# Planetarium Exploration of the Human Heart

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## ABSTRACT

We developed a virtual tour of the human heart in a planetarium environment to give immersive and highly scaleable educational experiences to museum visitors. While graphics software has been used for projects ranging from planets and 3D volume rendered skulls,we used Unity for the existing API and versatility. Unity included several features such as 3D textures we wished to use for this project. For our heart we had over 450 pictures of horizontal slices of a cadaver's heart and a blank mesh. To color the mesh we used the image data and made it the layers of a 3D texture, reading in the colors per pixel. Current challenges still exist however, such as simulating controls of other planetarium software like Uniview while making sure it's versatile to update for many projection platforms.

## INTRODUCTION

Through the Visual Human Project by the National Library of Medicine, our lab was given data on the human heart, and to outreach to the community, we created a planetarium exploration of the heart for the Bell Museum planetarium. Several tools we employed were 3D texturing or rendering, Bezier Curves, and a fish eye lens effect for projection onto the dome.

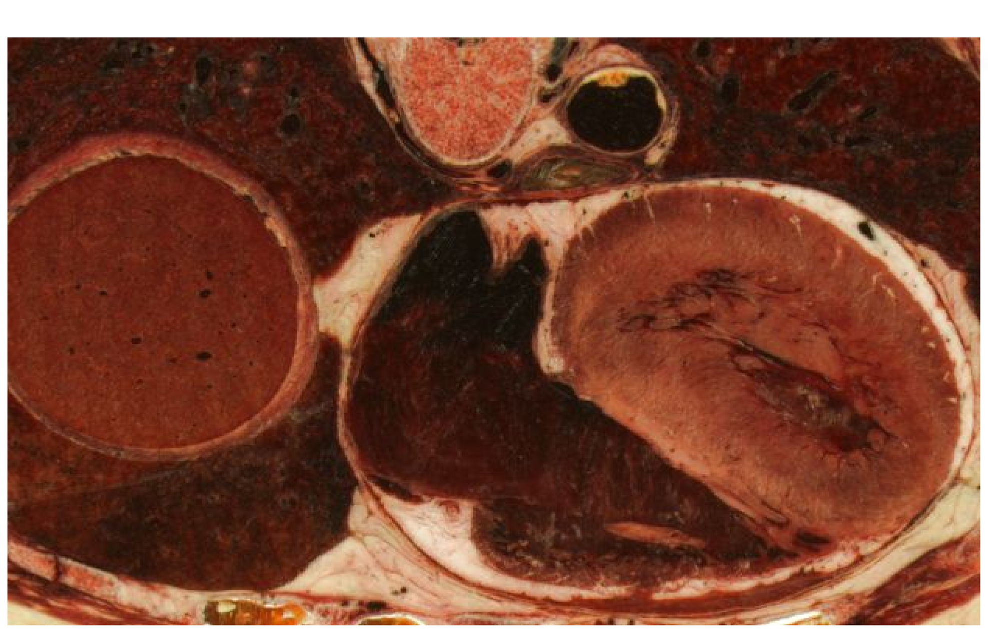
## OBJECTIVES

1. A High Fidelity and Smooth visual experience including but not limited to:
   A. Smooth Camera Control via mouse interface
   B. An Accurate 3D textured mesh from real visual data.
   C. Proper camera flight through the heart allowing for easy navigation.
2. Robust control of the presentation including notes, images, and camera placement
3. Proper projection onto the Bell Museum dome via lens effects

## BACKGROUND

Planetarium software such as Uniview and 3D development applications have created strong environments for interactive educational experiences. The National Library of Medicine Visible Human Project came forward with available data and images sets for the creation of 3D models accurately texturing the human body.

Using these resources and work in the Interactive Visualization Lab for previous medical tools, we can develop an accurate and interactive planetarium experience to educate and reach out to the community. Unity's recently released tools and platform versatility allowed for the unique exploration inside of a complex organ like the heart.



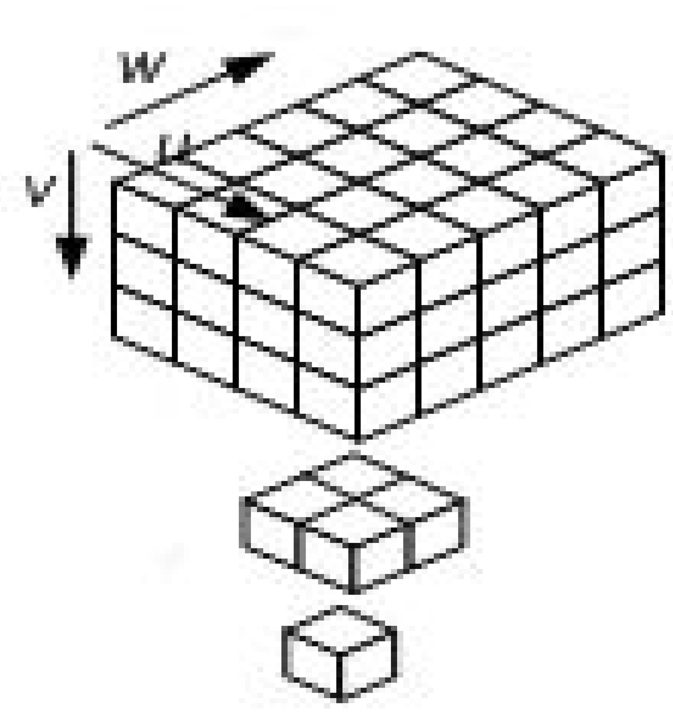
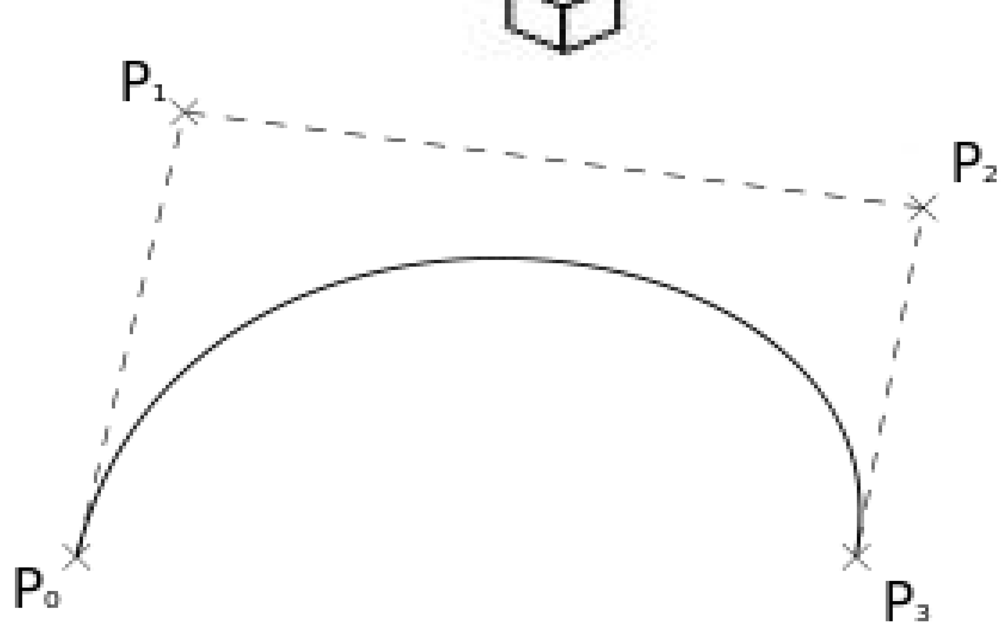
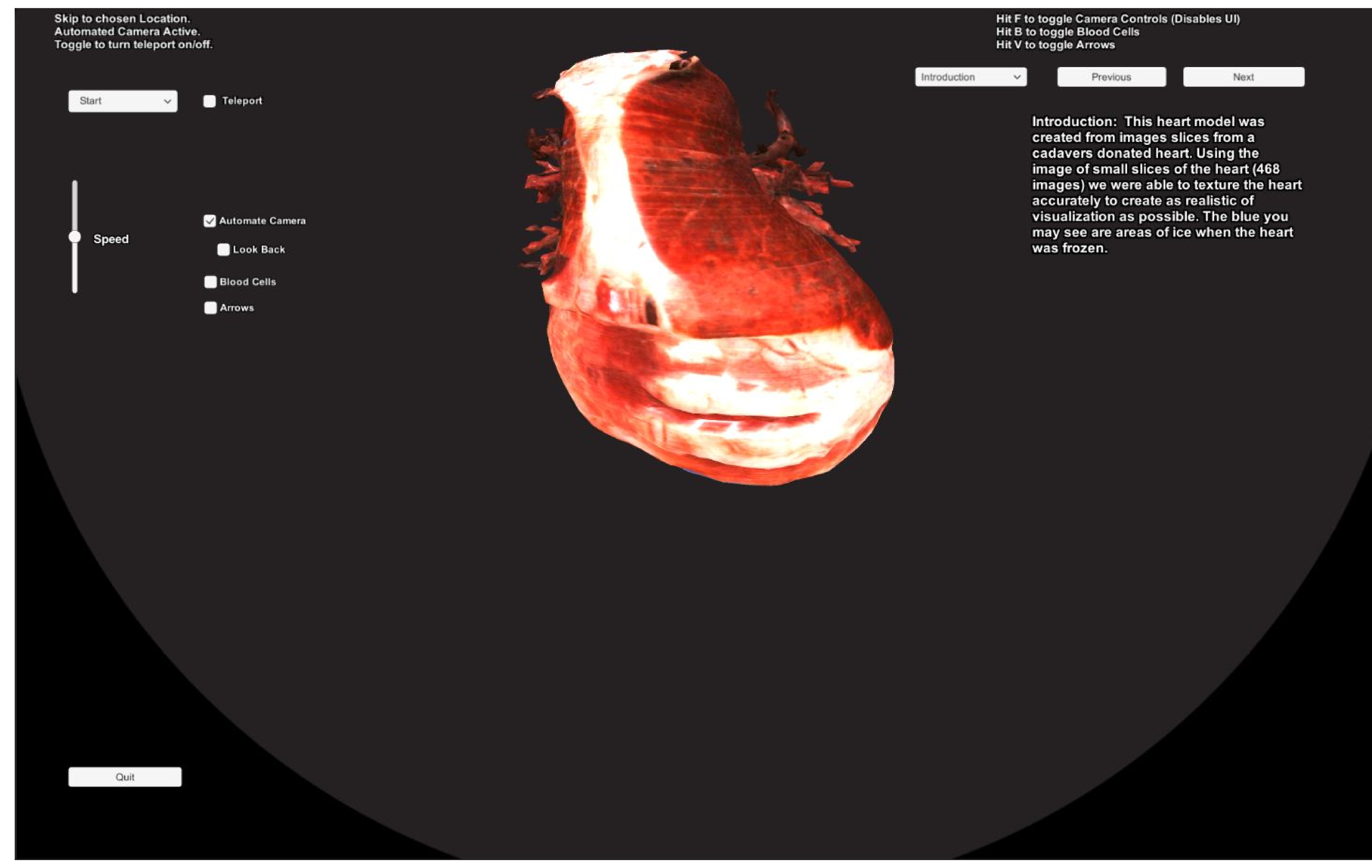



**Figure 1 Top Left:** 1 of the 468 images we used to create the 3D Texture using it's pixel color data. This view is a top down slice of the mid section of the heart.

**Figure 2 Top Right:** 3D texture example, showing the pixel box data as it's 3D form. https://msdn.microsoft.com/en-us/library/windows/desktop/ff476906(v=vs.85).aspx

**Figure 3 Bottom Right:** Example Bezier curve going to it's pass through points but being bent by two more points. https://en.wikipedia.org/wiki/B%C3%A9zier_curve

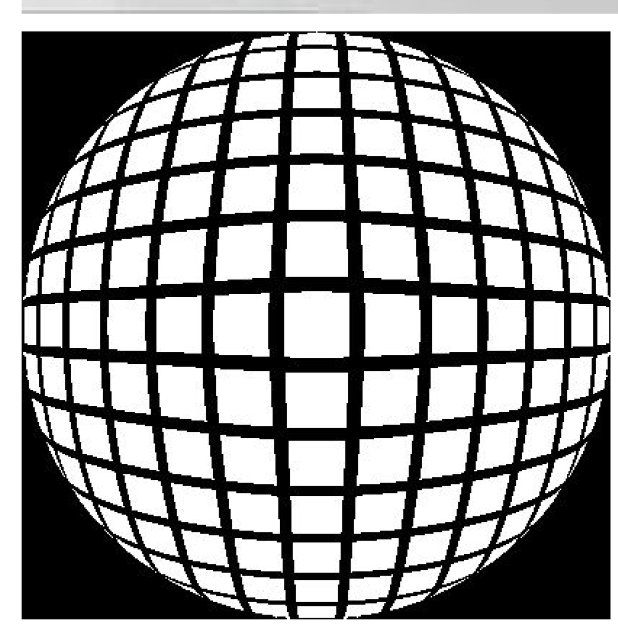


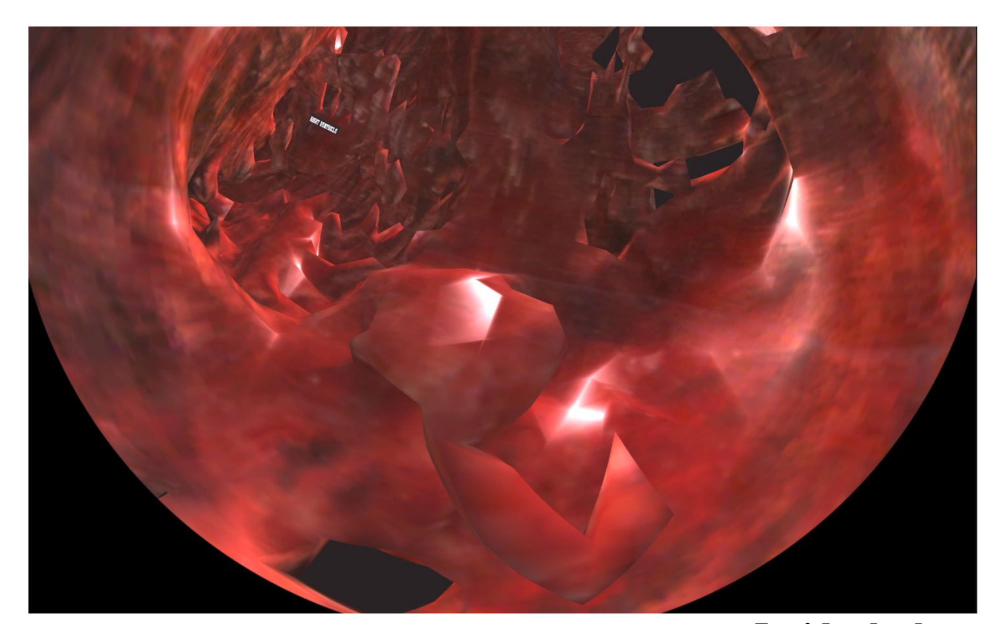




**Camera Control Screen above**

**Figure 4 (left):** Example of the Exploradome. The projector must be able to project an image that still looks correct rather than warped to the dome incorrectly, which the fish-eye effect is made to correct. http://www.parigiviaggi.it/image/exploradome.jpg

**FIGURE 5 (bottom left):** Example Fish Eye lens effect before projected onto dome.. http://4.bp.blogspot.com/-wB5lo4Xdm5w/T51uryQN-xI/AAAAAAAAAJg/LBPgTvAOjwA/s1600/grid_fisheye.png





**Inside the heart**

## DEVELOPMENT CHALLENGES

### 3D Texture

In the beginning of development' we only had a stack of 468 images slices of the heart. (Figure 1 on Bottom left). Most meshes are color with a single 2D texture however. Having no pre-existing texture to overlay on the 3D mesh, we needed to create a 3D texture for the mesh to be colored with. (See Figure 2 on bottom left) This 3D texture used the images as the colored layers, making the complete volume of colors. The mesh is colored based on where it is inside this texture.

### Smooth Camera

To make smooth camera movement and rotation effects, we first implemented a Bezier Curve class (Figure 3 on bottom left). The Bezier Curves were put into a spline that navigated the entire heart as if it were blood flowing through it. To help with orientation the camera is always constrained to twist itself so that it's up vector was toward the top of the heart. For smooth rotation, the camera interpolates slowly between a target rotation given by the Bezier Curves tangent and other target locations. Using the slope we also normalized the speed of progression to be consistent per frame.

### Projection Onto A Dome

To achieve this we implemented a fish-eye camera effect, bending the images of 5 cameras onto one circular plane. (Figure 5 on top left) This takes in a larger field of view by combining the 5 camera (front, right, left, top, and bottom) views and rendering them bent on a circular plane. We returned that plane as our actual camera view that was sent to the display, which then was aligned and unbent by being projected back onto the dome.

## CONCLUDING POINTS AND FUTURE WORK

1. Successful Life Sciences Planetarium Tour
2. Development for other multi platform engines
3. Medical Device Simulations
4. MRI and CT scan data implementation.
5. Educational Interactive Media for community outreach