

# MSc CAVE Rendering Assignment Report: Mandarin

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## ABSTRACT

A report detailing the process of creating a mandarin object and material with Pixar's Renderman and OSL as well as the two visual artifacts, showcasing it.

## KEYWORDS

Renderman, OSL, RIB

### ACM Reference Format:

Daria Tolmacheva. 2024. MSc CAVE Rendering Assignment Report: Mandarin. In *Proceedings of . ACM*, New York, NY, USA, 6 pages. <https://doi.org/10.1145/nnnnnnn.nnnnnnn>

## 1 MODELLING OBJECT

I chose a mandarin as my object to generate. The modeling for it was simple since I've only needed a sphere which was a little squished in the y-axis. The rest of the shaping would happen in the displacement shader. I use RIB directly for ease.

## 2 DISPLACEMENT

Displacement is the most sophisticated part of creating a mandarin material as it is a natural object so I've split it into multiple sections. Below I will elaborate on creating each of the following: general noise, top and bottom squishes, stem details, slices, dots and well as extra bits/changes added later. Throughout the process the algorithm was always to define position of the displacement artifact, define the appropriate values of the displacement, over that value and 0 based the position and add the result to the final output.

### 2.1 Noise

The mandarin is obviously not a perfect sphere and has a bumpy shape overall as any orderly features such as slices or squishes are only approximate. This is perfect to be represented with noise.

I started off with some low frequency perlin noise which I layered with higher frequencies. Smoothing this pattern by dividing it by squared frequency at every layer and adding a small displacement amount gives my sphere a more natural look. I started off with a fairly large displacement, but ended up playing with it later in the process multiple times.

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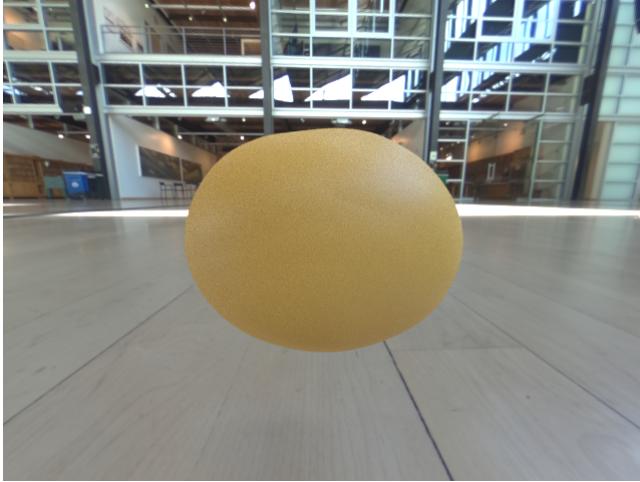
Figure 1: Mandarins photos



Figure 2: Mandarins photos top and bottom

### 2.2 Squishes

As we can see, both the top and the bottom of the mandarins I have as references are squished at the top creating a little crater in the middle. The squish ends in the stem hole but outside if that is fairly smooth. Perfect shape to be approximated with smoothstep



**Figure 3: Low frequency bumps**



**Figure 4: Top squish position and final displacement**



**Figure 5: Before and after bottom squish**

function.

The top squish is bigger both in diameter and depth, but the idea is the same for both: since they are positioned at the ends of the range of v values, I can easily define the squish positions with `smoothstep()` function over v to create a circle with faded edge. I then mix the displacement values according to the squish position and add the result to the final output.

### 2.3 Stem

Top part of the mandarin has a hole where the stem was connected to it. It is indented further than other deformities and has a sharp uneven edge. At the bottom they have a small green-grey dot slightly sticking out.

To recreate it in the shader I made a similar position mask to the squish one, but this time with a different edge. I made the values



**Figure 6: Top stem hole before and after fuzz**



**Figure 7: Top stem hole from afar**



**Figure 8: Slices placement**

used in the `smoothstep` very close to avoid smooth transition and emulate sharp indent. On top of it I have added noise to the values in the `smoothstep` via `fuzz` variable to avoid perfect circle shape. The noise I use to generate fuzz is just a high frequency one level unsigned perlin, multiplied by the max fuzz value (in this case 0.005).

For the bottom dot I slightly displaced a tiny circle out of the bottom of the mandarin model. Since it is so small making it more noisy and uneven seems wasteful since it isn't likely to be noticed.

### 2.4 Slices

The internal slice structure of the mandarins shows through in two ways: the indents between slices on the sides of the mandarin and the fold-like structures on the top of it. Those are not even and have different number of iterations on different fruits.



**Figure 9: Slices noise**



**Figure 10: Slices tweaks**



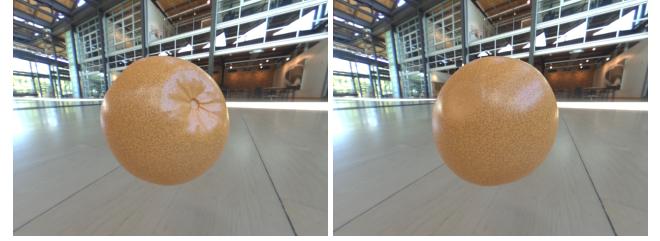
**Figure 11: Final slices**

I first tried making them via periodic noise but it was very orderly and the way of thinking required to introduce satisfactory effect with noise on periodic slices proved to be too time-consuming so I opted out for a solution requiring a loop and a smoothstep to create the slices.

Firstly, I generate a random number of slice edges between 7 and 9. As I create them, I offset their position on a circle by fuzz generated with perlin noise. I make sure not to create any of them near u value edge ( $u=0 \rightarrow u=1$ ) since it creates an overlap ruining the effect. As I create the slices with smoothstep, I add fuzz to both slice edges. This fuzz is generated by layering 5 frequencies of perlin noise to achieve effect close to the "folds" on the top of the mandarin. Since the slices on the sides and the bottom of the mandarins are much more mild, I fade out the slices as we leave the "folds" area at the



**Figure 12: Original dots pattern**



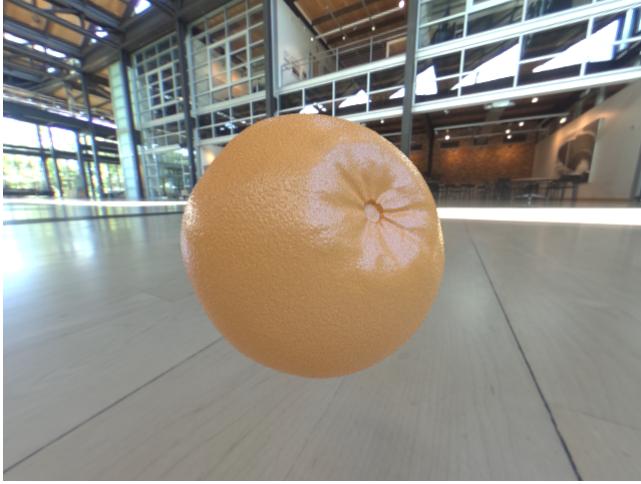
**Figure 13: Dots fadeout front and back**

top in two ways: literal fade out of the displacement value, and fade out of the fuzz added to the slice edge to create the fold. This way the slices become much more mild as we go across the mandarin following v line. I also need to make sure that the slices do not affect inside of the stem hole so I subtract its position from the slices pattern.

## 2.5 Dots

The surface of the mandarin is covered in little dots that have both a dent, a different color and higher subsurface scattering, so it is important to recreate them. They are scattered unevenly across the mandarin surface and have varied radii creating a high frequency noise effect. They appear all the way to both stems although a bit faded closer to them.

At first I attempted to create the dots myself using cell noise, however I never managed to get a satisfactory result of points escaping their own cells even after looping over the neighbour points to render overlaps as needed. In the interest of time, I have found a good enough solution online which works similarly to what I was trying to recreate myself[3]. It implements the idea I wanted to use, so I just needed to figure out appropriate scale/radius values. On top of that I faded out these dots pattern when they got close to the bottom stem dot.



**Figure 14: Final dots displacement**



**Figure 15: Extra noise - little vein-like crinkles**

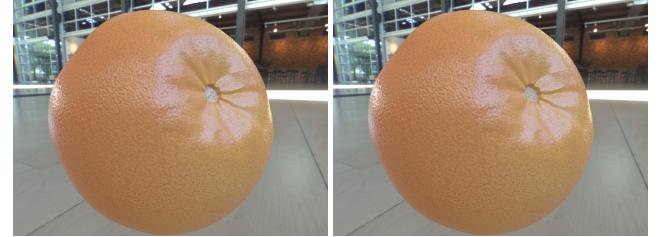
## 2.6 Extra bits

After finishing with the main displacement I had planned, I have come back to add some things to refine the look and fix issues I have found later during the process.

**2.6.1 Low Level Noise - Little Veins.** After looking at the mandarins more I realised I needed some more vein- and crinkle-like texture added to it. It is fairly subtle so just some wiggly lines generated by smoothstepped multilevel perlin noise do the job fine.

**2.6.2 Stem Hole Noise.** Being one of the first things I've tackled, the stem hole was not as detailed as I wanted it to be at that point. This was fixed by addition of extra noise inside the hole to mimic its actual rough texture.

**2.6.3 Other.** I have also come back to tune some of the noises a bit more at this point.



**Figure 16: Stem hole extra noise and roughness**

## 3 COLOR

The base color was done largely after the displacement so I had many masks already figured out. Among them top stem hole, bottom stem dot and the dots. All of these just use the calculated positions and give some pre-defined values to the mandarin surface, so I won't go in depth on it. Outside of these, there are two other colored artefacts I tackled: general color variation and tiny "black" dots scattered in some areas of the surface.

### 3.1 Low Level Noise

The general mandarin color varies a bit between more red and less red shades of orange. These are random and largely patchy. I have approximated this pattern with 10 layers of noise and two colors that seemed close enough to the real mandarins. Picking out the colors proved to be surprisingly difficult due to variety of lighting conditions.

### 3.2 Tiny Black Dots

At closer inspection, there are tiny black dots present on the surface of the mandarin. Some are scattered across random areas, and some are located around the bottom stem dot in the bottom squish. These dots look like different material from the mandarin skin - more solid with no reflections or subsurface scattering.

To make these dots, I reuse the same dots algorithm I have used before. However instead of fading them out in some area, I create two separate position patterns for them to occupy: the random one and the bottom center one. For the bottom center it is enough to have a fuzzy circle at the bottom and subtract the stem dot from it so they do not overlap. These dots also have smaller radius and are lighter in color. For the random one I layer multiple frequency noise to get the pattern similar to that on the mandarin and add the wider bottom squish area.

## 4 BRDF

The mandarin has a glossy skin with fairly strong specular highlight. It has areas of higher roughness such as stem hole, small black dots and bottom center dot. Also the main dots on the surface have higher subsurface scattering than the rest of the mandarin when lit up.

I used PxrDisney model for my mandarin with baseCoat, roughness and subsurface values being defined in the color shader. Subsurface color I decided on is a red-ish shade to match what I see in my



Figure 17: Mandarin tin black dots photo



Figure 18: Tiny black dots

experiments. I have tried to use PxrSurface to enable better subsurface scattering but in the end was not happy with the result so ended up switching back.



Figure 19: Tiny black dots position front and back



Figure 20: Tiny black dots final

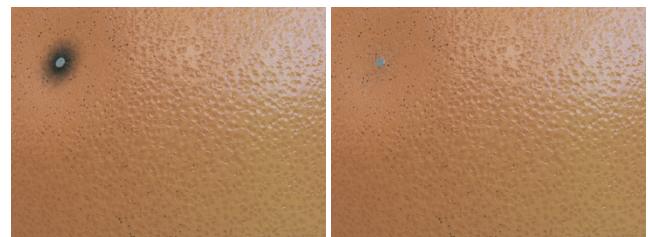


Figure 21: Tiny black dots bottom

## 5 FINAL IMAGE SET UP

For my final images I wanted to have one still life-like example which might showcase the subsurface scattering a bit better and one with multiple mandarins a la fruit flavoured product commercial.

### 5.1 Placement and Lights

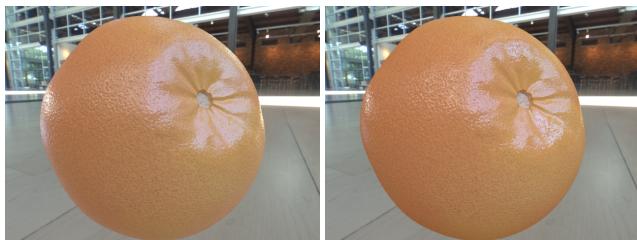
For the first image I placed my mandarin on a table plane with a wooden texture from Pixar. I've repeated the texture via a shader to get better resolution. The camera angle I chose highlights the slices structure and generally showcases the shape of the mandarin well. I have chosen an indoors apartment HDRI[1] for this scene with a window placed behind the mandarin to create a backlit scenario for this image. This way we can see the undertones of red from subsurface scattering as well as nice table reflection showcase.



**Figure 22: Mandarin subsurface scattering**



**Figure 24: Before and after depth of field**



**Figure 23: PxrDisney vs PxrSurface**

For the second image I decided to have several mandarins "fall" in a natural scene. This way I can showcase the displacement and textures of my mandarin from different angles including almost everything I have generated via shaders. The lighting in this scene is a garden HDRI[2] which provides harsh sunlight and suitable background.

## 5.2 Depth Of Field

In both images I have used depth of field, which I think works especially well in the first image where it blurs the table in the distance just about enough to draw attention to the mandarin in the foreground. Due to the lack of time I couldn't add motion blur to the second image despite it being perfectly suitable.

## 6 POTENTIAL IMPROVEMENTS

There are multitude of ways in which I can improve both the shaders and the images I have created, all of those being skipped due to the time constraints. As I mentioned above one such thing is motion blur which would greatly compliment the scene. There are also multiple places where more noise variation would benefit the result such as top stem hole as well as more middle frequency details on the mandarin skin. Both images would also benefit from better color matching and more BRDF tuning. However, even with all of this in mind I have learned a lot through this project and am proud of the result.

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