Garduino: Using Image Processing to Measure Health in Plants

Maria Pugliese, Matthew Tapia & Adam Flowers (with Patrick Kreidl, Professor)

Motivation

- The University of North Florida's "Garduino" project, founded by the UNF Chapter of the Institute of Electrical and Electronics Engineers, provides a hands-on garden bed which can pilot customized automated solutions [1].
- The Garduino project prepares engineering undergraduates for future projects and professions involving precision agriculture, image processing, and automation [1].
- The next step in the Garduino experience is using image processing to measure green pixel density in order to monitor the growth and health of plants in the garden bed at UNF.

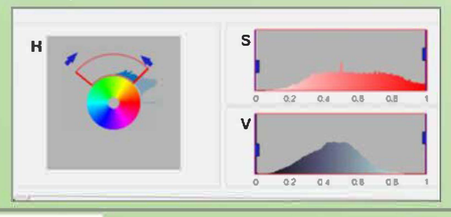
The main objective is to record and analyze the growth of vegetation through image processing

Figure 1: Automated Gardening at the University of North Florida

Theory

- **RGB image:** When using the RGB color space, each pixel has a layer of arrays to determine the shade of the color using red, green, and blue (RGB).
- **HSV image**: HSV has three components: hue, saturation, and value.
  - Hue indicates the type of color being used, commonly shown on the rainbow.
  - Saturation indicates the intensity of color.
  - Value shows us the lightness or darkness of a color.
- **Image Segmentation:** The process of manually segmenting, or "cropping," the RGB image selected to reduce error when calculating green pixel density.

Figure 2: HSV file separated into its components in MATLAB. On a color wheel of 360 degrees, green is determined to be between 63.7 and 110.2 degrees.



Summary of Current Work

- **Objective:** Quantitatively analyze plant health from color photographic imagery
- **Approach:** Apply MATLAB's image processing toolbox to test images
  - Observe a "chia pet's" development over a period of 11 days
  - Periodically capture a photo via standard digital camera

Figure 3: Images of the Chia pet over several days of growth

- **Algorithm:** Two-step image enhancement
  - Convert the RGB Image to an HSV Image
  - Determine the number of green pixels. Hue has a color range between 0 and 1, and the group's interpretation of green is between the values 0.177 and 0.306.

RGB Image → HSV Image → Binary Image

- RGB-to-HSV Conversion
- Threshold Operation (Figure 2)
- Utilized the HSV color space to analyze the pixels within the image
- Area Calculation
- Assisted free-hand segmentation to check for errors within the script

Figure 4: Original Image (Day 3)

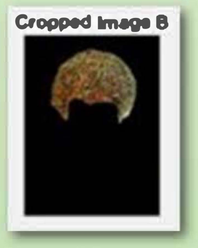


Figure 5: Segmented Image

Figure 6: Binary version of the HSV image B

223,198 pixels recorded in segmented Image B

Conclusion and Future Work

- Employed MATLAB's image processing toolbox to analyze plant health
  - Assumes plant health is correlated to growth of green-colored features
  - Green-colored features measured from imagery via percent area calculations
- Preliminary results point to importance of image acquisition and pre-processing
  - Processing results highly sensitive to consistency in lighting and positioning
  - Generalization to real-world conditions requires improved algorithm and data
- Future research will generalize the algorithm and broaden the scope of its agricultural applications.

Selected References

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[6] H. S. Abdullahi, R. E. Sheriff and F. Mahieddine, "Convolution Neural Network in Precision Agriculture for Plant Image Recognition and Classification," The Seventh International Conference on Innovative Computing Technology (INTECH 2017), pp. 155–155, Aug. 2017.

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School of Engineering

Garduino