A Novel Spatial-Spectral Analysis Method for Hyperspectral Soybean Leaf Images

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Abstract:

Hyperspectral imaging (HSI) is being widely applied in plant phenotyping platforms. Some new HSI devices such as LeafSpec was introduced recently which can provide a high signal-over-noise ratio along with higher spectral and spatial resolutions. However, most of the previous image processing algorithms only calculated the averaged spectrum from the leaf, but rarely include the spatially distributed information on the leaf level. Meanwhile, different nutrient stresses could result in different color patterns on the leaf which can be used to furtherly improve the quality of plant phenotyping. This study focused on the development of a new methodology that applies spatial distribution analysis on HSI soybean leaf images. Firstly, a novel way of encoding all the leaf pixels to a new coordinate system called Natural Leaf Coordinate System (NLCS) was developed. NLCS defined the coordinates of every pixel relative to the leaf venation so that the following spatial distribution analysis could be conducted more intuitively. Second, a new nitrogen index based on NLCS called NLCS-N was developed and able to outperform the whole leaf averaged NDVI by having a better correlation with the plants' nitrogen contents, and a more significant differentiation between the nitrogen-sufficient versus the nitrogen-deficient plants.