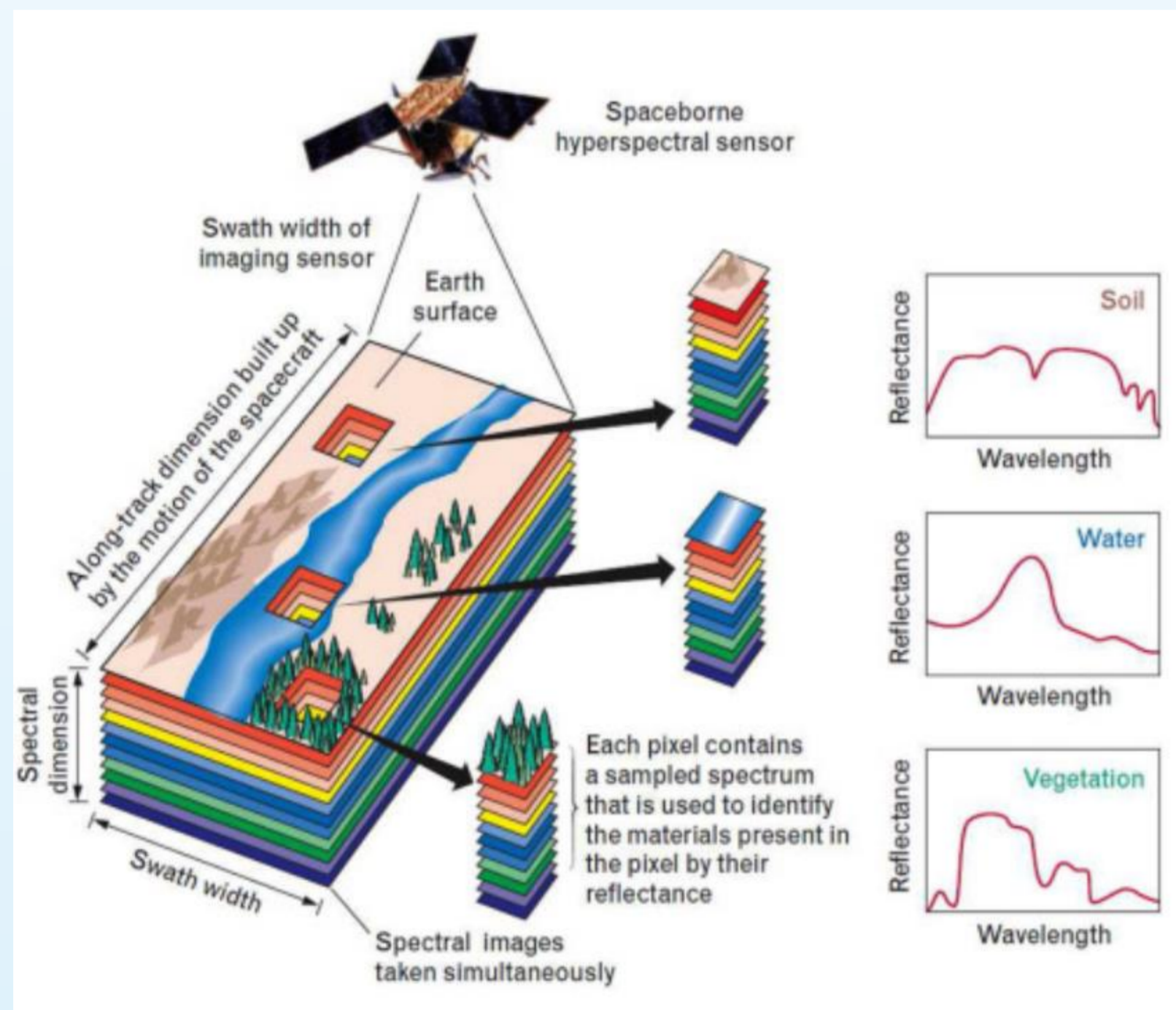# University of Peradeniya

DEEP LEARNING-BASED HYPERSPECTRAL UNMIXING FOR GEOGRAPHIC INFORMATION SYSTEMS (GIS)

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Abstract- Hyperspectral Imaging (HSI) is a powerful technique that captures multiple spectral channels, offering unique insights into objects beyond traditional imaging methods. Utilizing different deep learning architectures, we've developed algorithms that excels in solving the unmixing task with high accuracy compared to existing methods. This has direct applications for GIS software, particularly in lithological mapping, as evidenced by our exploration in Sri Lanka.

WHAT IS HYPERSPECTRAL IMAGING AND UNMIXING

- Hyperspectral imaging is an advanced technique that captures and processes information from across the electromagnetic spectrum. It allows for highly detailed and precise analysis of materials, environments, and objects based on their spectral signatures.
- Hyperspectral unmixing involves decomposing a mixed spectral signature into its constituent endmembers and their corresponding abundances.

ALGORITHM DEVELOPMENT FOR GIS

- Deep learning-based modified auto-encoder architecture is used for our unmixing algorithm.
- Usage of this new architecture enables us to feed spatial information to the neural network compared to the other existing algorithms. This helps to improve the unmixing accuracy.
- In addition to that, our novel algorithm addresses nonlinearity in the HS image with the two-stage learning process and multilayer decoder.
- Better results have been obtained compared to the existing algorithms.

HSI APPLICATIONS

- Unique spectral signatures in hyperspectral imaging (HSI) can be combined to map geological formations and their distribution over large areas, making it a valuable tool in remote sensing for lithological mapping.
- HSI applications extend to change detection tasks, such as monitoring land use changes and urban expansion in urban areas.
- Hyperspectral imagery is vital for monitoring land cover changes supporting environmental management and conservation.
- In glacial regions, HSI tracks glacier movements to provide insights into climate change impacts.

LITHOLOGICAL MAPPING

Lithological mapping is the procedure used to delineate the geographic distribution of specific minerals. This mapping typically employs various techniques including:
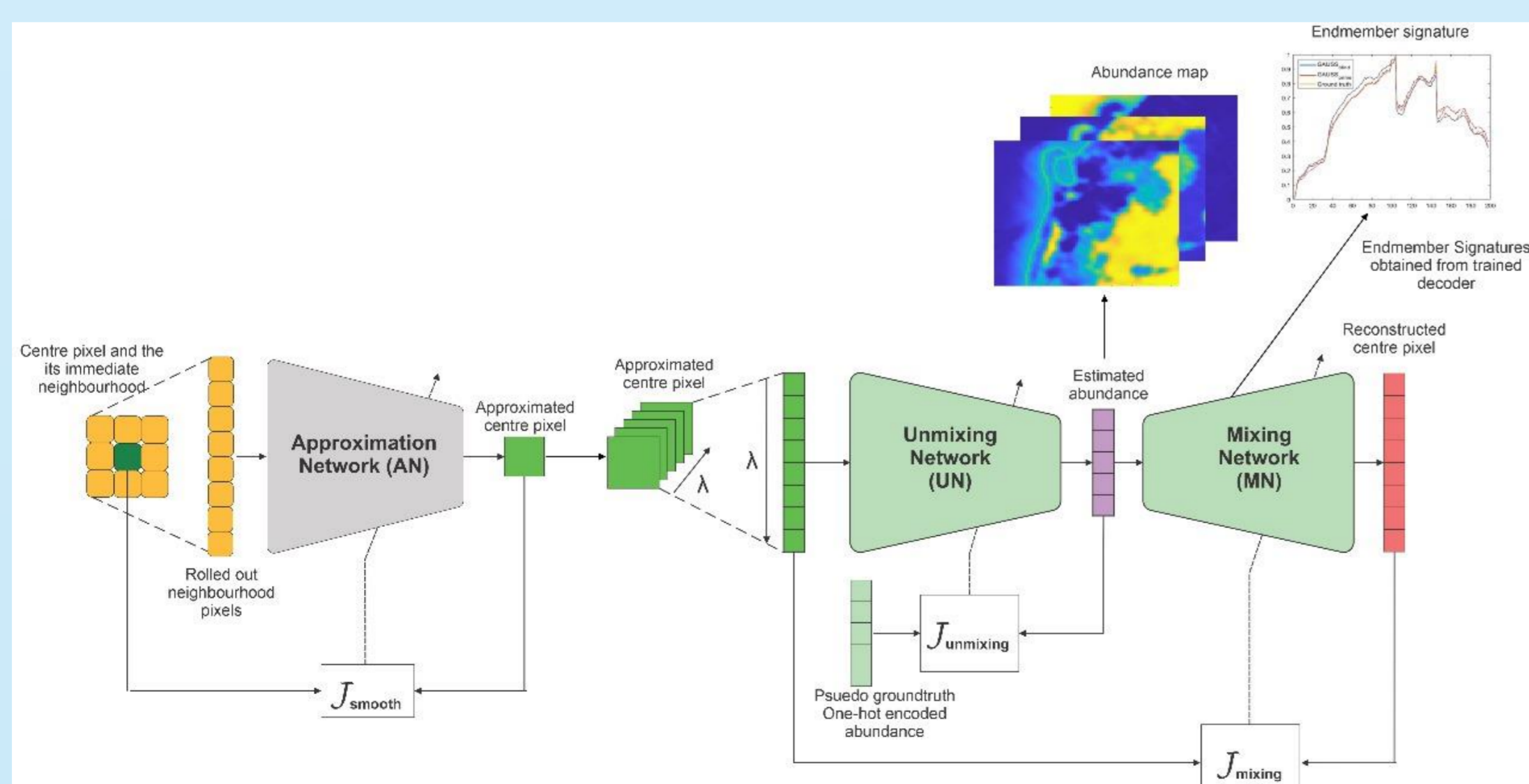- Aerial Methods: Magnetic Surveys, Gravity Surveys
- On-Site Methods: Seismic Surveys, Geochemical Surveys

However, it is important to note that these methods come with several limitations. Hyperspectral Unmixing is a preferred method for lithological mapping for several compelling reasons:
- Exceptional Spectral Resolution and Information Depth
- HSI data offer high spectral resolution, providing rich and detailed information for accurate mapping
- Unrestricted Data Access

Site	XRD Test Results	Relative Availability
Site 1	1.42%	0.0984
Site 2	24.24%	0.3234
Site 3	4.88%	0.1663
Site 4	48.87%	0.7688

ACHIEVEMENTS

- Our high performance novel algorithms have been published in numerous high-end journals.
- Mining has commenced in certain locations in Sri Lanka based on our mineral availability maps

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