

Team Third

Flow Visualization

By: Devin Sakamoto

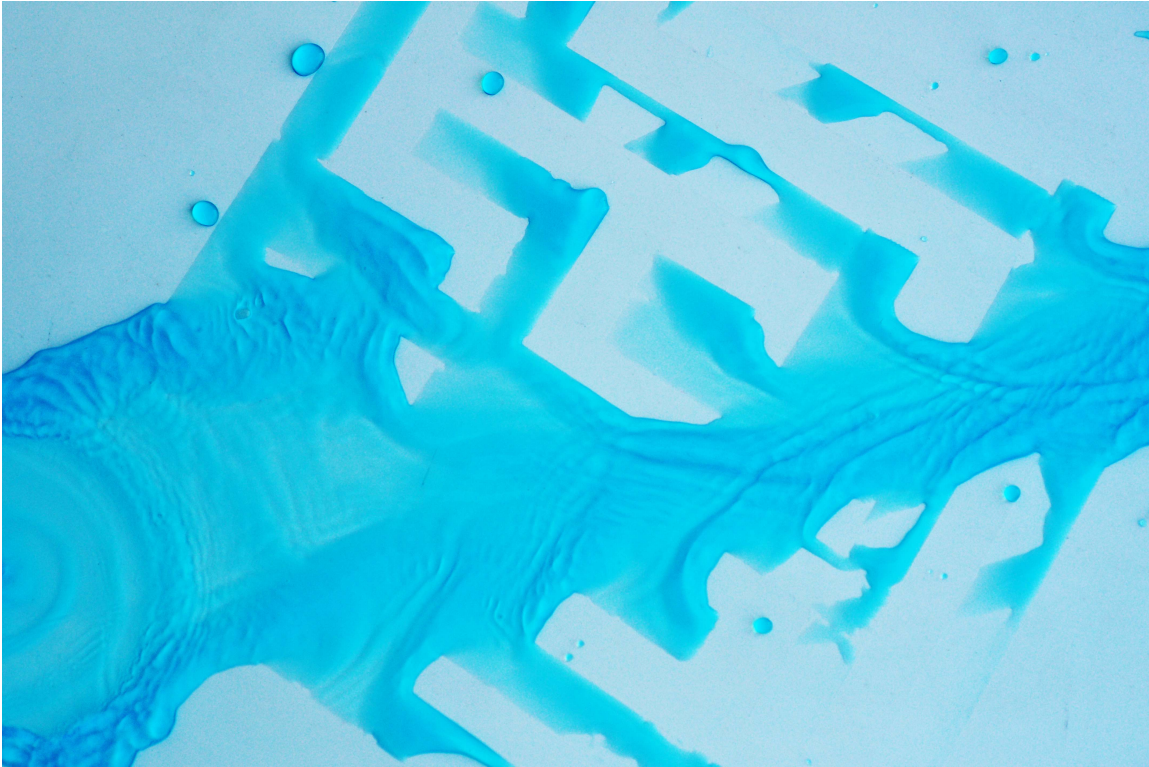


Figure 1: Final Image

Introduction

The purpose of this image is to illustrate the flow of water over a table with parts that are hydrophobic and parts that are not. This image is trying to replicate a video where a “maze” pattern was left not hydrophobic on a piece of acrylic and water was moved around. The water liked to stick the “maze” and the hydrophobic parts would stay dry. This image took another step to see how water would flow across the “maze” surface.

Background

Superhydrophobic surfaces are defined as a surfaces that repels water with a contact angle greater than 150° . Surfaces can do this with two properties: extreme micro-roughness and low surface energy. Surfaces with high energy have a natural high affinity for water. The opposite is true for a surface with low energy. Low energy surfaces tend to be more hydrophobic. When an extreme micro roughness is added to a low energy surface, the surface becomes even more hydrophobic. Water actually sits on top of the nano-particles with air in between the particles. Water cannot slip in between particles because the surface is already hydrophobic and the

space is too small. The actual contact area between the water and the surface is now dramatically smaller.

Visualization Technique

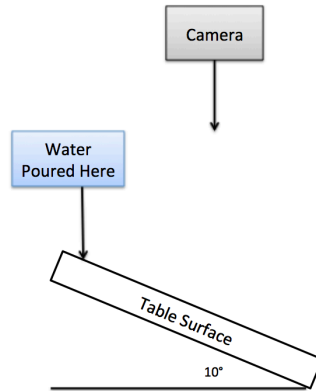


Figure 2: Image Setup

The setup used a white outdoor table made of plastic and metal. To create the maze pattern on the table, scotch tape was placed onto the table in the desired pattern. Then, Neverwet from Rustoleum was sprayed onto the table and left to dry for 24 hours. Neverwet is harmful to the body, so the table was sprayed outdoors to avoid inhaling the particles. Neverwet can be purchased online or at most home construction stores. After 24 hours, the tape was removed. The table was set to an angle of about 10° as seen in Figure 2. The maze pattern was situated so that one corner was at the highest point and the opposite corner at the lowest point. 8 oz. of water was mixed with three drops of blue food coloring and then poured onto the higher corner of the maze. The images were taken outdoors in the mid afternoon. They used only natural lighting.

Photographic Technique

The camera used was a Nikon D5000 DSLR with a macro lens. The macro lens was used to show the small details present in the flow. The lens focal length is 60 mm. The camera was about two feet above the table pointing straight down. Both the original and final images have pixel dimensions of 4288 x 2848. The image was taken in a shadow, so the aperture and the ISO had to be set to brighten the image. The aperture was set to f/5 and the ISO was set to 400. The fluid was moving so the shutter speed was kept lower. It was set to 1/400 of a second. Post processing was used to brighten the image and add a little bit of contrast using curves. Black spots on the table were also removed from the image using the stamp tool. The original image can be seen in Figure 3.



Figure 3: Original Image

Conclusion

Overall the image turned out well. All of the intended fluid physics shown are shown in the image and more. It is easy to see how the water interacts with hydrophobic material as well as water flowing around obstacles. The detail of the water is easy to see and it adds a lot of character to the image. To expand on this idea, the tape could be placed in different patterns to see the effect it has on the flow of the water. It would be interesting to see the effect of circular patterns of tape. In the end, the image could maybe use more color, but the actual details in the image are very easy to see and aesthetically pleasing.

References

"An Explanation of Super Hydrophobic Materials and How They Work." *AZO Materials*. AZO Network, n.d. Web. 14 Dec. 2015. <<http://www.azom.com/materials-video-details.aspx?VidID=408>>.

Ferraro, Nathan, and Joe Ferguson. "Superhydrophobic What? How Rust-Oleum NeverWet Works." *LiveScience*. TechMedia Network, 09 Jan. 2014. Web. 14 Dec. 2015. <<http://www.livescience.com/42461-how-neverwet-coating-works.html>>.