ReflectGAN: Modeling Vegetation Effects for Soil Carbon Estimation from Satellite Imagery

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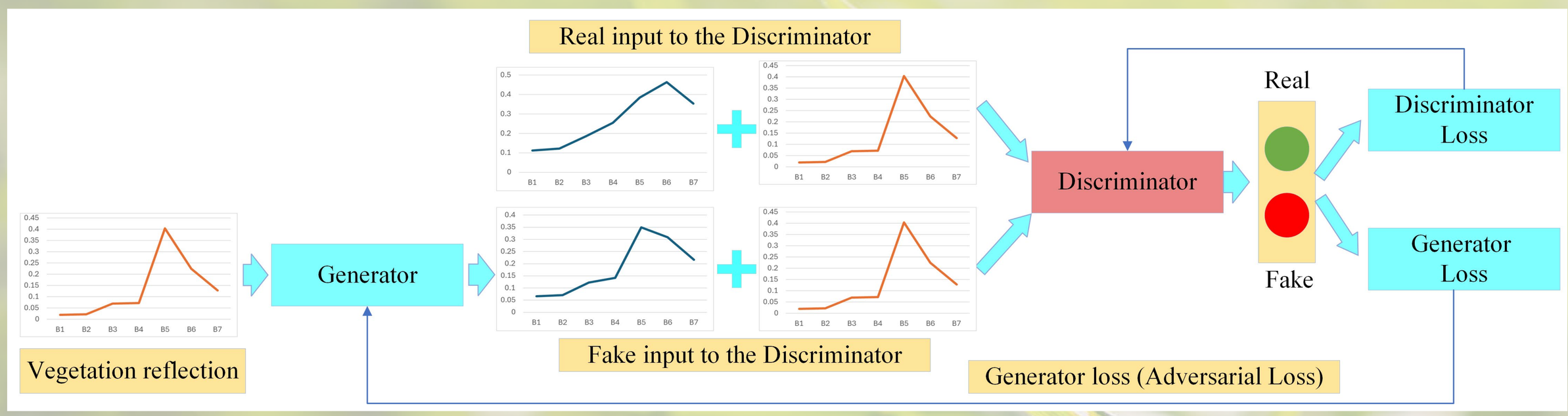
🛑 Existing Problem

- Vegetation contaminates soil reflectance in satellite imagery
- Spectral mixing hides true soil signals, degrading SOC accuracy
- Traditional methods discard vegetated samples or fail to correct them
- Existing GANs estimate abundance, not reconstruct soil reflectance

✅ Our Solution

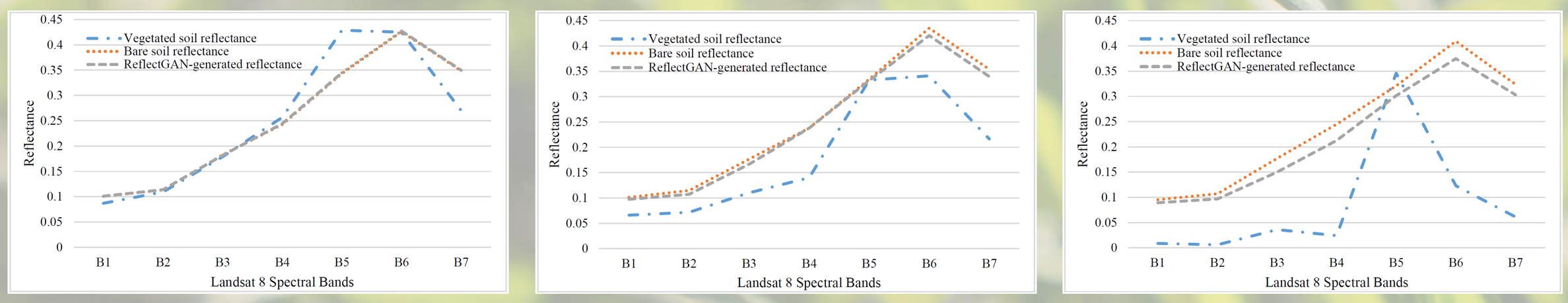
- Propose ReflectGAN to reconstruct bare soil reflectance from vegetated pixels
- Learn spectral transformation between vegetated and bare soil reflectance
- Preserve spectral consistency using residual learning and conditioning
- Improve SOC estimation without discarding valuable vegetated data

Proposed ReflectGAN Architecture



Key Findings

Comparison of different soil reflectance types against ReflectGAN-reconstructed reflectance, illustrating how the proposed method transforms vegetated reflectance into bare soil reflectance under varying vegetation densities:



(a) Lightly vegetated soil reflectance (NDVI = 0.25) (b) Moderately vegetated soil reflectance (NDVI = 0.42) (c) Highly vegetated soil reflectance (NDVI = 0.83)

SOC Estimation Under Vegetation: Results (Landsat 8, RF Model)

Method	R^2	RMSE	RPD
Index-based Correction	-0.09	6.90	0.95
PMM-SU	0.40	6.95	1.45
Pix2Pix GAN	0.16	6.16	1.09
CycleGAN	0.08	7.10	1.02
ReflectGAN (Proposed)	**0.53**	**3.93**	**2.11**

Dataset & Code

Full Paper

SOIL CRC — Performance through collaboration
Charles Sturt University
Deakin University
Computer Vision Lab
Federation University
Australian Government — Department of Industry, Science and Resources — Cooperative Research Centres Program