

Visualization of Combustion Within a Hybrid Rocket Motor

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As part of my thesis research I have collected images of combustion within a hybrid rocket motor. These images come in three distinct forms: color images, grayscale schlieren images and grayscale images of OH* chemiluminescence. For each test I have over 30,000 images. My EE368 project will consist of analyzing these images, and will focus specifically on completing the following tasks:

1. Develop code to remove noise in the OH* chemiluminescence images. It appears that the camera used to collect these images was slightly damaged, resulting in bad pixel values in random columns within each image.
2. Develop code to project the schlieren and OH* images onto the same plane using grid images taken prior to each test. Overlay the images by minimizing the squared difference between the leading edge of the fuel grain in each. Create a colormap for the OH* images and determine appropriate grayscale scaling/cutoff for display of the schlieren images.
3. Develop a code to take a mean of many images, detect the original fuel grain edge prior to combustion, locate the peak in OH* chemiluminescence and evaluate the edge of the boundary layer. Texture based methods, such as those described in references [1] and [2] shall be investigated in order to analyze the boundary layer development in the schlieren images. References [3] and [4] are also being consulted for this task.
4. Develop a code to look at the mean OH* pixel intensity throughout each test in order to quantify burn times for each test.

If time permits:

5. Explore the turbulent scales seen in the schlieren images e.g. by applying Hough transforms or looking at the spatial variation of the images in the Fourier domain.
6. Investigate the frequency of oscillation of the images by looking at the temporal variation of pixel intensity in the Fourier domain.

Note that work on the above tasks has already commenced. The code for Task 1, 2 and 4 is mostly complete. Much of the remaining time this quarter shall be spent running these codes and working on completing task 3. Tasks 5 and 6 will only be commenced if time permits.

This project does not require the use of an Android phone.

References:

- [1] Bovik, AC. *Handbook of image and video processing*. Academic press, 2010.
- [2] Gonzalez RC, Woods RE, Eddins, SL. *Digital image processing using MATLAB*. Pearson, 2004.
- [3] Smith, NT. *Schlieren sequence analysis using computer vision*. 2013
- [4] Smith, NT, Lewis, MJ, Chellappa, R. *Detection, Localization, and Tracking of Shock Contour Salient Points in Schlieren Sequences*. AIAA Journal (52:6, 1249-1264), 2014.