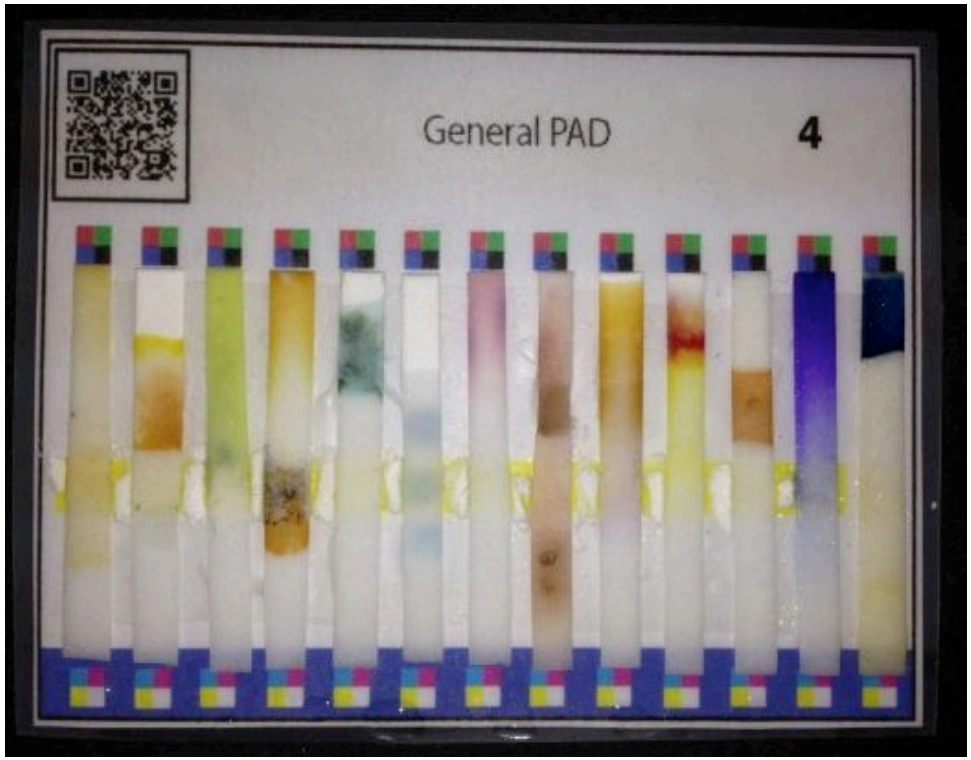
Qualitative Computational Analysis of Paper Analytical Devices

Tabitha Ricketts, Jenna Wilson



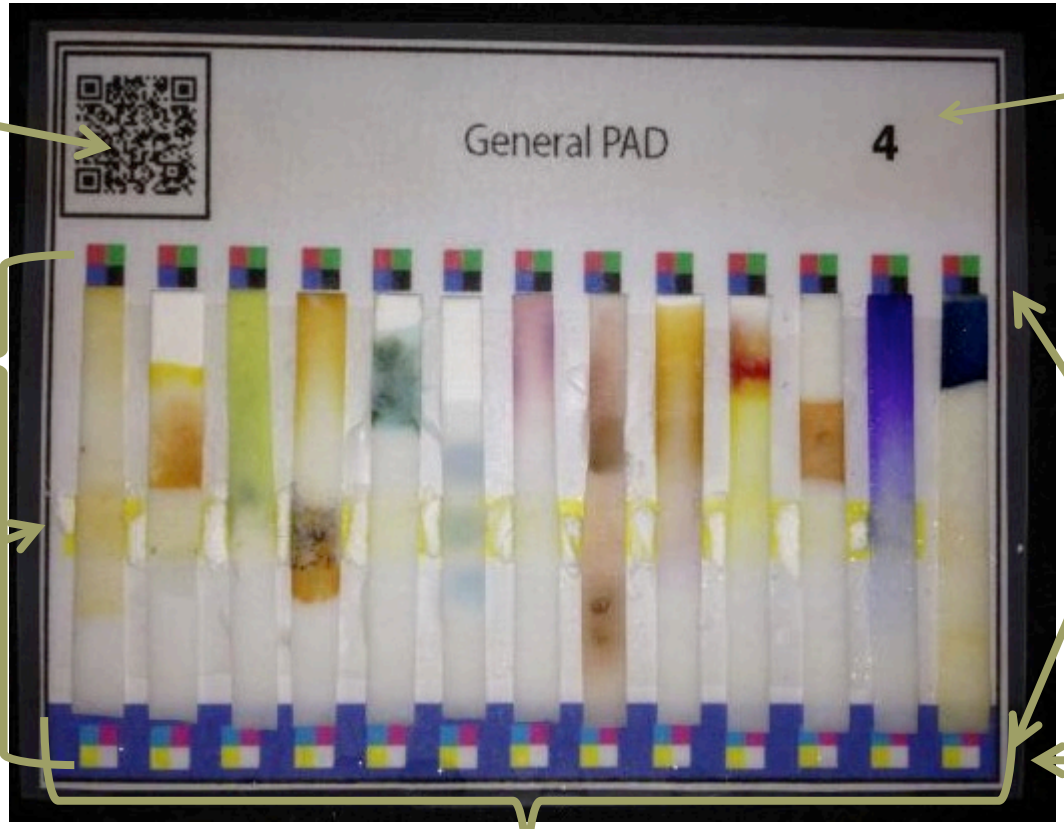
Faculty Supervisor Dr. Ian Bentley

Saint Mary's College, Notre Dame, IN 46556

Overview

- Background
- Two programs
  - PAD Lane Locator
  - PAD Catalog Generator
- Goal: fully automated PAD analysis

Paper Analytical Device



QR (Quick Response) code

Spotting position

Scrape line: for sample placement

PAD backing: hydrophobic laminate

Fiduciary markers: for alignment

Water line

Lanes for different colorimetric tests: hydrophilic lanes of paper

The Need

Why do we need the computational component for the PADs project?

- It provides an objectively qualitative analysis of color data, independent of human involvement
- It logs the data in catalogs of known samples, to compare with unknown samples for identification
- It allows for rapid analysis of a large number of PADs
- It is working towards the end goal of a fully automated identification analysis program that will help make PADs useable in target areas

Program Functions: What It Does

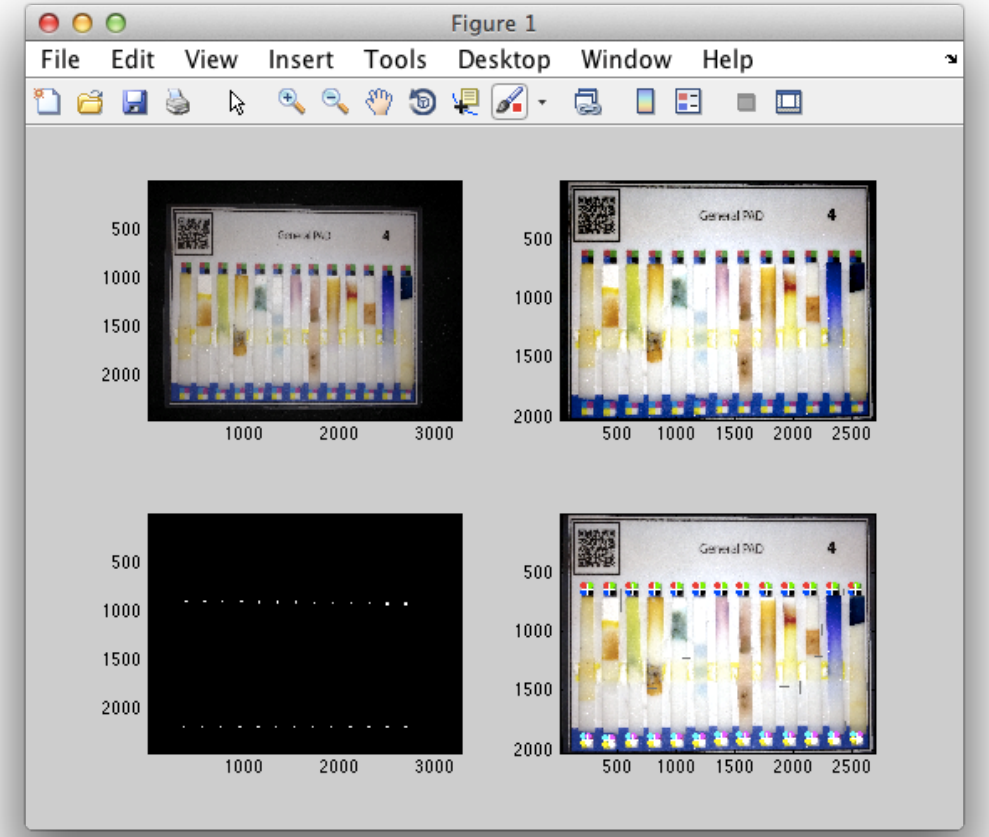
Lane Locator

- Determines position of fiduciary markers on a PAD image
- Records fiduciary marker positions to orient image
- Accounts for any missing or obscured markers
- Approximates location of lanes

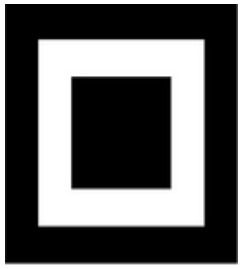
Catalog Generator

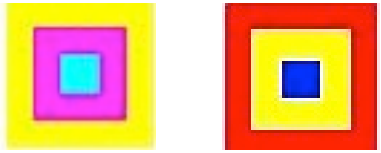
- Lets the user click within located lanes to define areas of interest
- Analyzes the RGB data within the selected areas to determine the exact color
- Exports the data in various forms, and generates a catalog of known samples

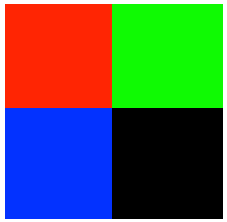
Lane Locator



Using Markers



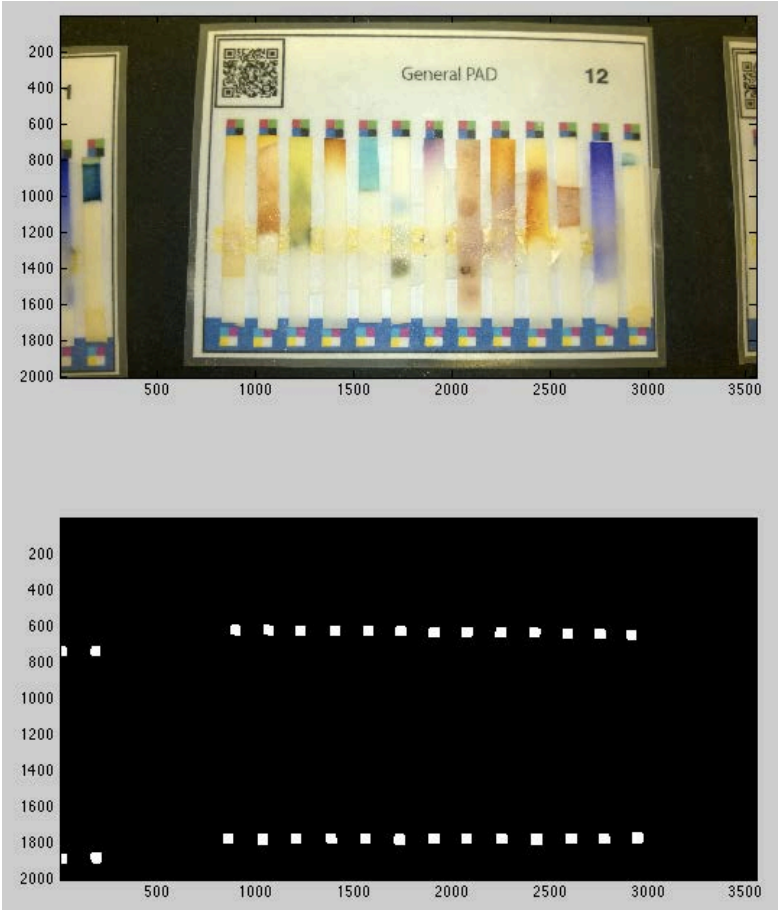




- The markers we are using on the PADs now are the third markers that we have tried.
  - This problem affected both program and PAD development
- We began with concentric squares, where we looked for colors bordered by other colors.
  - We found this difficult due to blur from printing and the original picture capture
- We are now using markers with adjacent colors, rather than concentric squares.

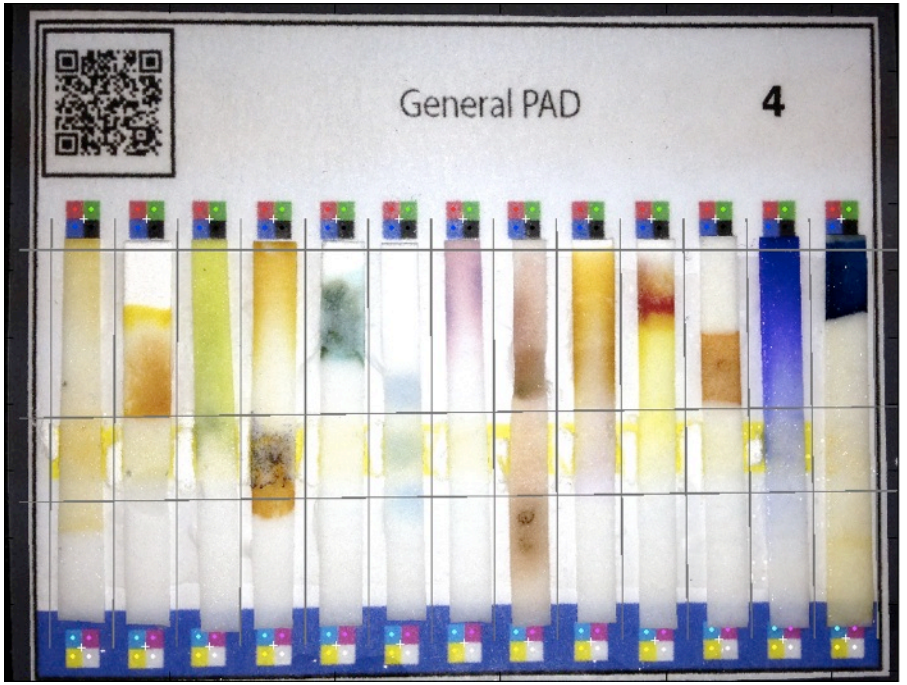
Identifying Markers

- First, we identify and label markers
- Next, we find the centers of each found marker
- Then, we use a random permutation generator to find the straightest best-fit line and exclude any false markers found
- Finally, we find the four corner markers
- Using the corner markers found, we can estimate where any missing markers should be

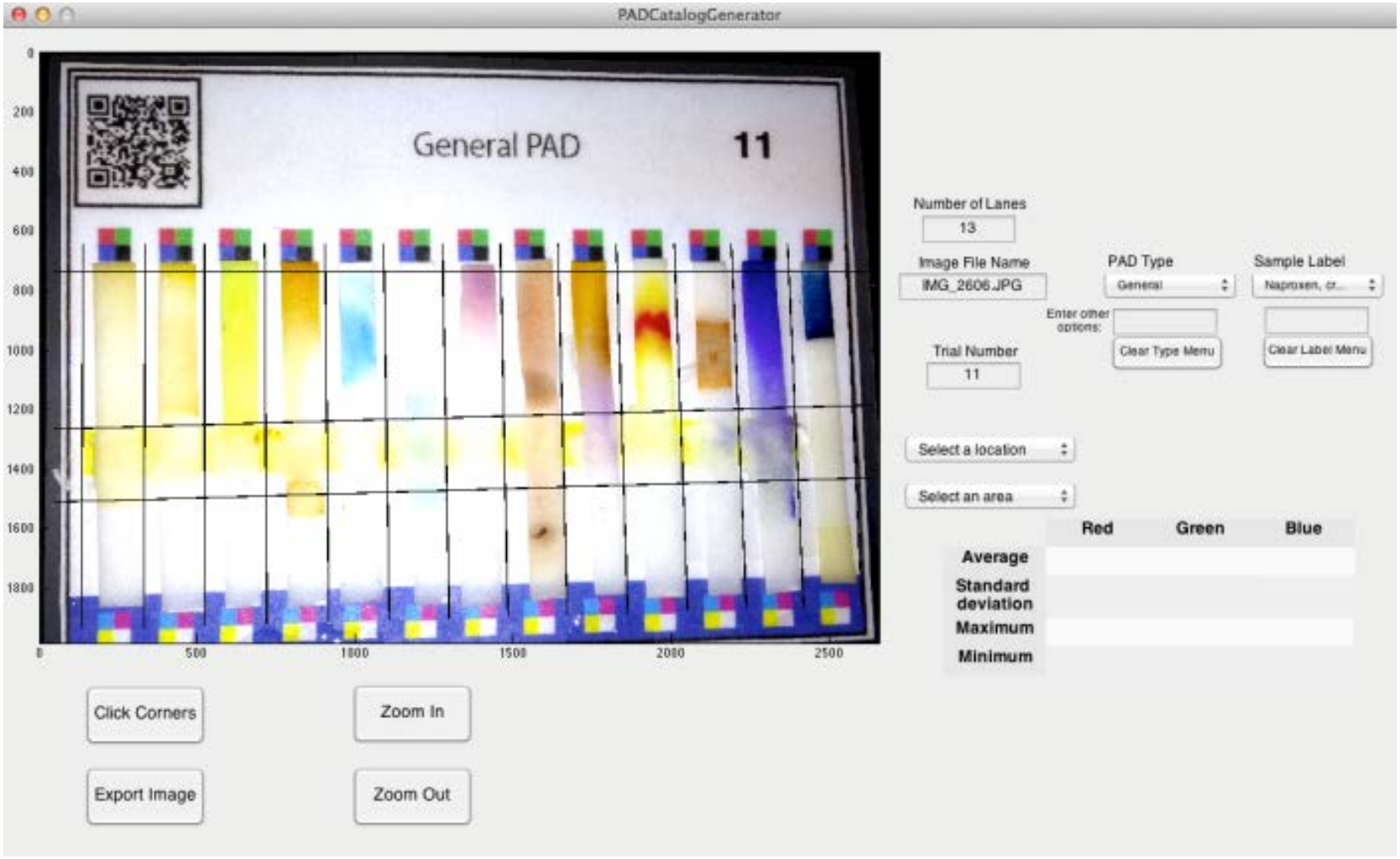


Labeling Lanes

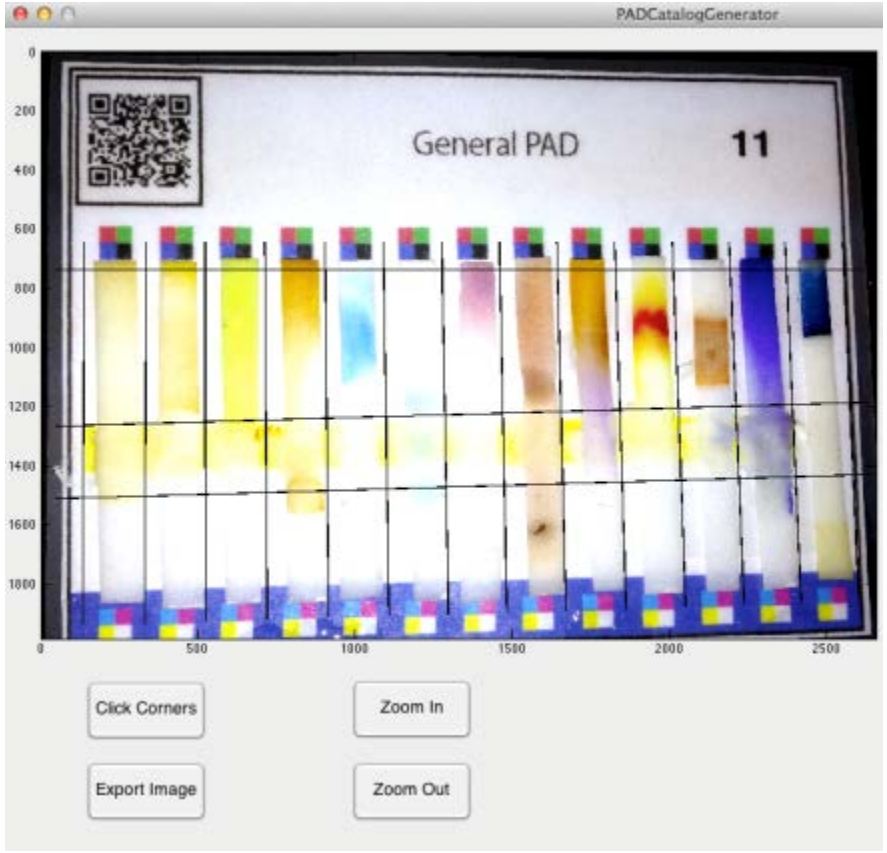
- Using the found points, we can draw lane boundaries and label the lanes
- We also can determine if the estimated marker position is lined up with the actual marker positions



Catalog Generator



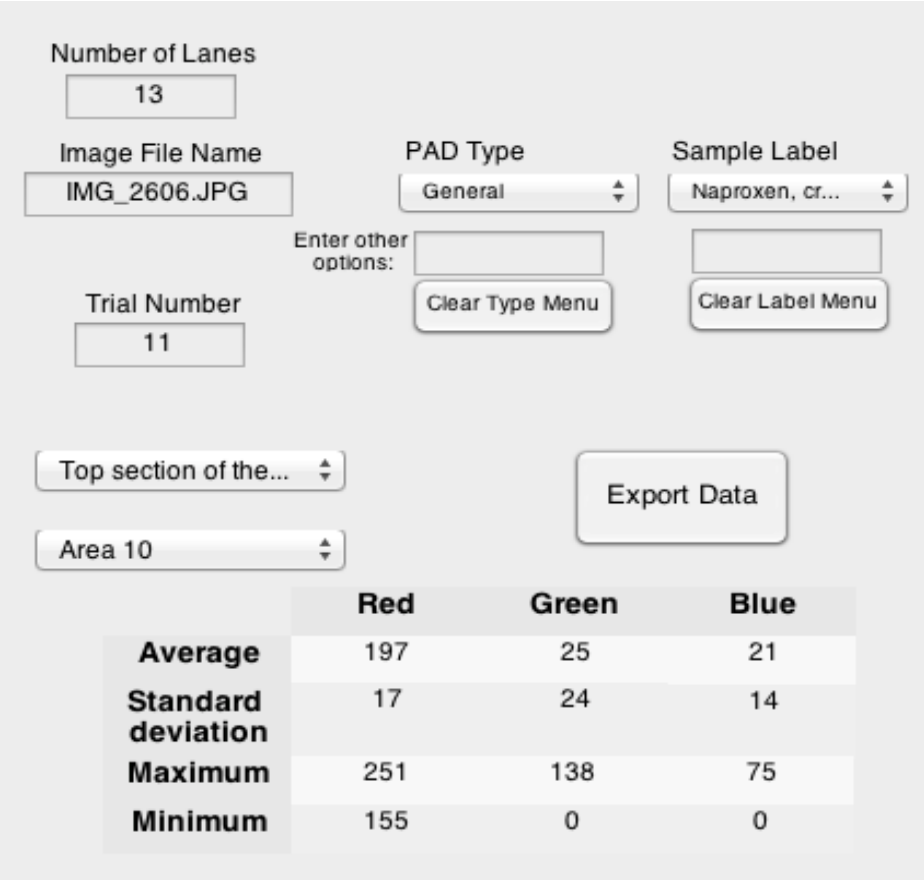
User Clicks



- We use the outputs from the lane location finder to define reaction locations for the user to click
- The program lets the user zoom in to choose very specific regions of color
- These regions are analyzed to qualitatively determine the RGB characteristics of the color

Color Analysis

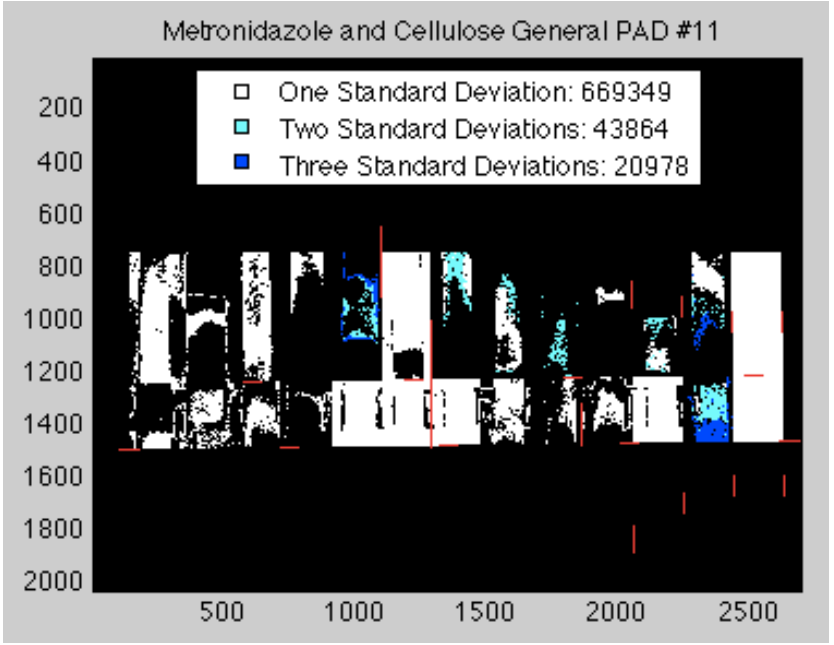
- This data, as well as data about the PAD and the sample being analyzed, is exported into a catalog and other files
- This includes histograms of the color regions, and image transcripts of user clicks

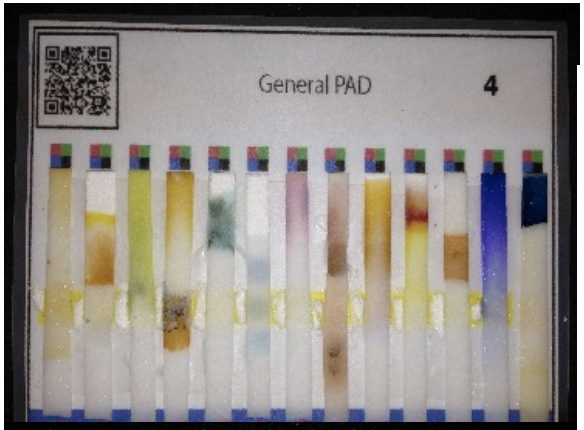


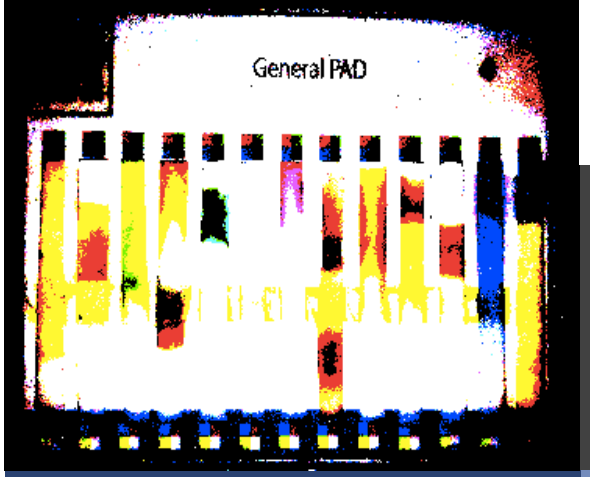
	Red	Green	Blue
Average	197	25	21
Standard deviation	17	24	14
Maximum	251	138	75
Minimum	155	0	0

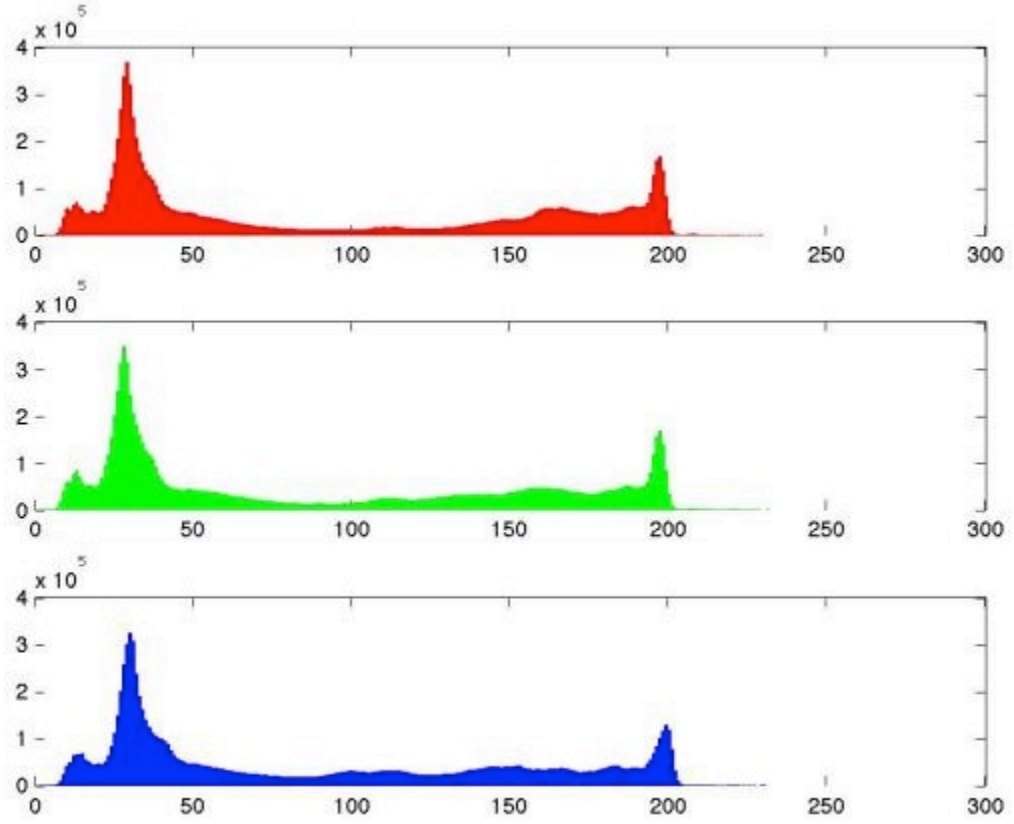
Comparing the Image to a Catalog

- The catalog has recorded RGB averages and standard deviations for each area of interest
- We can go through each area of interest and look for similar colors within one, two, and three standard deviations









Color Correcting an Image

The top left image is the original image. The middle image is the color corrected image. You can see that this image is clearer and brighter. The bottom right image is the high contrast image. You can see the exaggerated colors in this image. The high contrast images were essential to finding markers.

Acknowledgements

- Programming Team
  - Tabitha Ricketts[1]
  - Jenna Wilson[1]
  - Elijah Barstis[2]
  - Dr. TLO Barstis[1]
  - Dr. Ian Bentley[1]

- Acknowledgements
  - This research was funded by the Neuhoff Summer Science Research Communities Grant, at Saint Mary's College.

[1]Saint Mary's College, Notre Dame, IN 46556

[2]Trinity School, South Bend, IN 46556