A GLIMPSE INTO THE FUTURE OF AGRICULUTRE WITH HYPERSPECTRL IMAGING

Research question:

Is hyperspectral imaging a reliable technology in determining the nature of plant health and the detection of early signs of health deterioration?

Abstract:

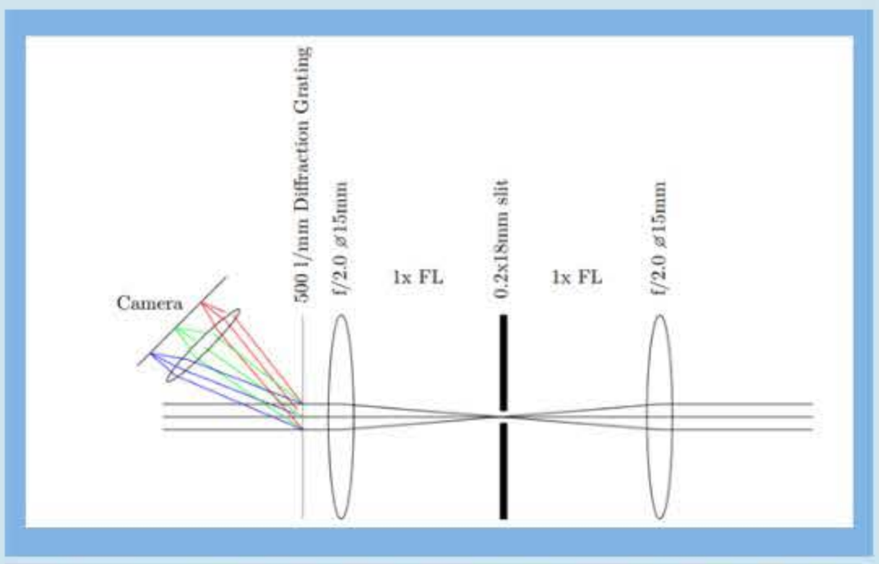
The emerging technology of the 21st century has allowed for a number of advances across the fields of robotics and engineering. With this, the integration of hyperspectral (HS) image captures into such designs allows for a powerful instrument that is applicable to important industries including agriculture (SCI, 2023) and medical science (Manea D, 2013). For this experiment, Green Leaf lettuce plants were grown in a terrarium in controlled conditions for 6 weeks, before being separated into 4 groups each with a specific growing condition, involving dehydration, overhydration, Weedkiller solution (Glyphosate and Nonanoic acid) or no change to prior growing environment. This lasted for 5 weeks, and a final capture was taken to showcase the changes that have occurred. The experiment demonstrates the suitability of analysing the health of plant samples with this technology, which allows for potential further research in the areas of agriculture to optimize the production of primary crop exports in Australia's economy and developing countries, especially with the impacts of climate change potentially jeopardizing the improvement of crop yields in the near future.

Literature Review:

A simple HS system utilizes a spectrograph to record photon reflectance across the electromagnetic spectrum into a digital sensor to collect and store information (book, Poole, parker & Gottwald, 2010), which can record both artificial or solar radiation that is reflected off of the materials surface, while the type of material an object is can be determined via its reflective characteristics and the absorption of radiation (Sagan V ,2021). Maximizing growth of crops and the methods to adapt and evolve our methods of farming is of high importance given a changing climate, the dynamics of changing ecosystems and issues involving pollution (Furbank & Tester 2011).

Hyperspectral imaging has already been able to detect early developments of toxic fungi on maize plants, including the changes that can occur to crops from its initial growing conditions, namely yellow and orange rust on wheat and sugar.

The Structure of the Camera:



The chamber incorporates two mirrors with a small single slit place equidistant between them. With the properties of light rays, the single slit concentrates the initially diffracted light into a single point. As light passes through the second mirror, the rays become inverted and is passed through a diffraction grating to split the light into its R,G,B components as seen above. The positioning of the diffraction grating is critical, having to be calibrated properly to prevent interference of the light rays, distorting the projected image.

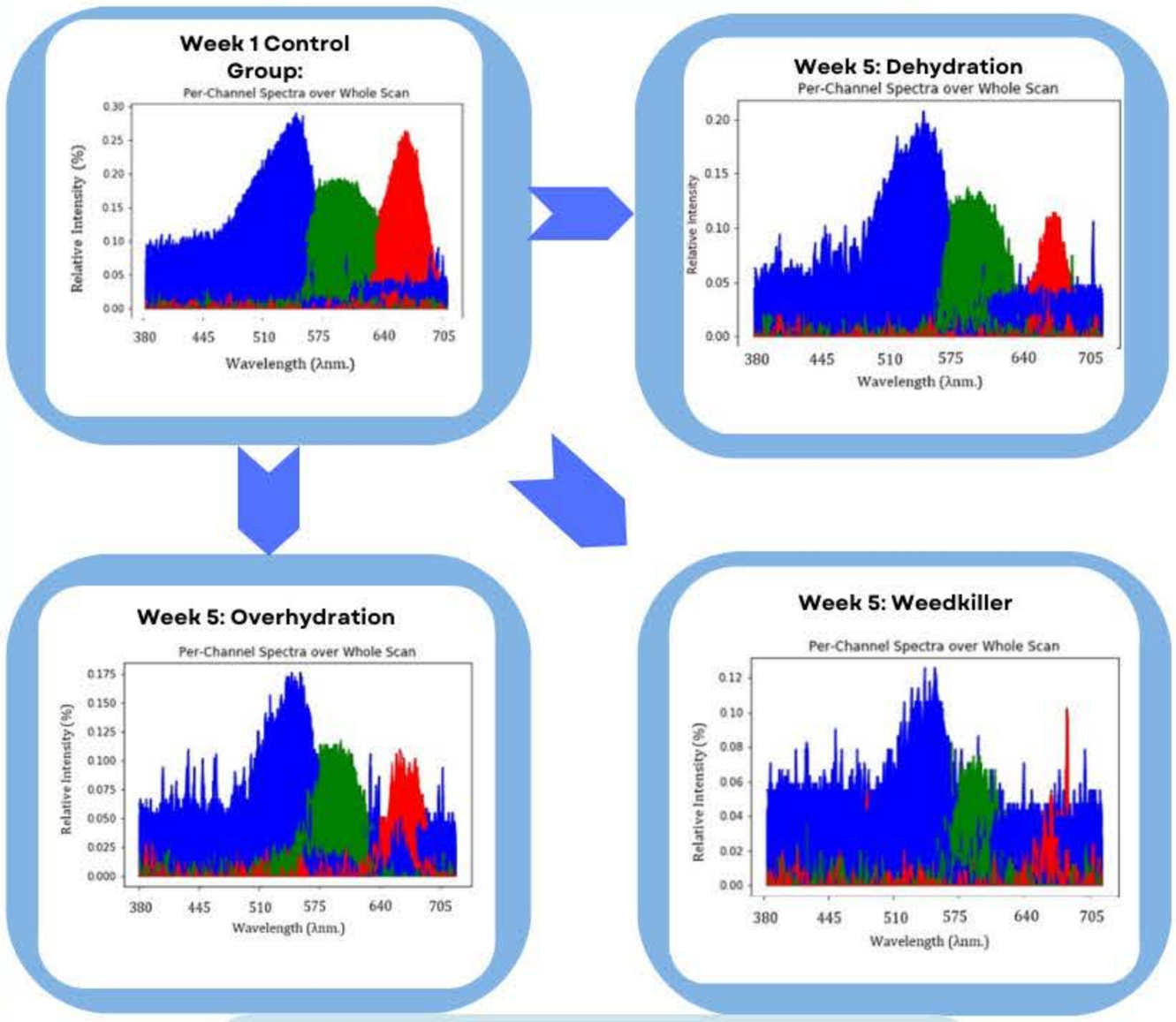
Hypothesis:

As the health of a plant sample deteriorates, a Hyperspectral Imaging tool will be able to scan and effectively detect a change in the plants spectra, showing changes to both wavelength intensity and its Red-Green-Blue components.

Null Hypothesis

As the health of a plant deteriorates, the hyperspectral camera will not reliable in detecting the changes in the plants wavelength intensities and its associated Red-Green-Blue composition

Results



Results and Further Research

Each graph here is the average of 5 samples from its particular independent variable to ensure reliability during experimentation. The graphs indicate that there exists an observable decrease in the relative intensity of each (R, G, B) light components for all three groups, with weedkiller experiencing the biggest change (Δavg = 0.133) and overhydrated the lowest (Δavg =0.092). The application of this imaging technology on plants can be repeated to better reflect an agricultural environment in which these imaging techniques we be mostly used. Reconducting this experiment to use a crop that that makes a significant contribution to the Australian economy such as wheat or barley would allow for a more valid report that can be utilized for optimizing the production of leading exports, while changing factors including humidity and temperature will allow for a further understanding of how hyperspectral imaging would detect health deterioration in a real world application

To view the full report, scan here:

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