A Low-Cost Deep Learning Solution for Early Detection of Lettuce Stress in Indoor Farms

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Indoor farming is a growing sector. Yet, there remains no economically viable tool that can signal vegetation stress to growers before it becomes visible to the naked eye. If early warnings to stress could be achieved affordably, the implications are significant: protecting crop quality, improving biomass yield, and detecting catastrophic failures. Here, I develop software to provide crop health maps based on full-spectrum infrared imagery. Crop health maps label each pixel in the image as “stressed” or “fine”. The blue NDVI index could not evaluate the health condition of lettuce heads, so I employed AI with state-of-the-art deep learning techniques that assess stress based on more complex features including the crop’s appearance. I collected a dataset of images containing lettuce canopies and trained image segmentation neural networks that classify each pixel of the image. Using a novel time-series technique, the networks can detect subtle responses to stress. Using a novel forecasting technique, the networks forecast maps that indicate canopy health in the future. Our method was evaluated on the dice coefficient which compares the overlap between predicted regions of stress and the true regions of stress. Our method identified stress not visible to the naked eye, including water deficits and pesticide damage. It achieved average dice scores 6x greater than the NDVI method. The patent-pending solution utilizes converted full spectrum cameras that cost $160 per unit and develops a system that provides accurate crop health maps to help growers improve their business’s profitability.