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Mapping and Remote Sensing (MFTTT)*



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Title:

HOW REMOTE SENSING DATA ENRICHES THE URBAN DEVELOPMENT: INSIGHTS ON IMAGE DATASETS, TECHNIQUES, AND APPLICATIONS

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PRESENTATION LAYOUT

1. INTRODUCTION

2. URBAN ENVIRONMENT CHALLENGES

3. STUDY OBJECTIVES

4. DATASETS

5. DATA ANALYSIS TECHNIQUES

6. APPLICATIONS

7. CONCLUSIONS

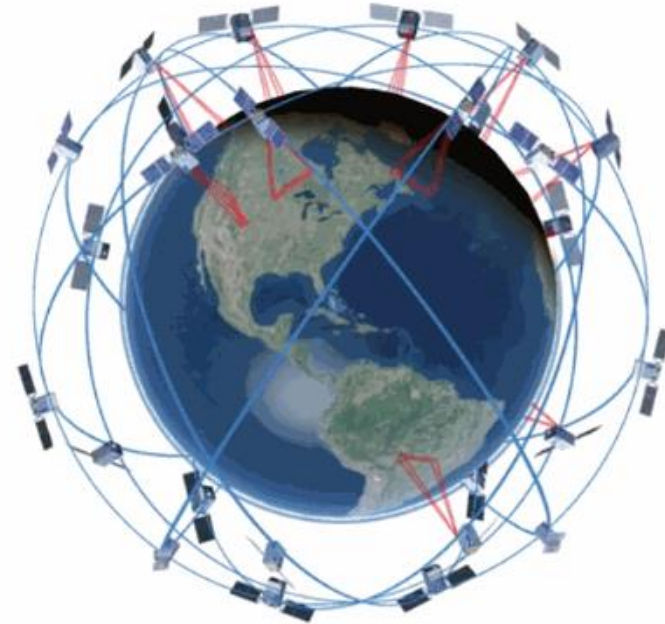
8. PUBLICATIONS

CALLING FOR COOPERATION



1. INTRODUCTION

- Rapid progress in remote sensing technologies offers powerful, instantaneous, and functional datasets for urban applications [Fawzy et, al., 2023].
- **About one thousand** Earth Observation (EO) satellites are in orbits according to Union of Concerned Scientists (UCS) [Geospatial world, 2022].



2. URBAN ENVIRONMENT CHALLENGES

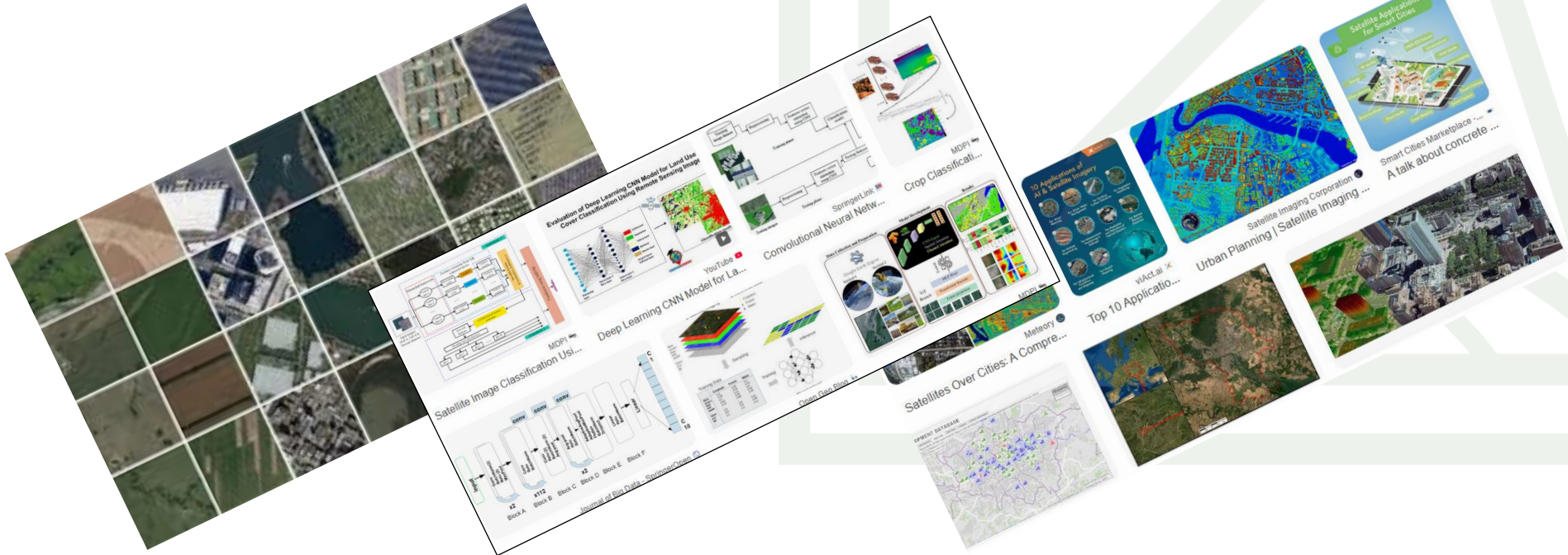
Considering the rapid expansion of urban areas and the volume of data generated, efficient Land Use and Land Cover (LULC) analysis approaches are essential to support urban applications, infrastructure development, water resource monitoring, and disaster management.



3. STUDY OBJECTIVES

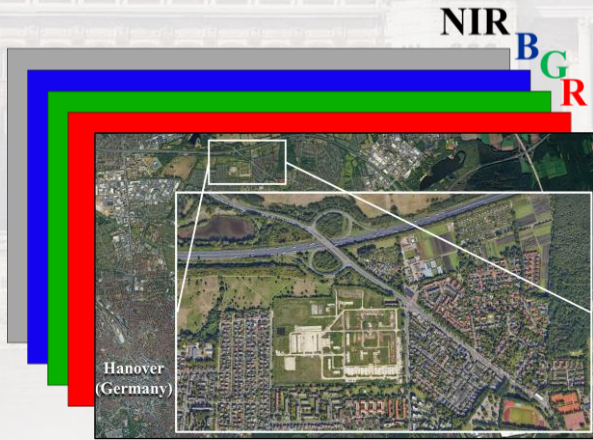
The main objective of this work is to demonstrate the relevant insights on:

- The available datasets
- The developed techniques
- The targeted applications



4. DATASETS

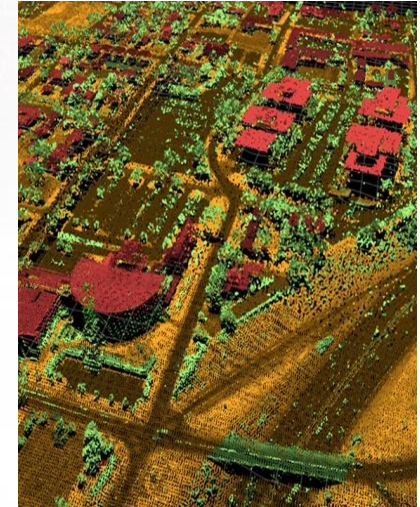
We are showcasing the outcomes of various studies using either single-data or integrated multimodal data for urban applications.



Very High Resolution (VHR)
multi and hyperspectral
Satellite data & Orthophotos



Digital Surface Models (DSMs)

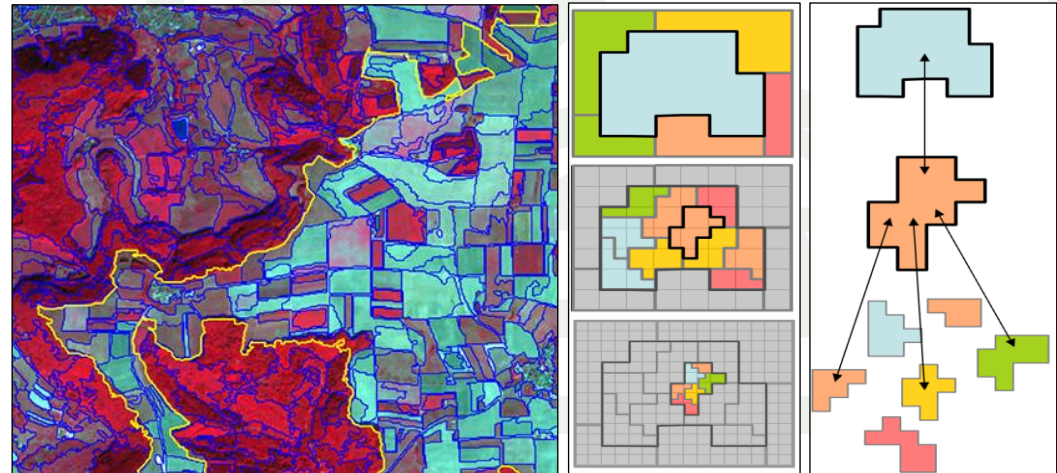
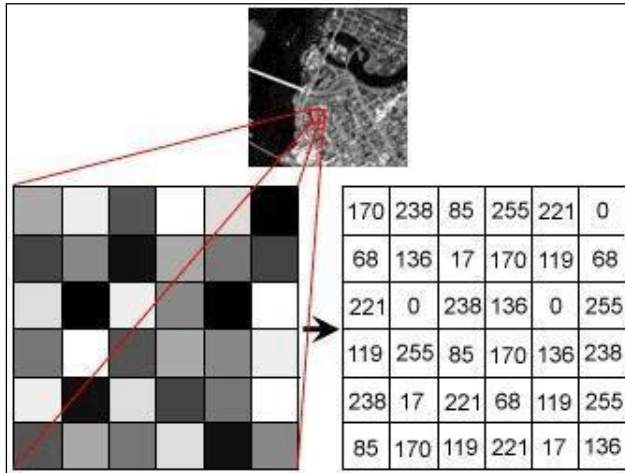


3D LIDAR point
clouds

5. DATA ANALYSIS TECHNIQUES

Traditional image analysis methods such as pixel or object-based image classification meet considerable challenges to manage the data:

- The need for manual control during the processing.
- The consumption of large time and computational power.
- Reflecting low generalization.

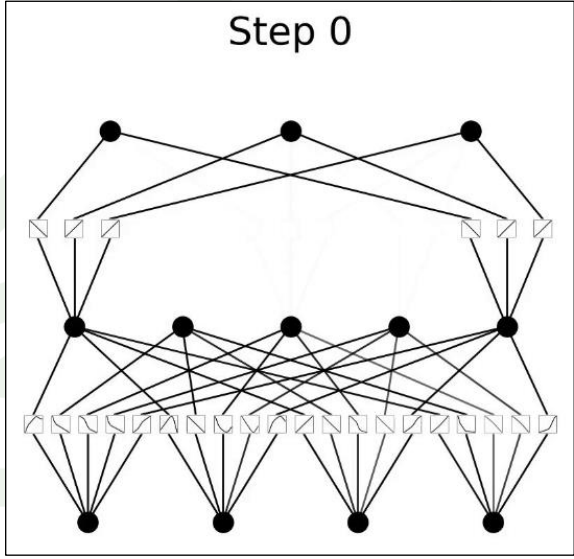
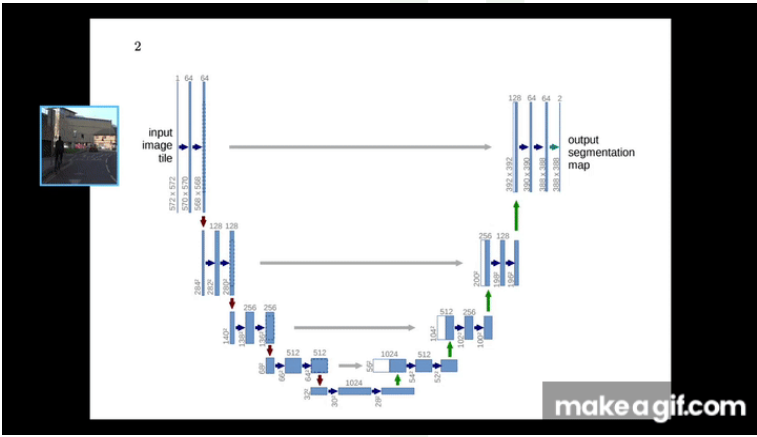
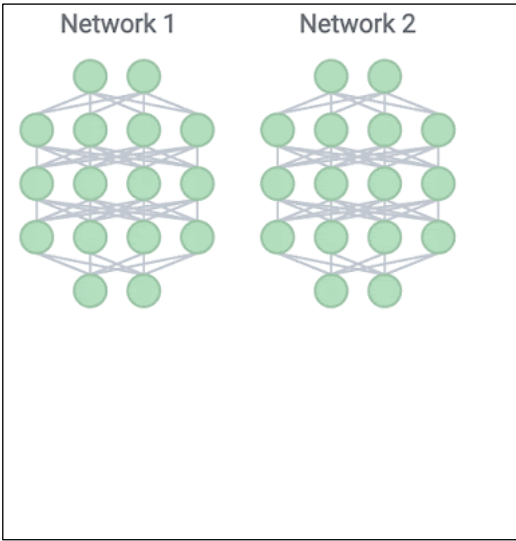


Pixel based image analysis [Goutam Das et., al, 2016]

Object based image analysis [eo4geo.eu]

5. DATA ANALYSIS TECHNIQUES

The latest revolution of artificial intelligence and machine learning strategies, particularly neural networks, offers promising solutions like SNNs, CNNs, and KANs.



Shallow Neural Networks (SNNs)
[do-wide-and-deep-networks]

Convolutional Neural Networks
(CNNs) [makeagif.com]

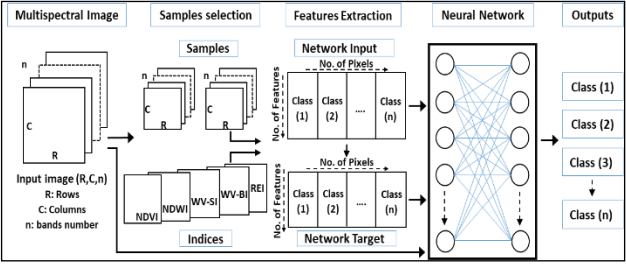
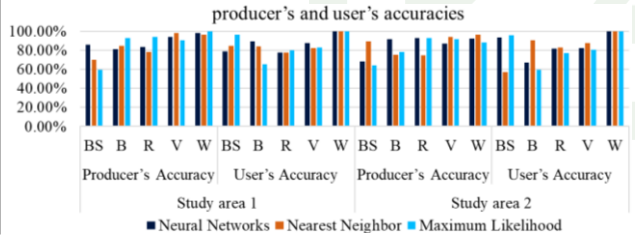
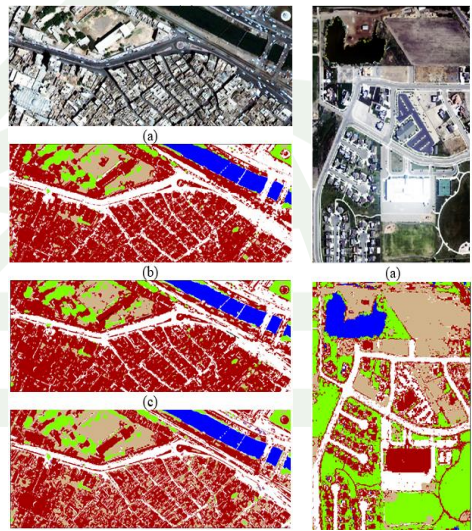
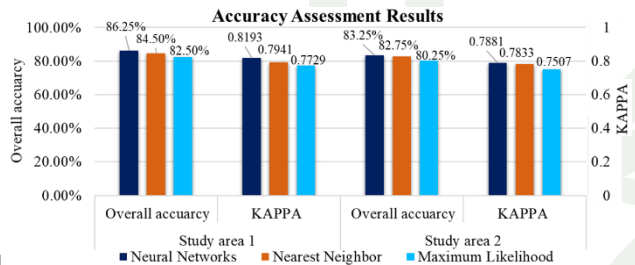
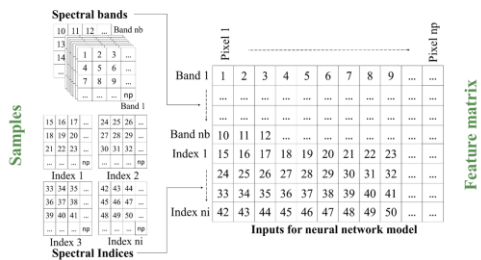
Kolmogorov-Arnold Networks
(KANs) [Daniel Bethell]

6. APPLICATIONS

A Shallow Neural Network Model for Urban Land Cover Classification Using VHR Satellite Image Features

Mohamed Fawzy ^{1,3*}, György Szabó ², Arpad Barsi ¹

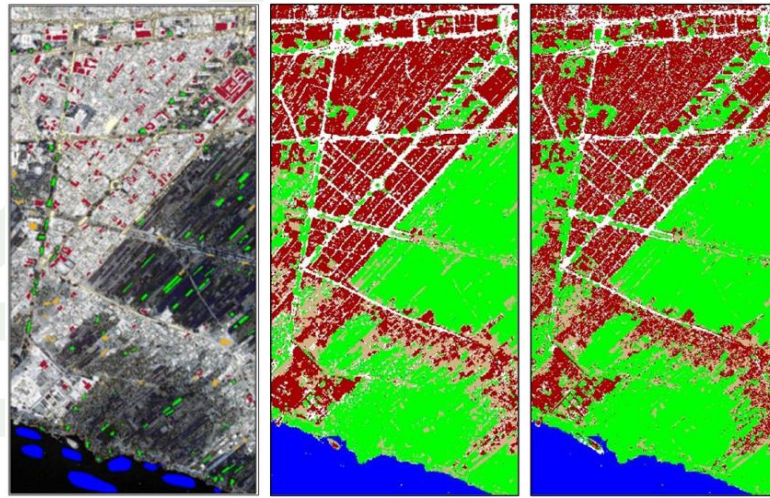
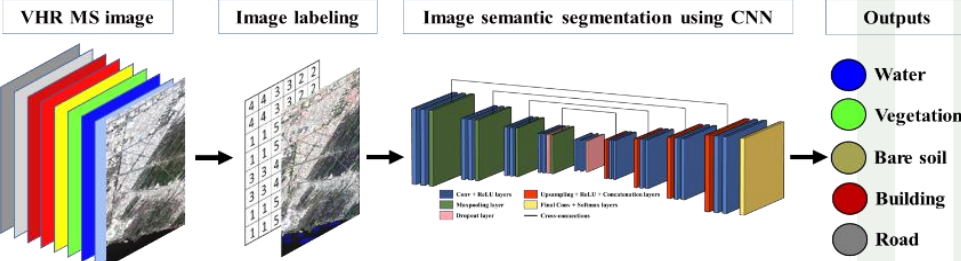
The ISPRS 2023 Geospatial Week (Egypt GSW'2023)



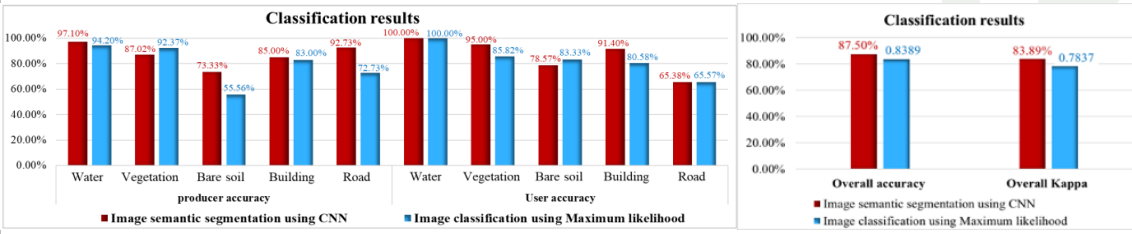
6. APPLICATIONS

A U-Net Model for Urban Land Cover Classification Using VHR Satellite Images

Mohamed Fawzy^{1,2*}, Arpad Barsi¹



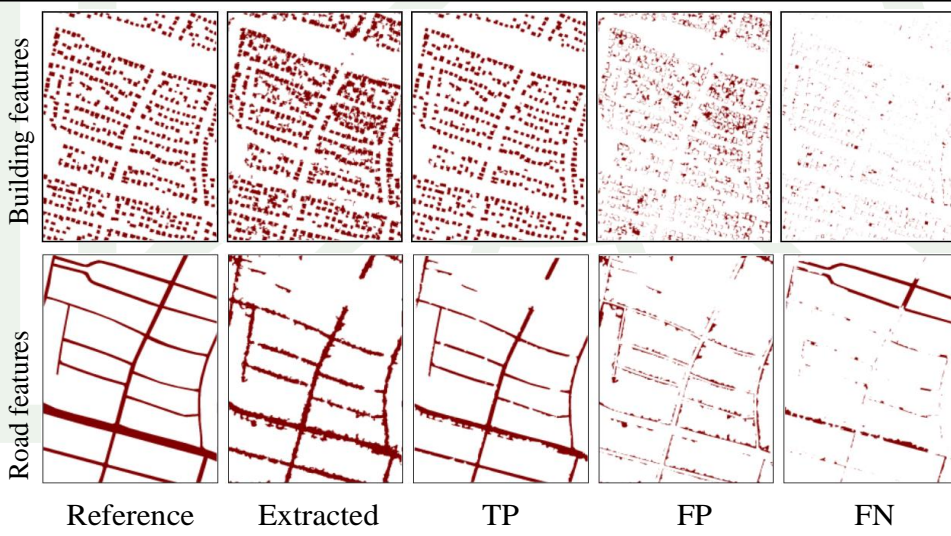
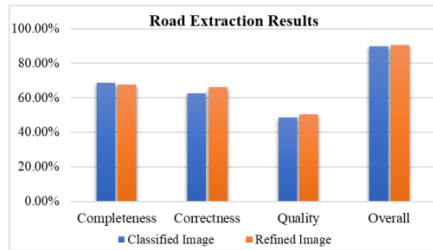
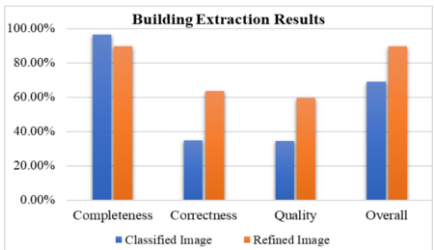
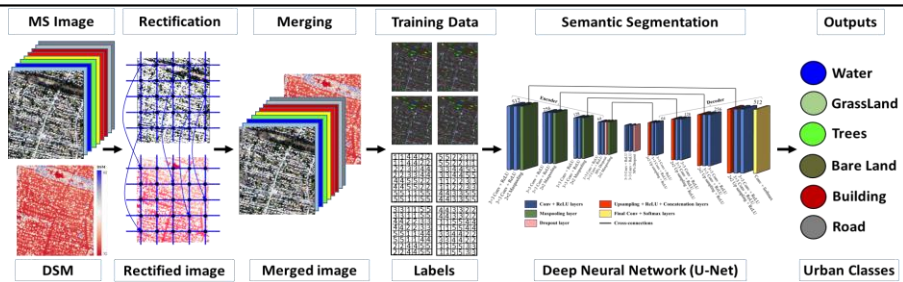
Classification outcomes



6. APPLICATIONS

Urban Land Cover Classification Using Deep Neural Networks Based on VHR MS Image and DSM

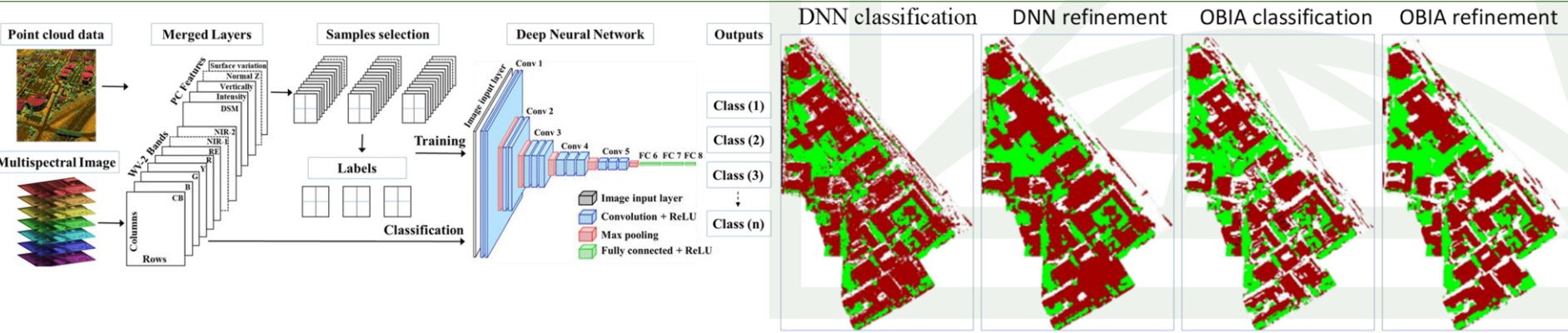
Mohamed Fawzy ^{1,2}, Attila Juhasz ¹, Arpad Barsi ¹



6. APPLICATIONS

URBAN LAND COVER CLASSIFICATION USING DEEP NEURAL NETWORKS BASED ON VHR MULTI-SPECTRAL IMAGE AND POINT CLOUD INTEGRATION

Mohamed Fawzy^{*1,2}, Mohammad Dowajy¹, Tamas Lovas¹, Arpad Barsi¹



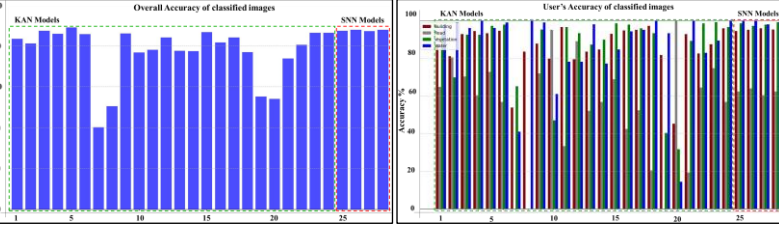
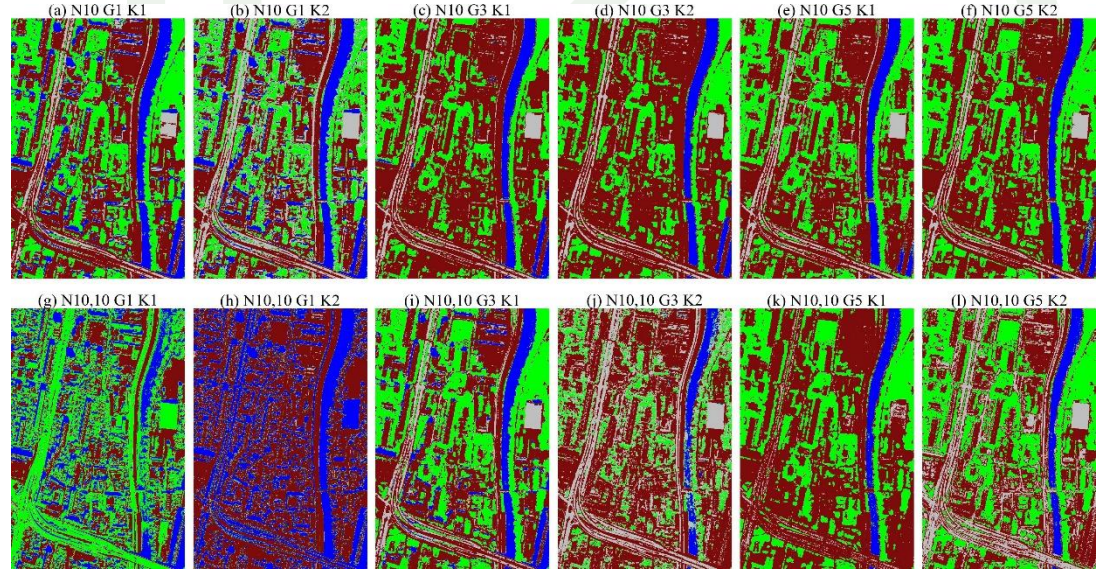
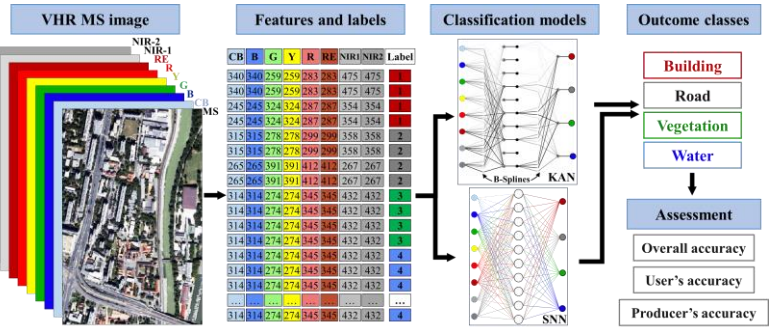
The proposed model achieved an overall accuracy of 83.25% for image classification and 87.00% after the refinement process, while the OBIA method achieved an overall accuracy of 80.75% for the classified image and 83.50% for the refined one.



6. APPLICATIONS

VHR Multispectral Satellite Image Classification with Kolmogorov-Arnold Networks for Urban Applications

Mohamed Fawzy^{1,2}, Arpad Barsi¹



7. CONCLUSIONS

- Object Based Image Analysis (OBIA) technique enables the user to take the advantage of more complex features and offers enhanced results that outperform the traditional pixel-based classification methods.
- Shallow Neural Networks (SNNs) have made significant progress in image analysis tasks for sustainable urbanization, producing results outperform state-of-the-art techniques, but also having some limitations that require further work.
- Convolutional Neural Networks (CNNs) models have the advance of high flexibility to different spatial and various spectral image characteristics and demonstrated encouraging outcomes in terms of optimizing feature extraction, object detection, and LULC classification.
- Kolmogorov Arnold Networks (KANs) models enhance scalability, makes it practical for processing multi-dimensional and large-scale satellite datasets efficiently, facilitate high-resolution mapping and reproducibility in urban applications.

8. PUBLICATIONS [<https://www.researchgate.net/profile/Mohamed-Fawzy-13/research>]

1. Fawzy, M.; Barsi, A. (2024), “A U-Net Model for Urban Land Cover Classification Using VHR Satellite Images”, Period. Polytech. Civ. Eng.
2. Fawzy, M.; Attila, J.; Barsi, A. (2024), “Urban Land Cover Classification Using Deep Neural Networks Based on VHR MS Images and DSMs”, submitted to Acta Polytechnica Hungarica, (Under review).
3. Abdurakhimov, A.; Fawzy, M.; Barsi, A.; Lóránt F. (2025), A GIS Tool for Modelling the Effects of Gasoline Station Explosions in Urban Areas, submitted to the Journal of Transport Geography (Under review).
4. Fawzy, M., Dowajy, M., Lovas, T., Barsi, A. (2024), “Urban Land Cover Classification Using Deep Neural Networks Based on VHR Multi-Spectral Image and Point Cloud Integration”, IEEE-IGARSS 2024, 7 - 12 July, Athens, Greece.
5. Fawzy, M.; Szabó, G.; Barsi, A. (2023), A Shallow Neural Network Model for Urban Land Cover Classification Using VHR Satellite Image Features, ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, ISPRS GSW’2023, Cairo, Egypt, September 2-7.
6. Fawzy, M.; Barsi, A. (2025), VHR Multispectral Satellite Image Classification with Kolmogorov-Arnold Networks for Urban Applications, accepted for the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, ISPRS GSW’2025, Dubai, UAE.
7. Fawzy, M.; Attila, J.; Barsi, A. (2025), High-Quality Road Detection Using U-Net-Based Semantic Segmentation with High-Resolution Orthophotos and DSM Data in Urban Environments, accepted for the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, ISPRS GSW’2025, Dubai, UAE.
8. Dowajy, M.; Fawzy, M.; Barsi, A.; Lovas, T. (2025), Automatic Road Surface Point Extraction Using Neural Networks Based on Geometric Features and Raster Structure Approach in Non-Urban Areas, accepted for the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, ISPRS GSW’2025, Dubai, UAE.
9. Fawzy, M.; Barsi, A. (2024), Urban Land Cover Classification Using Deep Neural Networks Based on VHR Satellite Images, Geospatial Information Conference and Exhibition, Debrecen, Hungary, May 23-24.
10. Fawzy, M.; Szabó, G.; Barsi, A. (2023), Building Extraction from VHR Satellite Images Using Shallow Neural Network model and Object-Based Post-Classification Refinement, Geospatial Information Conference and Exhibition, Debrecen, Hungary, June 1-2.
11. Fawzy, M.; Czinkóczy, A.; Szabó, G. (2022), Object Based Image Analysis Assessment for Urban Applications Using VHR Satellite Images Geospatial Information, presented at Conference and Exhibition “The meeting of theory and practice in geospatial information”, Debrecen, Hungary, November 3-4.
12. Fawzy, M. & Szabó, G. (2023), Artificial Intelligence Strengths for Geoinformatics Applications Based on Satellite Imagery, presented at The Global Surveyors’ Day and European Surveyors’ and Geoinformatics’ Day, Budapest, Hungary, March 21.
13. Fawzy, M. & Barsi, A. (2024), Using Advanced Remote Sensing Technology to Assess the Natural Disaster Effects Related to Climate Change, presented at The Global Surveyors’ Day, Budapest, Hungary, March 21.



9. CALL FOR CO-OPERATION

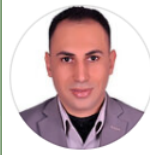
- Basically, we are interested in multimodal data analysis (e.g., VHR multi-spectral images, DSMs, and LIDAR point clouds) for urban applications.
- We are using standard image classification techniques like object-based and pixel-based methods through Erdas, Envi, eCognition, Arc and Q-GIS software.
- We are focusing on artificial intelligence (e.g., Shallow Neural Networks (SNNs), Deep Neural Networks(DNNs), Convolutional Neural Networks (CNNs), and Kolmogorov Arnold Networks (KANs)) for image analysis and urban applications.



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Hungary

819.3 Research Interest Score | **850** Citations | **16** h-index



Mohamed Fawzy ✓

PHD · PhD Researcher at Budapest University of Technology and Economics
Hungary

46.2 Research Interest Score | **29** Citations | **3** h-index



