enhanced. By working with Memento, it was discovered how a 3D image can be captured by comparing and contrasting it to the objects in its surroundings, and by utilizing Google Scholar, it was possible to determine exactly the type of 3D scanner a Microsoft Kinect is similar to (which is a RGB-D camera). Further reading and experimentation also led to the discovery of the limitations of Memento and Skanect. Memento, for example, could only obtain a high quality rendering of an object without even the slightest issue, or else the image became deformed or warped. Skanect also lacked the ability to capture high quality scans for large objects. The Kinect itself extends to about five meters scanning outside environments, which is also very limiting.

7. Acknowledgment

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