Smartphone Color Error Analysis

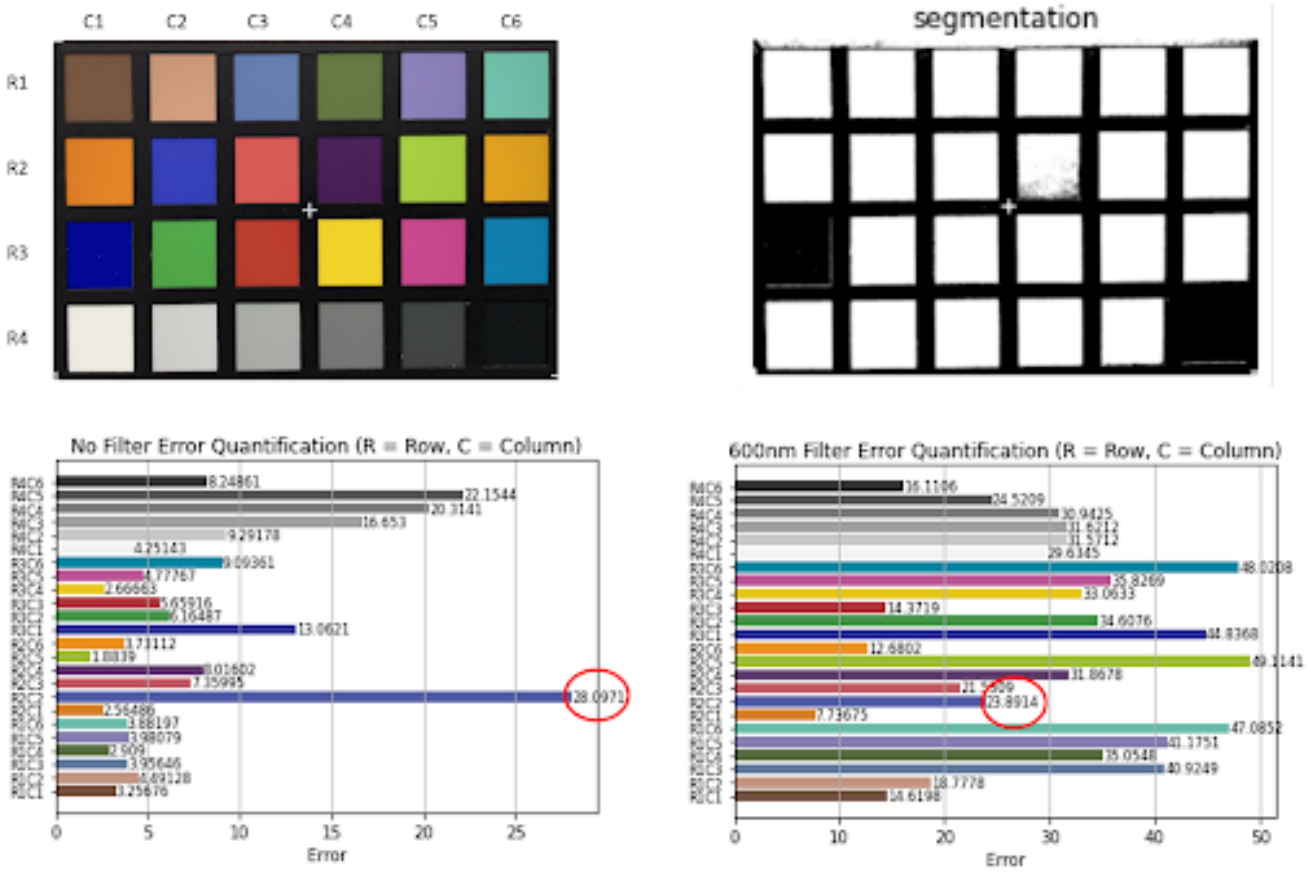
Student researcher: *Mackenna Hawes, Senior*

Color identification is the basic functionality of colorimetric analysis used widely for PH, pregnancy, and COVID diagnostics. Dependent on either human vision or resource-intensive laboratory equipment, there remains no ideal and accessible solution to quantify color. With increasingly powerful cameras now in the hands of billions across the globe, smartphones present a promising path to transform both the capability and accessibility of colorimetry.

Smartphone cameras are optimized to create compelling images rather than quantifying slight differences in color required for sensing. With this motivation, color accuracy in smartphone images was first quantified and then compared to measurements where optical bandpass filters were utilized to augment the camera. Using a lightbox (an illuminated, enclosed space) in a controlled environment, pictures of a color-correction card—a multicolored card used for calibrating cameras—were gathered.

Employing a kMeans algorithm to cluster colors in an image, along with an image segmentation algorithm, colors were automatically identified from images of the calibration card taken by differing makes and models of smartphones. The RGB values read from these images were compared to the ground truth colors obtained from the manufacturer of the card. To reduce errors on certain "problem" colors, bandpass filters having their center wavelengths ranging from 450 to 750 nm were placed in front of the smartphone camera and the process was repeated.

One example utilized a 600 nm filter, which reduced the error for one of the blue colored squares by 4.2%. Future



Smartphone cameras acquired images of a (top-left) color-correction card used for white-balance calibration. By employing clustering and (top-right) segmentation algorithms, RGB values acquired from the smartphone were compared to the ground truth of the color correction card providing a means of (bottom-left) quantifying error. Filters placed in front of the camera (bottom-right) reduced error for certain problem colors.

https://doi.org/10.7771/2158-4052.1628

goals for this project include designing filters to minimize error in these images and formatting them into a cling-sticker to be placed over a smartphone camera.

Success here means accurate, quick, and dependable measurements of color, allowing for smartphones to be used in colorimetry.

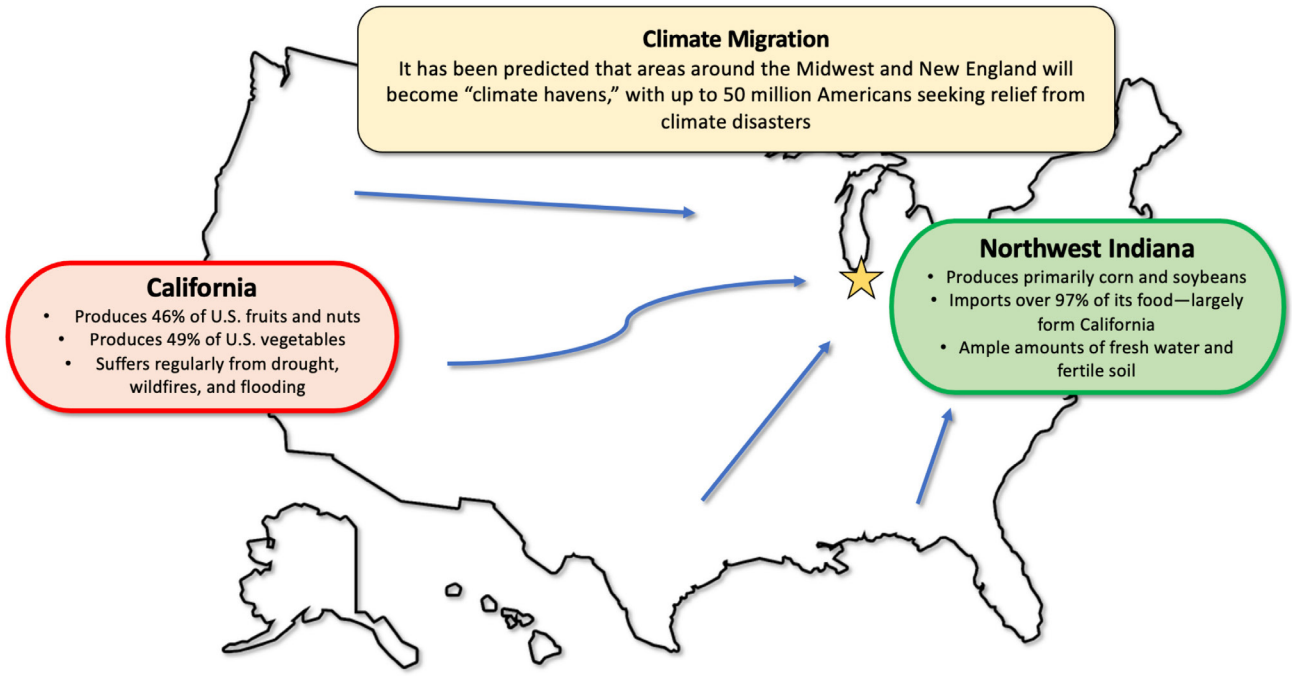
Research advisor Thomas Beechem writes: "Combining optics and compressed sensing, our undergraduate team is working to place a spectrometer in the hands of a majority of the world's population. With ubiquitous spectroscopy, tracking dangers like pathogens and pollution takes the lab to the sample instead of the sample to the lab."

Is Northwest Indiana Prepared to Be a "Climate Haven"?

Student researcher: *Luke Carl Jorgensen, Senior*

Climate change is forcing Northwest Indiana (NWI), along with the rest of the world, to urgently adapt. Sociological issues of environmental justice, food insecurity, and human migration are accelerating alongside rising temperatures. This research project brings together global, national, and local resources to show the need for interdisciplinary action. If up to 50 million people will eventually seek new homes in the Upper Midwest and New England (a figure that ignores the mass migration expected from the global South)—we must begin preparing. Luckily, there is plenty of available housing in NWI; 2021 housing vacancy rates in Gary, Indiana, were over 50% in some areas, and with economic investment these neighborhoods can be inviting to the new migrants. The region's economy has been ravaged by political corruption and questionable policy making for nearly a century, however, leaving one to ask: Where can we find the money for this type of honest investment?

My research shows that NWI spends over $2 billion annually on food imported to the region—money that could go into the region's developing local food supply. Indiana is full of corn and soy fields, while nearly half our nation's fruits and vegetables come from California; thus, NWI, and the nation, rely on an agricultural state that is suffering constant climate disasters. Investing in the local food system would be a step toward preparing NWI for a sustainable future, helping provide relief for the struggling West, creating economic stimulus for local



Northwest Indiana can be an inviting place for climate migrants, but we must begin investing in local food systems and stable housing now.