Automated Slum Detection from High-Resolution Satellite Imagery: A Deep U-Net Approach with ResNet34 Encoder.

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Abstract

Slum detection from satellite imagery is crucial for aiding urban planning, policy-making, and humanitarian efforts to improve housing and living conditions.. Unplanned and rapid urbanization has resulted in the spread of informal settlements that are hard to map with traditional survey techniques. This study presents a deep learning–based binary segmentation model derived from the UNet architecture for delineating slum areas in very-high-resolution (VHR) remote sensing imagery with high accuracy. The proposed slum detection model is based on a UNet architecture with a ResNet34 encoder that has been pretrained on ImageNet, allowing for effective extraction of hierarchical features from high-resolution satellite images. The encoder–decoder structure, enhanced with skip connections, preserves fine spatial details while integrating deep contextual information across multiple scales. The model was trained and evaluated on the Manually Annotated High Resolution Satellite Image Dataset of Mumbai, comprising 8910 tiles collected using Pleiades-1A satellite data with 0.5 m spatial resolution. This study successfully demonstrates the effectiveness of the U-Net architecture with ResNet34 encoder for binary slum detection, with an IoU of 0.848 and F1-score of 0.884, and correctly classifying 99.1% non-slum and 97.2% slum pixels in high-resolution Mumbai satellite images. The proposed approach offers a scalable solution for urban planners to efficiently identify and monitor informal settlements, supporting evidence-based interventions for urban development. Future work will assess the model's generalizability across different regions and utilize multi-temporal imagery to monitor slum expansion over time.

Keywords: satellite imagery; slum detection; informal settlements; urban planning