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Flow Visualization
Team Project 2 Report

For this project, we wanted to capture a vortex in water. The intent was to produce a vivid and well light image of the vortex in a way that we haven't seen yet in class. We have seen excellent pictures of vortex rings created by aerosols or smoke, but not of water.

To create a water vortex, you can drain the water from a container. In this case, we used a bucket to hold the water. The bucket was a five-gallon white, plastic bucket. To drain the water, I drilled a 2 cm diameter hole in the bottom. To create the vortex, I first filled up the bucket half way with water. This started the draining process, and thus started to create the vortex at the bottom of the bucket. Once I could see that the water was spinning in the bucket, I added the food coloring drops. I also timed the drainage of the water to figure out the flow rate through the hole in the bucket. The 2.5 gallons of water added to the bucket drained in 29 seconds. Doing the math, I found that the water was draining at 0.086 gallons/second, or 5.17 gallons/minute. The picture was taken from above the bucket looking down. In the picture you could see almost the entire bottom of the bucket when looking down from the top (Fig. 1). Knowing that the bucket was 10 inches in diameter, this makes the field of view 78.5 in^2 . Vortexes are often created by turbulent flow, but this one looks laminar. (wiki 1)

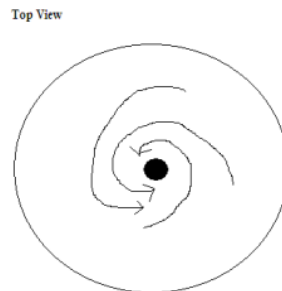


Figure 1: Top View

Vortex rings are made up of streamlines that rotate around a central point where the velocity of the spinning fluid is greatest near the center of the vortex. The strength of the vortex's rotation changes with time. It took a while for the vortex to start spinning, and got stronger as time went on. When the water level got below a couple inches the vortex lost strength due to the lack of water spinning around the center.

To visualize the vortex spinning around in the bottom of the white bucket I added food dye to the water. Once I could see that the water was spinning in the bucket, I experimented with adding different amounts and color combinations until I found a pattern that I liked. What I decided was the best for this image was the green food dye. The green dye showed up in the water the darkest and created the most highlights and depth of color. I added two drops of the green dye on the outer half of the spinning water. This allowed the dye to be pulled in to the center in a more uniform manner. Once the color started spinning I took this picture. I used two sources of lighting for this

image. The first was the normal overhead light from the ceiling in my kitchen. The second was a 100 Watt desk lamp. The 100W light was placed on the outside of the bucket, and it shined through the bucket onto the water. The reason I didn't use the 100W light above the surface of the water was because I was getting a glare and reflection of the light bulb in the picture. This distracted from the focus of the image, which was the spinning dye in the water.

As stated before, the size of the field of view was a little over 78 in². When I took the picture, I was holding the camera 6 inches above the water level, looking straight down into the bucket. The focal length used for this image was 5.8mm, with an f-stop and aperture value of 2.8. The shutter speed for this image was 1/60 second. The camera that I used was a digital, 6 Mega Pixel PowerShot SD630 Digital elph with a digital 3x zoom lens. The size of the image was 2816x2112 pixels. The only Photoshop processing done on this picture was cropping. I had to crop out the outside edges of the bucket as they were distracting to the eye when trying to study the picture.

I feel that this image reveals the beauty of flowing water. Water makes up everything in this world, and isn't always respected in the way that it should be. I feel that if you can see the beauty in water, and therefore in nature, you can get a different perspective on the way the world works. What I really like about this image is how the dark lines of concentrated dye stand out above the swirling dye below it. What I wish would be better is the focus and clarity of the image. When viewed on the big screen you could tell that the top of the image was a little blurred by the fast rotating water. This picture also allows you to see the physics of the rotating water in the green food dye, which was the intent of this image.

Resources:

1) <http://en.wikipedia.org/wiki/Vortex>