Land Cover Classification from Aerial Image Using U-net in Poland

Ammar Yousaf, Sirak Asfaha
Institut für Geoinformatik, Westfälische Wilhelms-Universität-Münster, Münster, Germany

Introduction

Land cover refers to the earth's surface features, including elements such as water, soil, vegetation, and their diverse sub-categories. Accurate and up-to-date land cover classification is important for effective environmental monitoring, urban planning, and sustainable resources management. In Poland, rapid urbanization, agricultural activities, and climate change have increased the need for precise land cover information. Traditional methods of land cover classification, which depends on manual interpretation of satellite image and field surveys, are time consuming, labor-intensive, and sensitive to human errors. The introduction of U-net architecture, deep learning (DL), technology presents a transformative opportunity to enhance land cover classification processes. Using high-resolution aerial imagery and DL algorithms, it is possible to automate the classification process, significantly improve the accuracy, efficiency, and scalability.

Study area

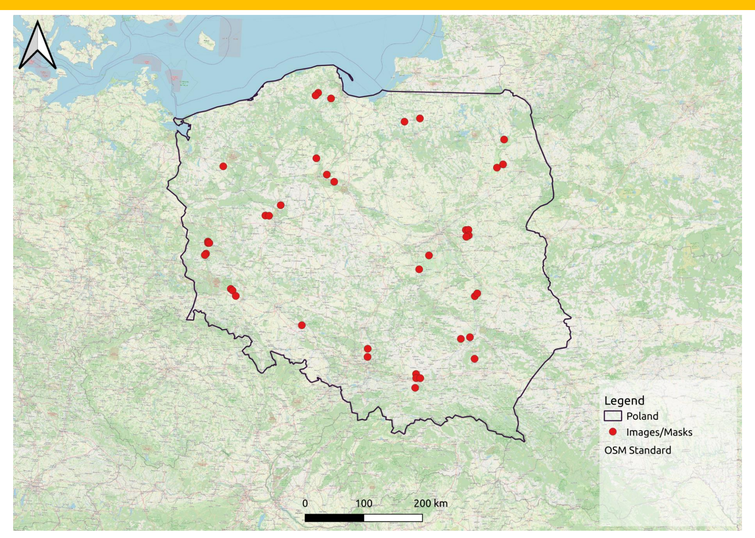

Figure 1. Study area Map of Poland

Dataset

The dataset (Fig. 2) is, from LandCover.ai [1] (Land Cover from Aerial Imagery), designed for the automatic mapping of land covers such as buildings, water, roads, and woodland from aerial images of Poland

- Raster Images and Masks are 3-channel and 1-channel GeoTiffs respectively
- 33 orthophotos with 25 cm per pixel resolution (~9000x9500 px)
- 8 orthophotos with 50 cm per pixel resolution (~4200x4700 px)
- Total area: 216.27 km^2
- Class: Unlabeled (0), Building (1), woodland (2), water (3), road (4)

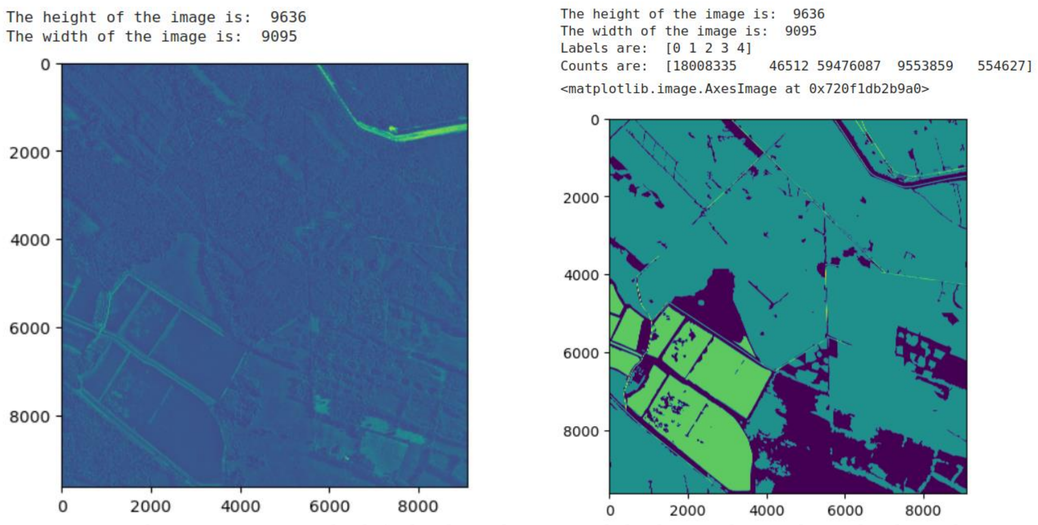

Figure 2. The raw image on the left displays the size, while the masks on the right show the size, classes, and class's pixel count.

Objective

1. Develop a U-Net model that accurately classifies land cover
2. To evaluate and compare the performance of U-Net model with and without data augmentation. The aim is to show the improved effectiveness of augmented trained data in generating reliable land cover data for environmental monitoring and urban planning purposes in Poland.

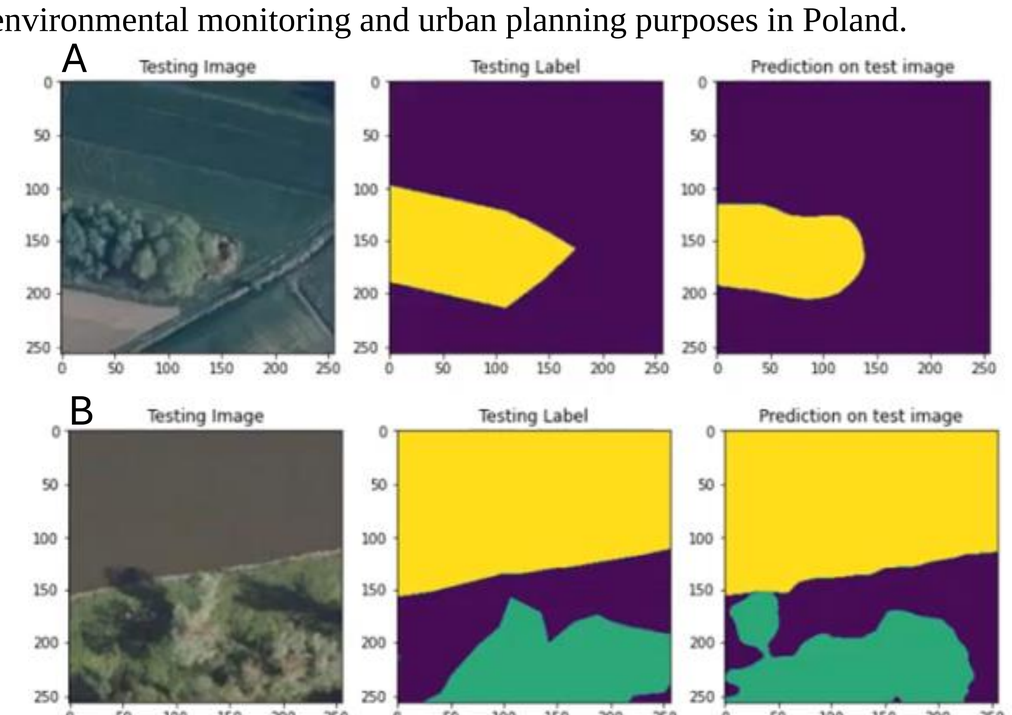

Figure 4. Shows the RGB of the test image, mask, and predicted result of the original data (A) and original data + augmented data (B)

Methodology

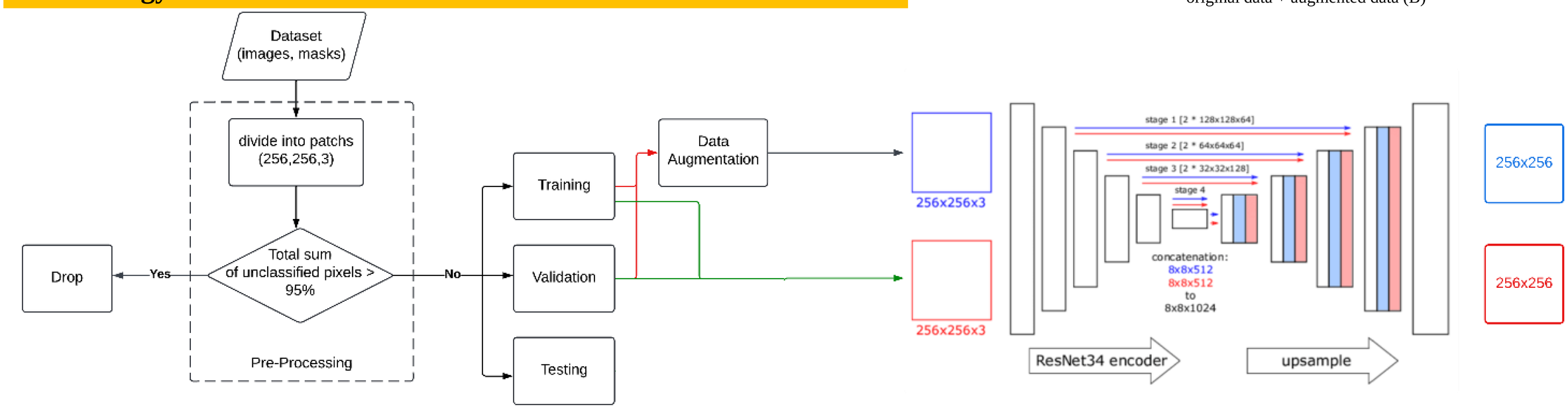

Figure 3. Flowchart for Land cover classification from Aerial Image using U-net CNN architecture

Results

Fig4. presents the land cover classification results obtained from the U-net (ResNet32), a convolutional neural network architecture, applied to aerial images of Poland. The input masks consist of five classes: building, woodland, water, road, and unlabeled. This study employed the Segmentation Models library in Python, which is based on the Keras (Tensorflow) framework. Image segmentation was performed in two approaches: using only the original images and using augmented images. The augmentations included horizontal and vertical flips, with a method to handle pixels generated outside the image boundaries during transformation. The performance difference between these two approaches is significant. Evaluation metrics, Intersection over Union (IOU), demonstrate that classification with augmented data outperforms classification without augmentation, as shown in Table 1.

	Intersection over Union (IOU)
Original dataset	0.73
Original + augmented dataset	0.81

Table 1. Results of the Accuracy and IOU metrics

Conclusion

- Land cover classification is important in sustainable urban and regional planning.
- The model shows robust performance, outperforming traditional classification methods.

Reference

1. Boguszewski, A., Batorski, D., Ziemba-Jankowska, N., Dziedzic, T., & Zambrzycka, A. (2021). LandCover.ai: Dataset for automatic mapping of buildings, woodlands, water and roads from aerial imagery. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern*
2. *Recognition (CVPR) Workshops* (pp. 1102-1110).
3. Růžička, V., D'Aronco, S., Wegner, J. D., & Schindler, K. (2020). Deep active learning in remote sensing for data efficient change detection. *arXiv preprint arXiv:2008.11201*.

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Institut für Geoinformatik
Universität Münster