Brian Haug Flow Visualization
MCEN 5151 Oct 12th, 2020

Image-Video Report #2

(Final Edited Image 1300 x 868 Pixels)

This was the second image assignment, in which many different fluid states were to be captured. The goal of this assignment was to capture a natural flow. After a short walk along the Boulder Creek, a spot was selected in which water was flowing between two rocks. This spot was chosen because it displayed multiple flow aspects while still allowing for a close positioning to the flow.

In order to capture this image, the camera had to be very close to the flow in order to capture the most physics. While standing knee deep in the creek about two feet from the up-splash, the image of a gravity-driven flow is shown between the two rocks and crashing onto a rock on the bottom which creates a spray and turbulence. The water also splashes up onto the rock on the right side of the image creating a thin layer of water across the entire rock known as wetting. The turbulence can be estimated using the Reynolds number. In which the velocity was determined by water falling 1 meter and the approximate size of the channel was 20cm.

$$Re = \frac{\rho V D}{\mu} = \frac{1000\frac{kg}{m^3}\cdot 4.4\frac{m}{s}\cdot .2m}{9.737e{-4}\frac{N\cdot S}{m^2}} = 900,000$$

For an open flow, a Reynolds number above 500,000 is required to induce turbulence[1]. This image shows a laminar flow between the two rocks but once the water hits the bottom rock and starts trending upward you can see the turbulent flow within the whiteness of the water. This whiteness in the water is created when air bubbles get entrained in the flow. The image also shows high wettability on the rock because of the thin layer of water around the entire surface. This is due to the strong interaction between the solid rock and the liquid water. This can also be referred to as total wetting, in which the final result is a film of nanoscopic thickness produced by the competition between molecular and capillary force[2]. This is in contrast to partial wetting, in which the water does not spread but produces a spherical cap resting on the surface.

Since this flow took place naturally outdoors, it was crucial to select a sunny day. The light from the sun allowed for enough light that the flash on the camera could be turned off because it was causing overexposure in reflections on the water.

This image was taken with a DSLR Canon Rebel ESO SL1 using a 18-55mm lens. A focal length of 35mm was used at a distance of about two feet. In order to capture the quick moving flow, a quick shutter speed of 1/500th of a second was used. The image also had an aperture f/5 and an ISO of 800.

Original Image (5184 x 3456 Pixels)

Edited Image (1300 x 868 Pixels)

This image was also edited in darktable to help focus the image and touch up some spots. To start, a simple crop was used to cut the distracting green trees in the background and zoom in on the most interesting part of the fluid flow. The image also had a little fuzziness in the deep blacks, and the denoise tool was used in order to help smooth out the busyness. The highlight reconstruction also helped to clear up the water on the rock in the right of the photo. This photo also has two white dots caused by small water droplets on the lens. It was my choice to leave these in the image because they are not overly distracting. These dots are also in fairly complex sections of the image where a stamping tool could be used but might be detectable so the circles were left.

This image reveals some of the static fluid physics on an object, mainly the gravitational and adhesion forces between the water and the rock. Overall the image taken shows an exciting flow with many different water effects. The dynamics range produces and turbulent nature of the water creates an interesting image to dissect.

References

[1] Mankbadi R.R. (1994) Unsteady, Wall-Bounded Turbulent Flows. In: Transition, Turbulence, and Noise. The Springer International Series in Engineering and Computer Science, vol 282. Springer, Boston, MA. https://doi-org.colorado.idm.oclc.org/10.1007/978-1-4615-2744-2_7

[2] Gennes, P.D., Brochard-Wyart, F., & Quéré, D. (2004). Capillarity and Wetting Phenomena.