ND*nano* Undergraduate Research Fellowship (NURF)
2011 Project Summary

Student Name: Kelsey Weaver

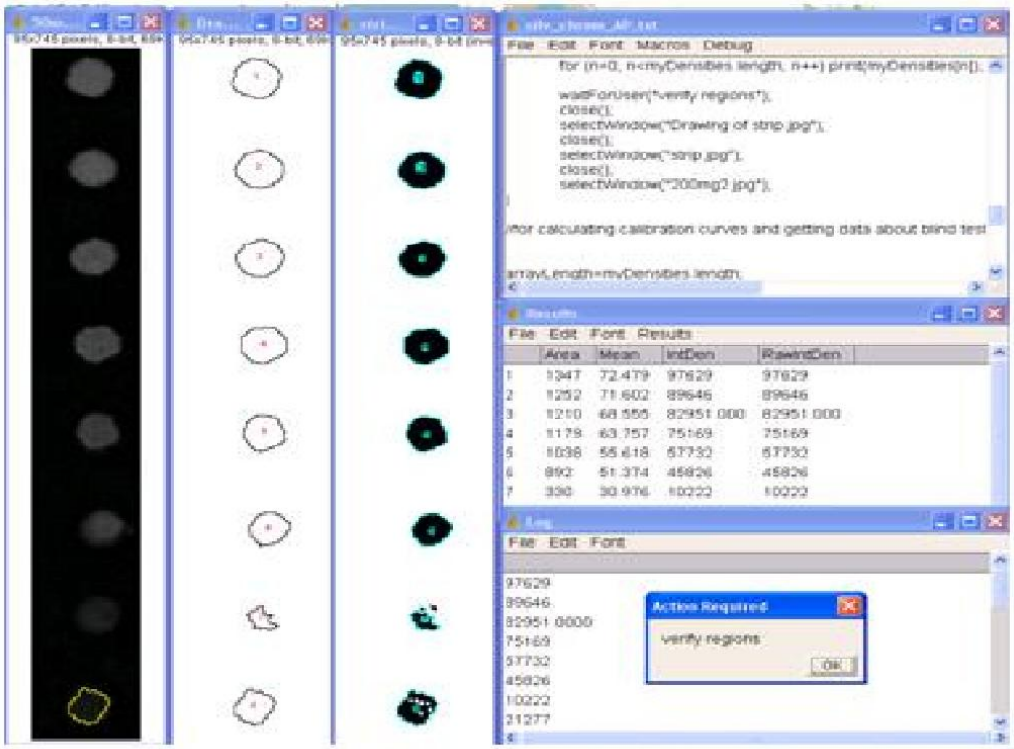
Faculty Mentor Name: Dr. Marya Lieberman and Dr. Patrick Flynn

Project Title: Detection of Counterfeit Pharmaceutical with Paper Analytical Devices

Project Summary:

Agricultural production levels depend on many factors, including the concentration of chloride in the soil. According to the Food and Agricultural Organization of the United Nations, irrigation and seawater from coasts can alter the chloride levels in soil. Though many plants require small amounts of chloride for growth, even the most highly tolerant plants cannot withstand more than 350 ppm. Although ion chromatography can be used to determine ion concentrations in water, chromatographic equipment and the necessary electricity are often unavailable in the developing world and an alternative method is needed. Paper Analytical Devices, or PADs, are colorimetric tests being developed for these and other purposes. PADs are manufactured with regions containing known amounts of reagents that react with chloride in water. As the PAD is submerged in water, any chloride present will change the color intensity of the reagents on the paper. The PAD can then be photographed with a cell phone camera and the obtained image can be analyzed by local or remote image processing software to obtain a quantitative concentration estimate. The competing technology in field testing utilizes conductivity measurements, where the ability of the solution to transfer electric current is measured. Though this method is quick and reproducible, a power source is needed and relevant ions get lumped together.

This summer, I used silver-chromate as the main reagent for testing chloride concentration in water. First, the PAD is loaded with varying concentrations of silver-chromate in a vertical 'spot' fashion. Then, any chloride present in the water sample being tested will work to turn these red silver-chromate dots to white. Once the test was perfected and produced consistent results among a range of chloride concentrations, I explored methods of analysis using ImageJ, a Java-based imaging program created by the National Institute of Health. The analysis relies heavily on the remaining color intensity of the spots on the PAD after the test has been run. Though relative colors can be gauged with the human eye, precise and quantifiable results require image analysis. A useful macro I developed in ImageJ detected the spot regions on the PAD and measured the sum of the pixel values in the region, a measure known as integrated density. This helped to automate the analysis process and will later be useful in the creation of a cell phone application or remote image analysis.



Here is an image showing the macro in progress, detecting Regions of Interest from the PAD, measuring integrated densities in these regions, and performing calculations with the resulting measurements.