Leveraging deep learning for the reconstruction of plant hyperspectral data from RGB images

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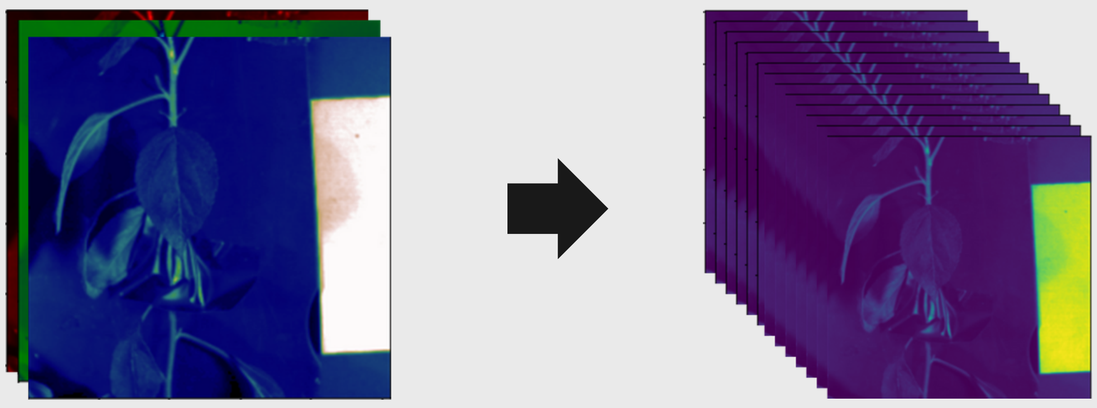
INTRODUCTION

Forest and agricultural lands are under increasing stress.

Hyperspectral imaging has proven to be a valuable tool in stress detection, including early phases of stress. This technology is expensive and complex to use, making it inaccessible to majority of stakeholders. Researchers have investigated reconstructing hyperspectral data from RGB images. They targeted generic objects and focused on the 400-700 nm range with 31 bands.



RBG images **N-Band hyperspectral**

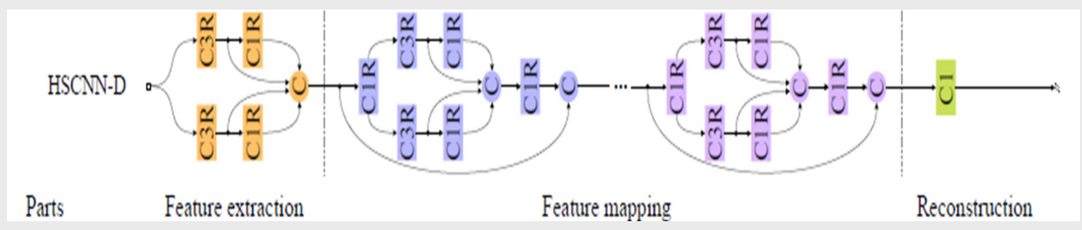
OBJECTIVE

This study aims to develop a model that reconstructs hyperspectral data from RGB images. It builds on previous results by expanding the reconstructed spectrum from the visible 400-700 nm range to the wider 400-1000 nm range. The **700-1000 nm** part is indeed crucial for **plant health analysis**. In addition, taking advantage of the material-dependent nature of the reflectance spectrum, the model is trained only on vegetation images. As such, **less data** and **reduced complexity** is required to map the spectral scheme from RGB images.

METHODOLOGY

The HSCNN-D model, winner of the NTIRE 2018 competition, was selected and modified to make it less complex. This was achieved by:

- Reducing the number of feature mapping blocks from 60 to 5-10
- Adding drop out layers in the feature mapping block to guard against overfitting



HSCNN-D model

The Virginia Tech dataset was used, containing images exclusively of trees in the 400-1000 nm range and different ambient conditions (distance, species, and atmospheric). Segmentation was applied, combining SAM and NDVI, to remove all non-vegetation pixels.

Bur Oak Tree **SAM segmentation** **NDVI segmentation**

RESULTS

Best model at 42 bands achieved comparable error to state-of-art NTIRE models.

N	B	Segmentation	MRAE	RMSE
31	8	None	0.4591	0.2537
42	10	SAM	0.297	0.1267
42	10	SAM+NDVI	0.268	0.105

Trained HSCNN-Veg model was compared to the HSCNN-D model on 14 plant images from the NTIRE 2022 dataset. Results show specific model can achieved better results than generic one with less complexity and training data

	HSCNN-Veg	HSCNN-D
Average MRAE	1.5238	2.9263
Median MRAE	0.6874	1.4949