EVOLUTIONARY OPTIMISATION TECHNIQUES FOR BAND SELECTION IN DRONE-BASED HYPERSPECTRAL IMAGES FOR VEGETABLE CROPS MAPPING

[a]Anagha S Sarma, [b]Rama Rao Nidamanuri
Department of Earth and Space Sciences, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India 695547
[a]anagha.anaghauma.sarma@gmail.com,[b]rao@iist.ac.in

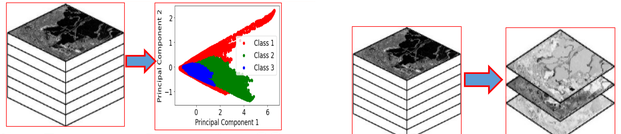
Background

- Plant-level identification of crops is vital for operational precision agriculture
- Drone-hyperspectral imaging is a potential technique for plant-level crop mapping and automation of crop-type identification
- Dimensionality reduction: an essential pre-processing step to handle redundancy and computational complexity

Dimensionality Reduction

Feature extraction
- Linear/nonlinear combination of the original features
- Loss in spectral integrity
- eg: PCA, MNF

Feature selection ✓
- Select suitable features from the original data
- Spectral integrity retained
- eg: Stepwise regression, genetic algorithm



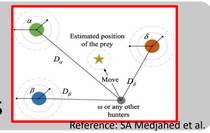
Why Feature Selection??

- Hyperspectral sensors capture data in spectral domain
- Feature selection- data remains in the spectral domain
- Potential application for real-time processing
- Evolutionary optimization-nature inspired algorithms suitable candidates for feature selection

Objective

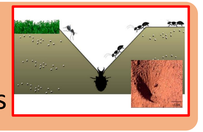
To study the impact of two evolutionary optimisation algorithms (GWO and ALO) for band selection in drone-based hyperspectral imagery for plant-level crop mapping

Grey Wolf Optimisation (GWO) based on leadership hierarchy and hunting mechanism of grey wolves



Reference: SA Medjahed et al.

Ant Lion Optimisation (ALO) based on the trapping mechanism of antlions and random walk of ants



Dataset

- High-resolution drone hyperspectral imagery of agricultural fields, GKVK, Bengaluru, India
- Crops: tomato, cabbage and eggplant
- Sensor used: Cubert FireflEye imager with 4nm spectral sampling interval
- Image size: 1000 * 1000 * 138
- Spatial resolution: 2-5 mm, depending on the flying height of the drone

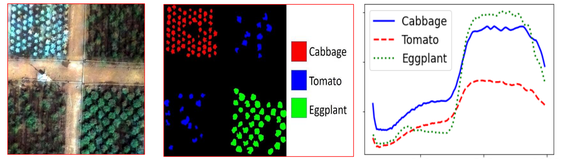
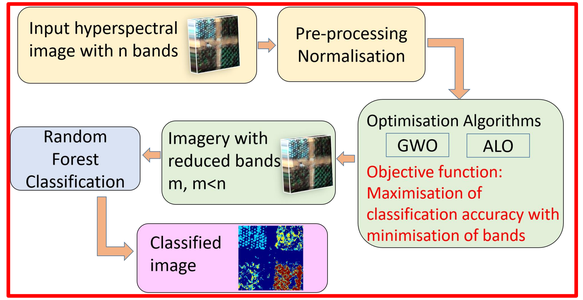


Fig. 1. True colour composite, ground truth and spectral reflectance

Methodology



Results

Table I. Band and Accuracy Assessment

Wavelength range(nm)	Number of bands		
	Original	GWO	ALO
450-550	25	1	1
550-650	25	4	2
650-750	25	3	2
750-850	25	2	4
850-950	25	1	2
950-1000	12	0	1
Total bands	137	11	12
Accuracy (%)	99.69	97.12	97.8
F1score	0.99	0.97	0.98
kappa	0.99	0.95	0.97

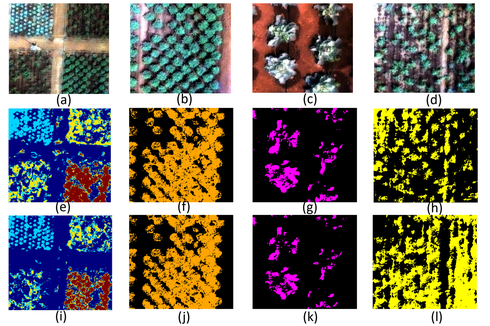


Fig. 2. (a)-(d) True colour composite of drone imagery of vegetable crops, (e)-(h) classified images using GWO, (i)-(l) classified images using ALO

Conclusions

- Fewer spectral bands at certain wavelength ranges offer crop discrimination at plant level with good classification accuracy
- Prevents data deterioration due to redundant bands for near-real time processing aiding precision farming

Acknowledgement

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References:

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[2] SA Medjahed et al., "Gray wolf optimizer for hyperspectral band selection," Applied Soft Computing, vol. 40, pp. 178–186, 2016.
[3] M. Wang et al., "A feature selection approach for hyperspectral image based on modified ant lion optimizer." Knowledge-Based Systems 168 (2019): 39-48