# NASA Droplet Image Analysis

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Summary

## I. PROJECT OUTLINE

This project tackles the problem of analyzing images of fuel cell droplets with various image recognition techniques. The goal is to determine the correct radius as a function of time of a moving combusting droplet, taking into account obscuration of the image due to sooting, ash build-up, and loss of resolution due to diffraction.

Our final product is aimed to assist NASA research into efficient fuels, for the purpose of ground and space travel. We hope to help accelerate the analysis process by several orders of magnitude– from years to hopefully a few weeks.

We tackled the problem with two similarly related, but distinct algorithms, one implemented in Matlab and the other in C++. The programs both implement the Hough Circle Transformation in seeking and measuring the objects size and diameter, but how each program executes and tackles different scenarios differs.

Both programs attempt to track the droplet's movement across the frame, and measure the radius as a function of time, as accurately as possible. While the Matlab version analyzes the droplet with greater accuracy for high to extreme noise levels, it does take 15-30 minutes to execute. OpenCV takes 1-2 minutes to execute on each sample, offering speed as well as accuracy, but is restricted to situations when the noise level is mild to moderate.

## II. PROJECT TIMELINE

1. We each took five weeks to serve as group leader. Tasks included:
   (a) Planning meetings with Professor Liu and our sponsor.
   (b) Communicating with our sponsor via email.
   (c) Scheduling group meetings.
   (d) Making sure group is aware of due dates.
   (e) Submitting assignments.
   (f) Coordinating presentations.
   First 5 weeks was done by Amanda, the second 5 by Willie, the third 5 by Ramya, and then the last 5 by Rylan.

2. Rylan wrote the first draft of the MATLAB script.

3. The group decided to bifurcate. One team would develop an executable based on OpenCV, the other based on MATLAB's image processing toolbox.

4. Ramya worked on OpenCV (entire implementation).
   (a) Looked into installation and documentation of OpenCV.
   (b) Worked on preliminary scripts and algorithms in OpenCV.
   (c) Worked on modifying script so as to run on all files in directory, as well as locate all possible candidates for the circle.
   (d) Worked on modifying the algorithm so as to implement a backtracking approach to reduce false IDs of circles. Had to rewrite algorithm several times.
   (e) Worked on creation of video file and GIF file for result checking via command line tools in UNIX.
   (f) Debugged and code up-keeped OpenCV version.

5. To see what would work well, the MATLAB team worked on three algorithms.
   (a) Rylan looked into active contour models and edge detection algorithms
   (b) Amanda worked on multi-level zoom (i.e. identify a region of interest, zoom, identify a region of interest, etc.) She also wrote the Make_Video script in the final software package.
   (c) Willie looked on dynamic circle finding (i.e. vary sensitivity, threshold)

6. Willie put it all together for final draft of MATLAB