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

ROBO043

Robotics and Intelligent Machines

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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.

1. In this research project, the student directly handled, manipulated, or interacted with (check ALL that apply):

- ☐ human participants
- ☐ potentially hazardous biological agents
- ☐ vertebrate animals
- ☐ microorganisms
- ☐ rDNA
- ☐ tissue

2. I/we worked or used equipment in a regulated research institution or industrial setting (Form 1C):	☐ YES	✓ NO
3. This project is a continuation of previous research (Form 7):	☐ YES	✓ NO
4. My display board includes non-published photographs/visual depictions of humans (other than myself):	☐ YES	✓ NO
5. This abstract describes only procedures performed by me/us, reflects my/our own independent research, and represents one year's work only:	✓ YES	☐ NO
6. I/we hereby certify that the abstract and responses to the above statements are correct and properly reflect my/our own work.	✓ YES	☐ NO

SCIENTIFIC REVIEW COMMITTEE APPROVED
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May 11–17, 2024
Los Angeles, California

The stamp or embossed seal attests that this project is in compliance with all federal and state laws and regulations and that all appropriate reviews and approvals have been obtained including the final clearance by the Scientific Review Committee.