Flow Visualization

Team Third Report

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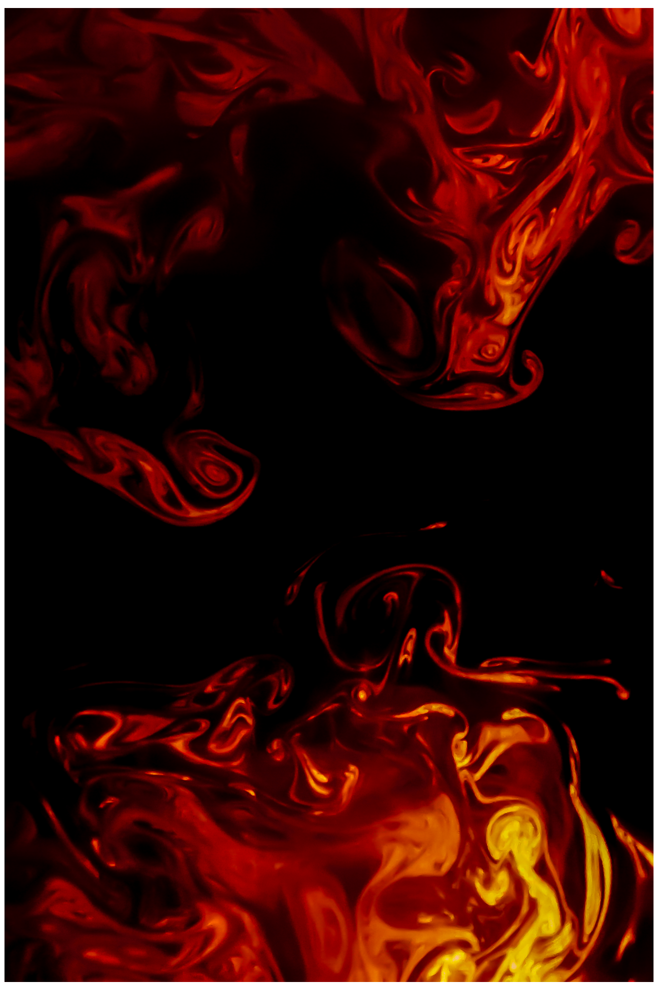

1 Introduction

The purpose of the "Team Third" project is to our last chance to work as a team to create some stunning flow visuals. After the discussion with all teammates, we have decide to play with laser and fog this time. Our team met at DIDL at idea forge at Fleming Building at CU-Boulder. In the following sections, I will introduce the experiment setup, the flow physics behind the image, as well as my post processing procedure. Team member includes Galen Melchert, Cyron Completo, Sung Moon, Kevin Oh and me Hanwen Zhao.

2 Experiment Setup

The untouched original image as show below, we set up a dark room for easier view of the laser. We tried some different setups but it turned out that to get the best view,we placed the laser machine on the ground and pointing upward. The fog machine is placed on the table pointing the laser sheet. The table was about 80 cm height, and distance between table and the wall is about 50 cm. The difficult of capture the laser sheet flow is that there are hard to focus since the darkness and big aperture we are using to ensure the maximum of light goes into the lens. A simple demonstration of setup as shown below:

The image was captured on Sony A7RIII with Sony FE 35mm f/1.4 lens. Here are some details of the image info:

- 35mm
- f/2.8
- 1/60 sec
- ISO 6400

3 Flow Physics

It is hard to capture any laminar flow in a small room with five people in it. Therefore, our team was aiming to capture some interesting turbulent flow images. The turbulent flow occurs at high Reynolds number. From the fluid dynamics class,

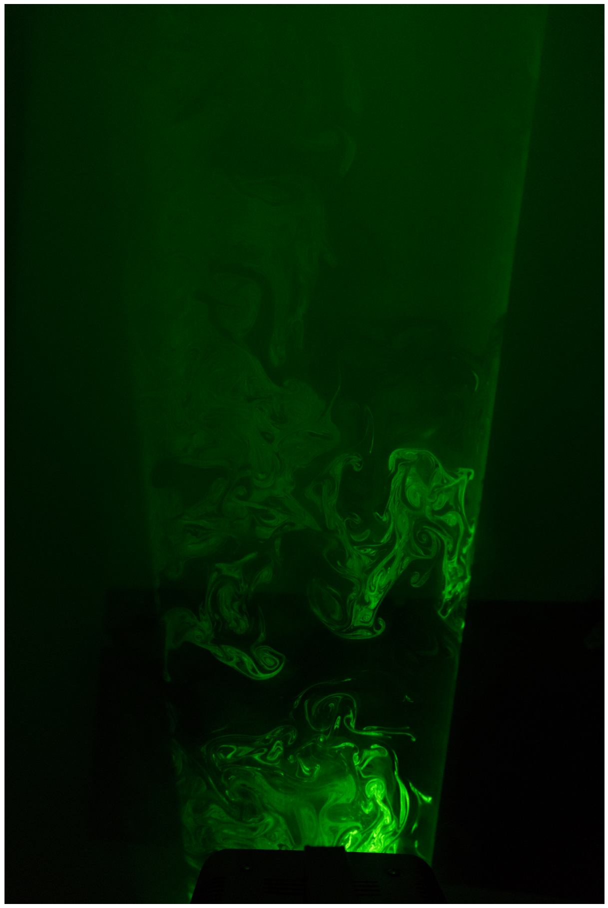

Figure (1) Original, untouched image.

we define Reynolds number Re < 2300 is laminar flow, and Re > 4000 is turbulent flow, any Reynolds number between them considered as transient flow. The Reynolds number can be calculated from the following equation:

$$Re = \frac{\rho v l}{\mu} = \frac{v l}{\nu} \tag{1}$$

Where:

- v = velocity of the fluid
- l = characteristics length
- ρ = density of fluid

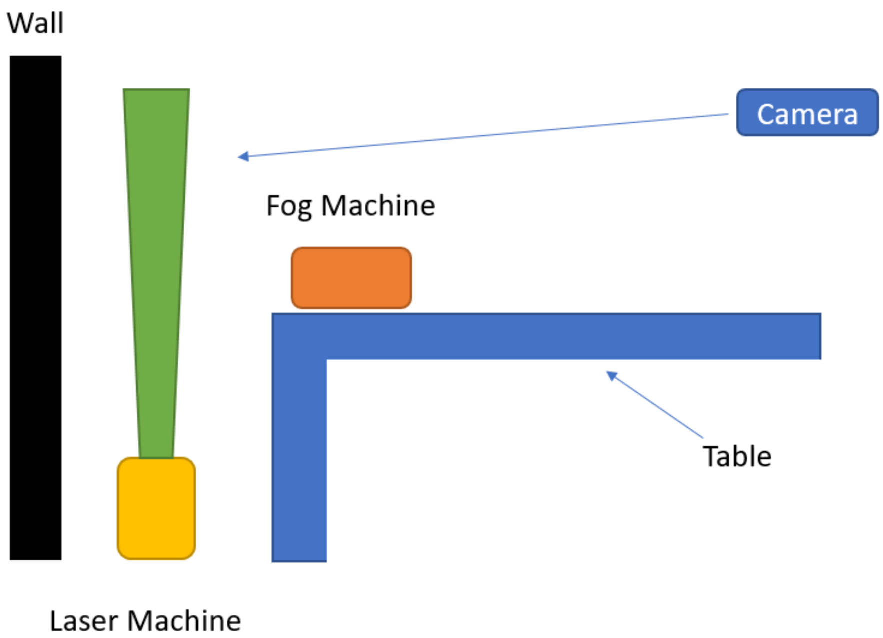

Figure (2) Magnets layout demonstration.

- μ = dynamic viscosity of the fluid
- ν = kinematic viscosity of the fluid

However, we couldn't specifically identify the parameters for the fog machine we are using. Therefore, we are estimate the Reynolds number based on 50-50 mixture of glycerol and water.

- ρ = 1142.0 kg/m^3
- v = 0.98094 m/s
- l = 0.60969 m
- μ = 0.00837 Ns/m^2

Plug into the equation, we have:

$$Re = \frac{1142 * 0.98094 * 0.60969}{0.00837} = 81601 \tag{2}$$

which falls into the turbulent flow region.

4 Post Processing

For post-processing, I don't really like the green color from the laser. Therefore, I first did color inversion in Photoshop and adjust contrast in Lightroom. The original image was quite noisy due to high ISO, thus, I applied noise reduction in Lightroom. The following images show parameter I adjusted for this image.

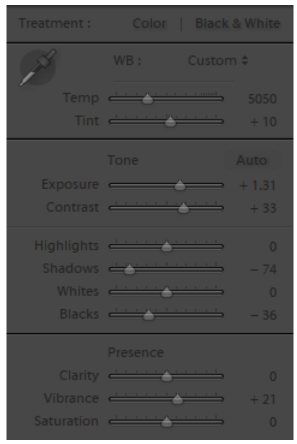

Figure (3) Before color inversion.

Next, I tweak some values on the shadows, whites and blacks to create better contrast.

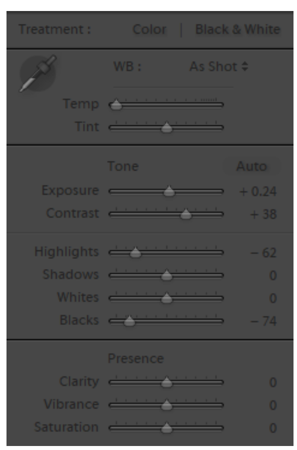

Figure (4) After color inversion.

5 Acknowledgements

Special thanks for Professor Hertzberg provided us fog machine and laser machine.

6 Reference

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