Rendering Project

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Fig. 1. Final image

This paper describes the process of creating a photo-realistic perfume bottle as shown in Figure 1. This project used Renderman with Python API for all aspects of the final render, including modelling, shading, texturing, lighting and rendering.

Additional Key Words and Phrases: RenderMan, computer generated images, visual effects

1 INTRODUCTION

The real-life object chosen for this project is a perfume bottle made of golden aluminium as shown in Figure 2.

This object is chosen because it can be constructed with simple primitives and there are some dirt and scratches which would be interesting to reproduce. Different parts of the object from various angles were taken for reference, which will be used for different steps in the process. This report will describe the steps to produce a rendered scene containing the object.

2 MODELLING

The object has two main parts, a cap and a body. These can be constructed with simple primitives, such as cylinders and spheres.

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Fig. 2. Reference image

The edges of the top face of the cap and bottom face of the bottle are smooth and the base of the bottle is slightly indented as shown in Figure 3. The object was measured to model accurately as shown in Figure 4.

The object was constructed using geometric primitives with RenderMan Python API [Pixar 2022]. The main part of the bottle body and the cap was constructed with cylinders. The curved part of the body was reproduced by a spherical segment. The radius and the

Fig. 3. Reference images for the top of the cap (left) and the base of the bottle (right)

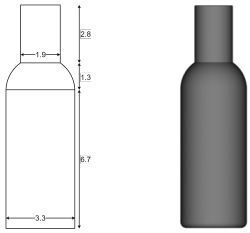

Fig. 4. Comparison of the measurement of the real life object (left) and the modelled object in orthographic view (right)

starting point of the segment were calculated with the formulas described by Weisstein [2006].

Toruses and disks were used to construct the smooth edges at the top of the cap and the base of the bottle as shown in Figure 5.

Fig. 5. Smoothed edges of the model

The cap is moved slightly upwards to make a small gap between the bottle and the cap.

3 BRDF

Both the bottle and the cap are golden metallic materials but the cap is smoother and shinier than the bottle. The body reflects less light compared to the cap due to the roughness, dirt and fine scratches on it.

The PxrDisney shader is used for both materials. The metallic value is set to 1 and the roughness value is set to 0 for the cap to recreate the shiny metallic material. The bottle is less smooth than the cap, so higher values are given for the roughness and anisotropic properties. Even though the bottle is made of metallic material, it looks less metallic compared to the cap so the metallic value was set to 0.9.

4 TEXTURE AND DISPLACEMENT

There are mainly two aspects of the body texture as can be seen in Figure 6. First, there are fine vertical lines running throughout the body. Second, there is a pattern with many random short vertical lines in darker colour.

Fig. 6. Fine lines on the left and texture pattern on the right

The implementation steps for texture and displacement in closeup can be seen in Figure 7.

Fig. 7. Comparison of the original texture (left), texture with the fine lines (middle) and with the pattern (right)

The pattern for the constant fine lines was calculated with OSL floor function and the calculated value was applied for both displacement and base colour to emphasise the pattern.

The random lines for the surface pattern were implemented with the combination of multiple Perlin noise and smoothstep functions as shown in Figure 8. First, random vertical thin lines were created using Perlin noise. To create lines with random lengths at random positions, a pattern to filter the created lines was generated by combining Perlin noises in u and v axes.

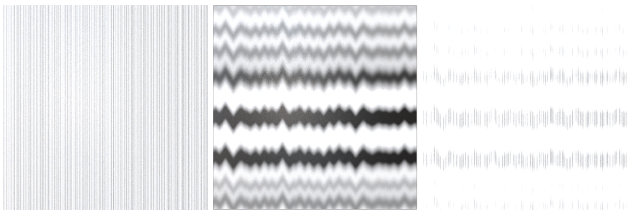

Fig. 8. Random lines (left), filter (middle) and filtered lines (right)

After filtering the lines, steps were repeated 7 times and the lines were overlaid to create the random pattern as shown in Figure 9.

The implementation results after applying the patterns described above can be seen in Figure 10.

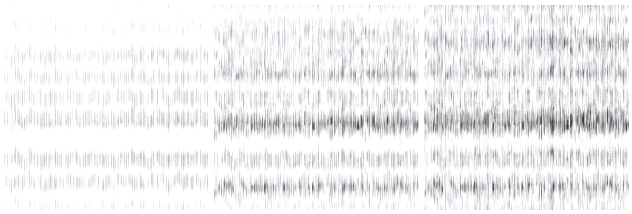

Fig. 9. After 2 loops (left), 5 loops (middle) and 7 loops

Fig. 10. Final result of texture implementation

5 NATURAL VARIATION

The pattern implemented in the previous section faded out at the middle part of the body as the part has been touched by fingers when grabbing it. Also, when looking at the object closely, there are many thin white curly scratches all over the body as shown in Figure 11.

Fig. 11. White curly scratches on the surface

As the object has been used for over 5 years, there are some small holes and a big dent on the surface as can be seen in Figure 12. In addition, a shiny pattern like metallic flakes can be found on top of the body surface when looking at it carefully.

The faded part was implemented by filtering a pattern representing fingerprints with a mask as shown in Figure 13. The pattern was generated using simplex noise and a mask was generated using a sine wave.

Fig. 12. Holes (left) and a dent (right) on the surface

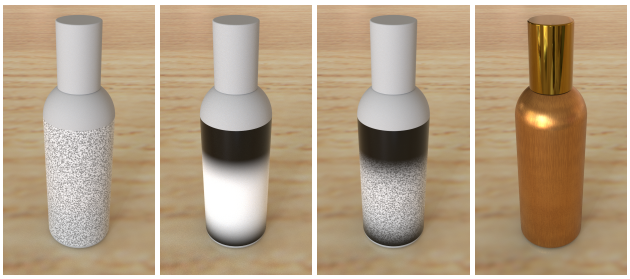

Fig. 13. Fingerprint pattern, mask, masked pattern and the texture after applying the pattern (from left to right)

The fine curly white scratches were implemented with a pattern and a mask similar to the fingerprint pattern. The pattern was generated by taking the absolute value of Perlin noise. The value was multiplied by 20 to make the lines thinner. The implementation steps can be seen in Figure 14

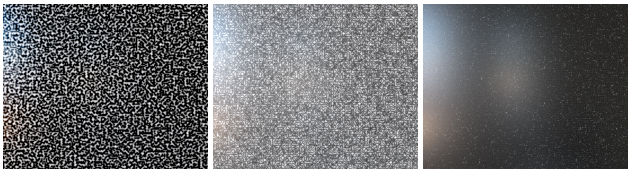

Fig. 14. The initial perlin noise (left), absolute value of the noise (middle) and multiplied value (right)

The random spots pattern was generated with the combination of simplex noise and linearstep function as shown in Figure 15. The pattern was applied for both base colour and displacement.

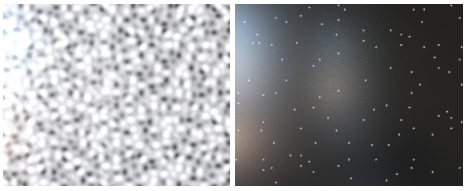

Fig. 15. Simplex noise on the left and pattern after applying linearstep function on the right.

The flake pattern on the surface was generated using PxrFlakes with less randomness and high frequency. The texture results in closeup after applying each aspect can be seen in Figure 16.

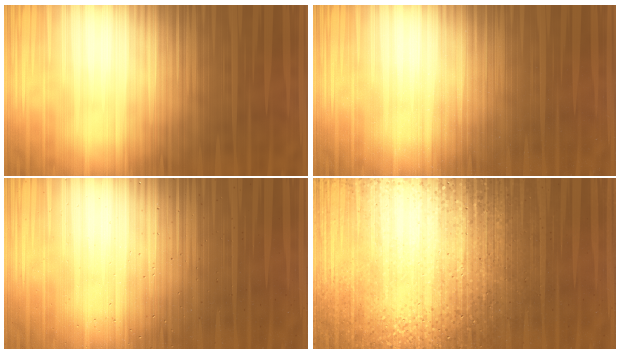

Fig. 16. The texture results after applying fade (top left), scratches (top right), spots (bottom left) and flakes (bottom right)

Finally, the big dent was implemented. I painted a texture for the dent in Krita and applied the R value as a displacement in the shader.

6 ENVIRONMENT MAP

The reference images were taken indoors with natural light coming from windows.

To recreate a similar environment, I looked for an indoor HDRI with no artificial light. After trials with various HDRIs, I decided to use a studio HDRI from PolyHaven [Poly Haven 2022] shown in Figure 17 and included in the scene using PxrDomeLight.

Fig. 17. HDRI [Poly Haven 2022]

I rotated the dome light to set the position of the window in the HDRI similar to the environment where the reference image was taken. Also, the intensity is slightly lowered as the lighting in HDRI is stronger than the reference image. As a result, the object is lighted similar to the reference image and the light coming from outside created a soft shadow of the object.

7 SCENE

The object was placed on a desk in the reference image.

The desk and wall were reconstructed using simple square patches. A wooden texture image and corresponding normal map available at Pixar One Twenty Eight [Pixar 2018] was used for texturing the desk. The wall texture was taken from PolyHaven [Poly Haven 2022] and applied to a patch similar to the desk. The roughness of the wall material was increased as it looked like a plastic material after applying the texture.

A bottle is placed in the middle of the scene and the camera is rotated slightly downwards to show the top of the cap. For the other version, different colours of bottles are placed in the scene and one of these is laid on its side to show the bottom part of the bottle as shown in Figure 18.

Fig. 18. Another Version

8 CAMERA ARTEFACTS

The reference image was taken with an android device with a low-quality camera. It is a flat image with no depth of field.

Even though the reference image doesn't have a depth of field, I wanted to add it to the final render to lead viewers' eyes to the object. After trials, I decided to use a 10mm lens and an f-stop of 4 to make clear focus on the object and some blur in the background. The field of view was adjusted to 40 so that the shape of the object looks similar to the reference image. For another version with multiple objects, the f-stop was increased to 8 to focus on all the objects clearly.

9 CONCLUSION

The final render was done with appropriate values of sampling, pixel variance and shading rate after trying with different values.

Even though I tried to generate a texture for the bottle similar to the actual object by applying various patterns I can find, it was very difficult to produce a photo-realistic bottle. Also, the pattern is mismatched between different parts of the bottle in the final images. I looked for a solution to this but it could not be fixed in the end.

Working on this project helped me learn various aspects of rendering process. Although there is still much room for improvement, I am satisfied with the final results.

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