Team First: Flame

Noah Granigan

October 10, 2018

MCEN 4151-001: Flow Visualization

University of Colorado Boulder

I. INTRODUCTION

This Team First Image is of a partially pre-mixed flame, and was made with the help of Brandon Gushlaw, Winston Douglas, and Peiwin Yang. The intent of the image was to capture the flow of a partially pre-mixed flame. I tried many different camera angles with different ranges of depth. The side view, displayed in Figure 1, had the best view for being able to tell what was going on in the flame. The flamelet concept for partially-premixed combustion is based on an equation involving the scalar field.[1]

II. APPARATUS & FLUID MECHANICS

To capture this image, I stood next to a teammate who was holding the flame with an actuator, and spraying Dove Men+Care Dry Spray deodorant, with the "Extra Fresh" scent. I captured the image of the flame, which was approximately 50 cm in length. The camera was approximately 40 cm from the frame along the z-axis, and the approximate shot I took is within the blue rectangle.

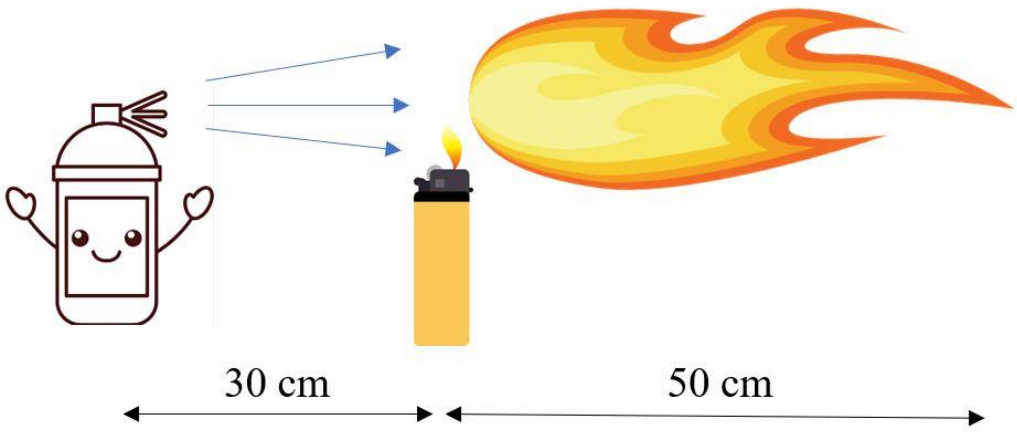

Figure 1: Diagram of apparatus, camera 40 cm from frame along z-axis

Muller et. al. created a model in 1994 that was used to calculate the unsteady flame propagation and the stabilization in turbulent jet flames.[1] It's a very complicated model, but it's remarkable to me that something that seemed unpredictable like a flame can me modeled with advanced mathematics.

III. VISUALIZATION TECHNIQUE

No color aides were used in the making of this image. Dove Men+Care Dry Spray deodorant was provided by myself. Brandon Gushlaw provided the lighter, and we all took either images or slow-motion videos of the flame. No additional lighting was used either; there was no flash on the camera. There was no lighting on the flame, including natural light, as it was taken at night.

IV. PHOTOGRAPHING TECHNIQUE

The camera used for this photograph was a digital Nikon D300, which I borrowed from my teammate, Brandon Gushlaw. The focal length of this shot was 55 mm, and the exposure was $^{1}/_{1250}$ of a second. The aperture was f/5.6 with ISO set to 400. These settings are not surprising for a picture of a light source surrounded by darkness. The distance from the flame to the lens was about 40 cm. With the desired camera height, even with the flame, the field of view in the final image is about 50 cm horizontally and 30 cm vertically. I chose the camera location and angle, so I could frame the flame the best I could.

***Figure 2**: The original image*

The original image, Figure 2, had a size of 2896×1944 pixels, and the final image, Figure 4 seen below, had an image size of 1933×981 pixels, due to cropping. The curves were adjusted as well, as shown in Figure 3. This was done to make the background blacker and enhance the flame. Other settings, such as the contrast, brightness, and saturation, were altered to accentuate the flame. The clone stamp tool was also used to remove flame sections that were not aesthetically pleasing.

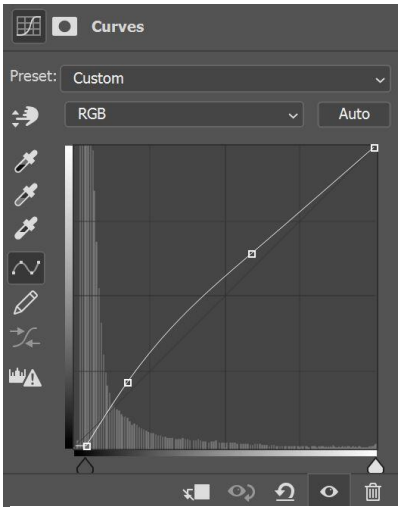

***Figure 3**: Adjustments to the curves*

V. RESULTS

The final image, Figure 4, reveals the flamelet concept on a partially pre-mixed flame that can be modeled and predicted using the scalar field. The physics of this phenomenon is demonstrated with the captured image of a turbulent partially pre-mixed flame completed using a flammable spray onto a lighter. I like how I was able to get such a great contrast of the black background and the bright flame. I believe that I was successful with this image, but in the future, I would like to figure out a way to reduce the noise of the image. This is common with new photographers shooting in the dark.

Figure 4*: The final image, also shown on title page*

VI. REFERENCES

[1] Muller, C. M., Breitbach, H., and N. Peters. “Partially premixed turbulent flame propagation in jet flames.” *Science Direct*. vol. 25, no. 1, pp. 1099-1106. https://doi.org/10.1016/S0082-0784(06)80747-2. Accessed 10 Oct 2018.