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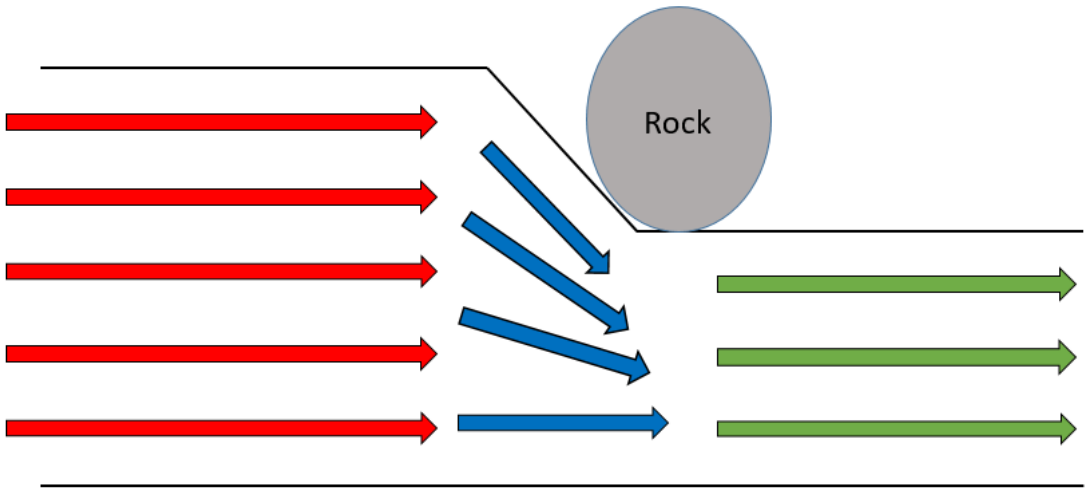
Get Wet Report
MCEN 4151 – Flow Visualization
2/19/2018

Laminar Flow in Boulder Creek

This image was taken at Boulder Creek on Sunday, February 4th around 10:00am. I worked with a partner, Ryan Neff to choose a good location and find good spots for photos. I chose to photograph this area because of the clear water and interesting reflections off the surface of the water. The reflections show that the water in the creek is laminar flow. This particular day was very overcast, but still very bright. This was the source of my light on the water, as the clouds acted as a diffuser of the sunlight. It was also a snowy day, which also contributed to the smooth lighting source. We can see a bit of snow on the rock to the right side of the image. After taking several images, I chose this one for the focus and capture of the interesting wave phenomenon.

The sketch below shows the transition of the water as it passes by the rock. It can be simplified as a pipe diameter change model. This simplification allows us to estimate parameters such as



Top view of transition region

Reynold's number and shear forces on the water. The Reynold's number equation is shown below.

$$\mathrm{Re} = \frac{\rho V L}{\mu}$$

From estimates of the flow velocity, we can assume:
V = 0.5 m/s
ρ = 1000 kg/m^3
μ = 8.9 * 10^-4 Pa
L = 3 m

This gives us a Reynold's number of 1685. The laminar region of flow is a Reynold's number of <2300, so our flow was clearly laminar. The numbers above were taken from the scale of the image, assuming the water at this point had a "pipe diameter" of 3m, which was just the width of the creek.

The visual technique used in this image was very simple. I tried taking the photo from several different angles to capture the flow and the light on the water. I also modified setting like exposure and focus to get different images, but chose this one based on its true-to-life resemblance. The lighting, as mentioned earlier, was the diffusion of sunlight. There were no external sources of light. The reflections off clouds and snow provided soft, even lighting for the surface of the water.

The FOV on this image is approximately 3 feet by 3 feet. I chose this region to focus exclusively on the water flow and reduce the background distractions. The flow was approximately 5 feet from my standard 18-55mm lens using a shutter speed of about 1/250 seconds. I used a Pentax K100 for the shot. In the end, I used Gimp for minor color enhancements and saturation editing. The image is fairly close to what the flow appears as in real life.

This image reveals the effects of uneven obstacles in the path of fluid flow. Creeks and streams have many interesting bends and obstacles due to the complex patterns of nature that create many different flow patterns throughout the length of the stream. I chose this pattern because many rocks create turbulent wakes, but this rock simply allowed the water to pass by in the laminar regime.

I think this image turned out very much like how I wanted. I did not do a lot of image processing because I wanted to keep the natural colors and effects of the light and water. It reveals the physics very well because the flow lines are highlighted by the light on the water's surface. If I could improve this image, I might consider getting a shot closer to the surface of the water to focus on the reflections and wave patterns of the flow.