Michael Johnson

MCEN 4151

Professor Hertzberg

5/9/18

Team Third

Figure 1: Final Image

Introduction

This image was created for the Team Third assignment. The purpose of the image was to capture flow that was both turbulent and laminar using rheoscopic fluid. The setup for the image was more involved than previous assignments as well as the glass on the tank made it hard to capture an image that didn't have a reflection of the camera in it. I chose the above image due to the flow pattern looking like a night sky. This image was captured with the help of Michael Guenther, Lara Buri, Cara Med, and Madison Emmet.

Flow Apparatus

The flow apparatus that was used is shown below in figure 2. The experiment was run in the ITLL on CU Boulder's campus. A 55 gallon tank was used to contain the fluids and a recirculating pump was used to create the flow through the tank. This pump had a flow rate of approximately 0.05 L/s. A black plastic

sheet was then placed at the back of the tank to serve as a background for the images. Lights were then placed on top of the tank to provide light for the images as well. The camera was placed approximately 6-12 in from the side of the tank.

Figure 2: Experimental Setup

In an effort to see the flow patterns more clearly, rehoscopic fluid was placed in the water and allowed to flow through the system with the water. The rheoscopic fluid used was Pearl Swirl which does not list the ingredients to the solution listed on the bottle. The Pearl Swirl was used to reflect the light coming in from the top of the tank. The reflection of the light makes it much easier to see the way that the flow is acting. The flow through the system can be described as a turbulent flow over an object, which in our case was a nut. Although the nut is not visible in my image this is still the best way to describe the flow as the nut was out of the frame. To describe this flow mathematically we can use the equation for the Reynolds Number:

$$Re = \frac{\rho Q x}{A \mu}$$

Where ρ is the density of water, Q is the volumetric flowrate which is 0.05 L/s (5 x 10^{-5} $\frac{m^3}{s}$), A is the cross-sectional area of the tank which is 3 ft^2 ($0.27\ m^2$), x is the length of the tank which is 4 ft. (1.22 m), and μ is the dynamic viscosity of water which is 9.737 x 10^{-4} $\frac{N*s}{m^2}$. Solving this equation for the Reynolds number (Re) we find that Re = 232.02. This Reynolds number is low which tells us that the flow of the fluid through the tank is laminar. The object in the tank causes the flow to split so that it can move around the object this then creates a wake downstream from the object which in turn creates turbulence in the water. This turbulence is see in the middle of the final image in figure 1.

Photographic Technique

The image was captured using a Nikon D3300 DSLR camera with and 18-55 mm. 1:2.5-5.6 lens. The exposure setting was 1/15 sec., the f number was f/5.6, an the ISO settings were ISO-400. As stated earlier the camera was approximately 6-12 in. from the side of the tank. The camera was also placed at a slight angle downward in an attempt to cut down on the glare from the side of the tank. The original

image shown below in figure 3 has a size of 1478 x 987 pixels which is the same as the final image that I submitted.

Figure 3: Original Image

Using the original image I made the image grayscale using GIMP. This was all of the post-processing that I performed on the image.

Conclusion

Even though the setup for these images was more difficult than intended I think that the images turned out really well. I like how my image looks like a cloudy night sky with the particles in the image reminding me of stars. If I were to go back and try to capture this image again I would try and focus it a little better and maybe increase the contrast in the image to make it more defined. Overall I am happy with this image.

Image Assessment Form
Flow Visualization
Spring 2013

Name(s) Michael Johnson

Assignment: Team Third Date: 5/9/18

Scale: +, ! = excellent √ = meets expectations; good. ~ = Ok, could be better. X = needs work. NA = not applicable

Art	Your assessment	Comments
Intent was realized	!	
Effective	√	
Impact	√	
Interesting	!	
Beautiful	!	
Dramatic	!	
Feel/texture	√	
No distracting elements	!	
Framing/cropping enhances image	!	

Flow	Your assessment	Comments
Clearly illustrates phenomena	!	
Flow is understandable	!	
Physics revealed	!	
Details visible	!	
Flow is reproducible	!	
Flow is controlled	!	
Creative flow or technique	!	
Publishable quality	√	

Photographic/video technique	Your assessment	Comments
Exposure: highlights detailed	√	
Exposure: shadows detailed	√	
Full contrast range	√	
Focus	!	
Depth of field	!	
Time resolved	!	
Spatially resolved	!	
Photoshop/ post-processing enhances intent	!	
Photoshop/ post-processing does not decrease important information	!	

Report		Your assessment	Comments
Collaborators acknowledged		!	
Describes intent	Artistic	!	
	Scientific	!	
Describes fluid phenomena		!	
Estimates appropriate scales	Reynolds number etc.	!	
Calculation of time resolution etc.	How far did flow move during exposure?	√	
References:	Web level	X	
	Refereed journal level	N/A	
Clearly written		!	
Information is organized		!	
Good spelling and grammar		!	
Professional language (publishable)		√	
Provides information needed for reproducing flow	Fluid data, flow rates	!	
	geometry	!	
	timing	!	
Provides information needed for reproducing vis technique	Method	!	
	dilution	!	
	injection speed	!	
	settings	!	
lighting type	(strobe/tungsten, watts, number)	!	
	light position, distance	!	
Provides information for reproducing image	Camera type and model	!	
	Camera-subject distance	!	
	Field of view	!	
	Focal length	!	
	aperture	!	
	shutter speed	!	
	Frame rate, playback rate	!	
	ISO setting	!	
	# pixels (width X ht)	!	
	Photoshop and post-processing techniques	!	
	"before" Photoshop image	!	