Urban Slum Detection and Mapping: Semantic Segmentation on VHR Satellite Imagery

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Approximately 1.1 billion people live in slums worldwide today with the number expected to grow by 2 billion in the next 30 years. Slum rehabilitation efforts rely heavily on slum mapping and monitoring. The dynamic nature of slum growth and rapid changes in population emphasize the need for an automated system. Traditional mapping methods are manual and time-consuming. The goal is to contribute to slum rehabilitation by providing a robust segmentation tool for policymakers and urban planners. Existing AI models for slum segmentation are restricted by their lack of interpretability and limited generalization across diverse urban contexts. Feature analysis involving interpretable models like SVM, revealed crucial features in slum areas like diverse textures, lack of vegetation, and irregular patterns. I developed a deep learning model using a U-Net architecture and fine tuned the Segment Anything Model (SAM), on over 10,000 slum satellite images and their masks. The U-Net model demonstrated promising performance in both Karachi and Tanzania slums, while the fine-tuned SAM model outperforms U-Net, emphasizing the potential of advanced pre-trained models in addressing the dynamic challenges of urban mapping applications. Results showcase improved precision in slum segmentation with a pixel accuracy of 90.7% (+31.3% from baseline SAM) and 87.1% (+35.9% from baseline SAM) for Karachi and Tanzania respectively with the fine-tuned SAM model. Ultimately, my research provides a crucial tool for informed decision-making in waste management, disaster planning, health initiatives, and other challenges faced by millions living in informal settlements.

Awards Won:
National Geographic Society: Excellence in Geography and Geospatial Science Award
U.S. Agency for International Development: Third Award Working in Crisis and Conflict