Smoke from Burning Paper

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Team First

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Figure 1: Colored smoked from burned paper

Team #07: Ross Cooper, Dylan Crane, Anna Lynton

Background

For the Team First project, our team wanted to capture images involving smoke and lasers. Since it was hard to capture quality images using a zero-blaster and laser apparatus, the team continued on to just capture images of smoke. My goal for this project was to take a quality picture of smoke and work on my post-processing skills. Working with Ross Cooper, Dylan Crane, and Anna Lynton was a great opportunity because everyone was excited for the project and had good ideas.

Capture Setup

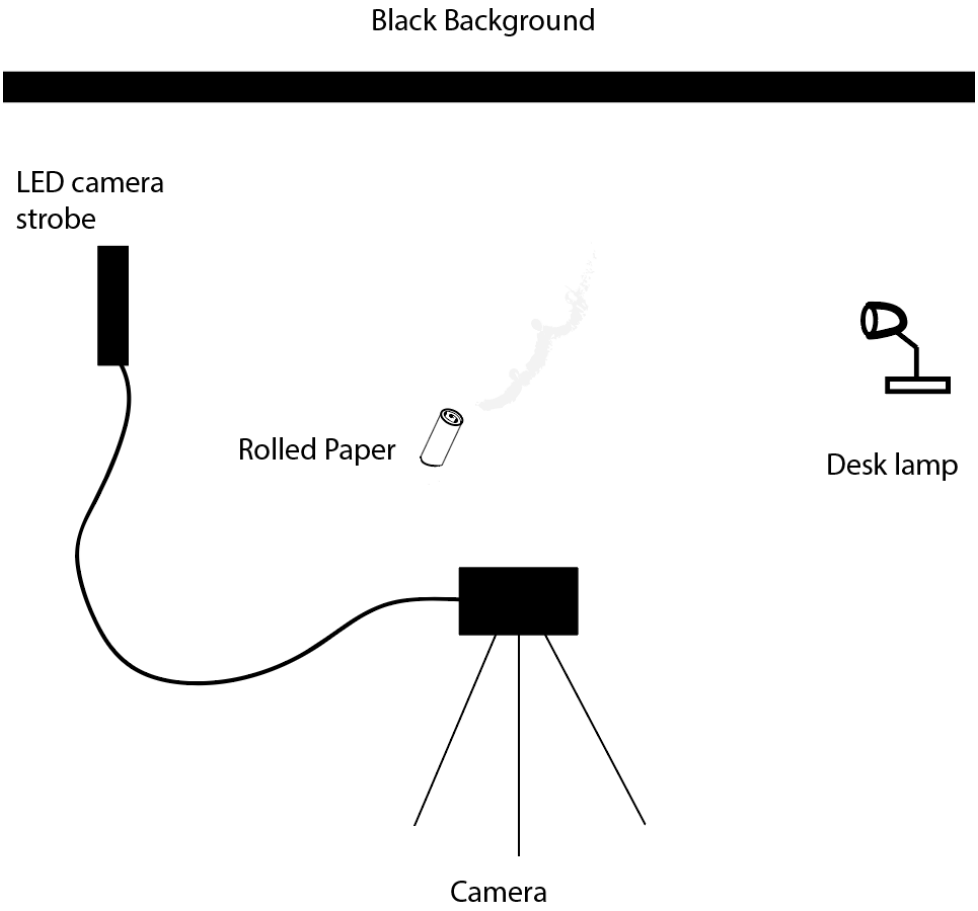

Figure 2: Capture setup

Figure 2 shows the setup used to capture the image. An LED camera strobe and desk lamp were used as light sources. They we positioned on both sides of the smoke relative to the camera to optimize the light. A black background was used to maximize the contrast. The piece of paper used was a standard 8.5” x 11” piece of printer paper. Thus, the smoke in the photo of the image is about 1 inch to 2 inches long.

Flow Physics

The image shows a short plume of smoke. The Reynolds number, defined as

$$Re = \frac{UD}{v}, \quad (1)$$

where *U* is the velocity, *D* is the distance, and *v* is the dynamic velocity describes the flow regime [1]. Laminar flow is sheet-like smooth with little disturbances while turbulent flow is chaotic with irregular fluctuations. The flow is clearly laminar since the flow looks smooth and sheet-like with no distortions. The smoke follows a laminar pattern because the ambient flow of air near the source is very parallel to the edge of the paper. As you go farther from the smoke source, the air flow is less uniform, causing the smoke to have an increasing scattered flow. This is pictured in Figure 3. Since this plume of smoke is small and close to the smoke source, the flow is laminar.

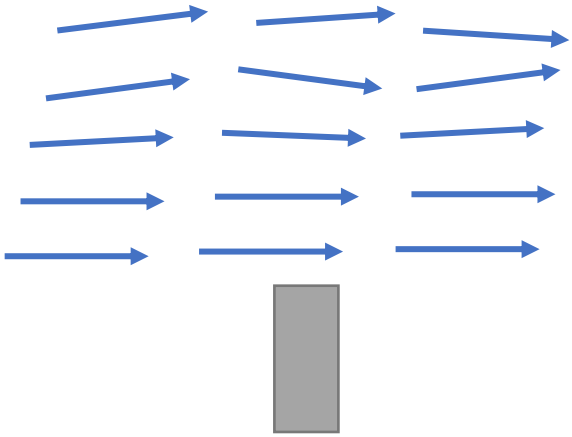

Figure 3: Ambient air boundary flow

Visualization Technique

We used a lot of light to capture the smoke, an LED camera strobe light as well as a desk lamp. The paper was lit and then held for a few seconds until dropped in a trash can while the images were captured.

Photographic Technique

We used a Nikon D610 DSLR camera with a Tamron AF 28-300 mm lens. The camera was set up at 55 m focal length, an ISO of 1100, F-stop of 5, and a shutter speed of 100. The lens was about 4 feet away from the burning paper when the picture was taken. The original image was 4016 pixels by 6016 pixels and the edited image was 600 pixels by 900 pixels. Figure 4 shows the post processing edits used to enhance the photograph. I increased the exposure, shadows, and whites of the image as well as decreased the contrast, highlights, and blacks to make the smoke pop. I then messed around with the colors until I was satisfied.

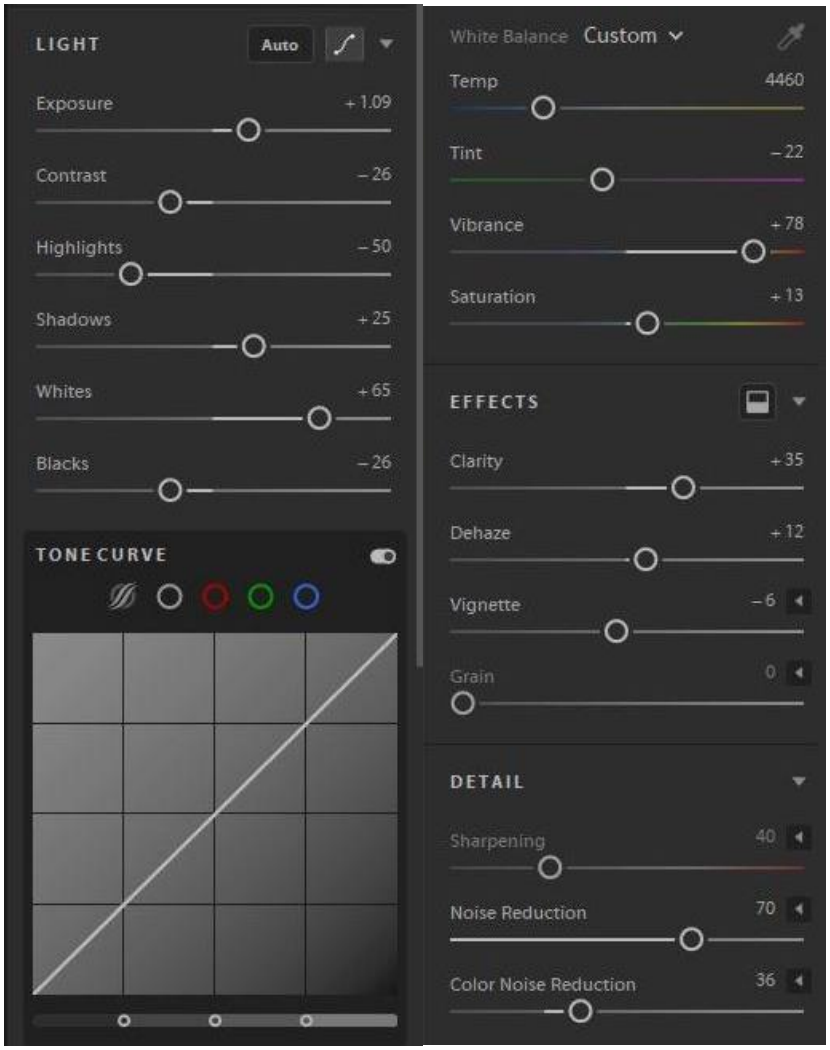

Figure 4: Post-processing edits

Results

I like the contrast in the image. The blue smoke pops against the black background. The laminar flow of the smoke is clear. I would like to know why the smoke looks like it has a tip to it. I fulfilled my intent with this image because as a novice photographic, I am glad to have taken this quality image with my team. I would like to take more smoke photos to keep improving on my fluid flow photography skills.

References

[1] Munson, Bruce Roy, et al. *Fundamentals of Fluid Mechanics*. John Wiley & Sons, Inc., 2013.