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Flow Vis Team Photo 3

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For my third team photo, I chose to take a picture of fog produced by a common fog machine. The original intent was to take a picture of a "helicopter" leaf as it spirals down and the affect it has on the fog. This turned up being harder than we originally thought. The leaf didn't affect the fog enough, and we didn't have a high-speed camera as well to capture the fast movements. From this attempt I realized that the fog was producing some very interesting flow when bouncing off the background set up.

For the photo a fog machine was placed about one foot away from a solid black background. The black background was tilted at approximately 70-80 degrees from horizontal. This created an upward flow of the fog against the background. This flow now created awesome vortices, which I could observe with my eye and catch on camera. Vortices are circling flows that are often turbulent, and always beautiful. The speed of fluid flow is fastest at the center of the vortex, and decreases with distance from the vortex center [1]. You can see these vortices especially toward the upper part of my photo. The force and the angle that the fog is hitting the background cause these vortices. Also aiding to this vortex formation is the curved nature of the background. The black background is actually a targa roof for a car and is curved where the fog is hitting it and causes rotational motion. Vortices are typically defined by their vorticity, which is defined as the curl of the fluid velocity [2].

$$\omega(z, t) = \nabla \times \mathbf{v}(\mathbf{z}, t).$$

This equation defines the angular velocity at every point by taking the gradient crossed with the linear velocity at every point.

For this image the visualization was very simple. Fog is naturally visible to the human eye but to enhance the flow visualization I set the fog machine in the sunlight instead of using artificial light. This gave very clear and crisp photos especially against a black background.

The field of view for this photo is approximately 2 ft x 2 ft after being cropped. I shot the photo using a Canon PowerShot SX30 IS. The focal length was 22.546 mm with a F number of 4.5. Also the exposure time was 1/100 second which gave the best light

for the photo. The final dimensions were 2928 x 2208 pixels after cropping. Using Photoshop, I blacked out the background completely making the fog even more radiant. I also changed the curves in order to capture the full spectrum of colors in this photo. I changed it to black and white only since I was using a black background and the smoke is predominately white and grey. I played with a few other tools such as brightness/contrast, exposure, and gradient map as well, but they were very minor changes.

I think this image reveals some great visualization for the reaction of fog to an outside force as well as vortex formation. I would be really interested in seeing what causes some of the fog to "peel off" of the vortex. I would assume pressure or air gradients would cause some peel off, but I could not find anything online. I would have liked to have a high-speed video camera to capture the movement and watch the formation of these vortices. Vortices are a stunning phenomenon and I'm glad I could capture some in a photo.

1. http://www.learner.org/courses/physics/glossary/definition.html?invariant=vortices
2. http://www.ams.org/notices/201101/rtx110100010p.pdf