Computer Vision for Building Damage Assessment Using Satellite Imagery

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Introduction

Large-scale disasters damage thousands of buildings at once, making manual damage assessment slow, costly, and unsafe.
Therefore, our work develops a two-stage AI pipeline that automates the detection of buildings and identifies their level of damage using pre and post-disaster satellite imagery. This approach reduces human assessment time and increases scalability for emergency response and disaster recovery planning.

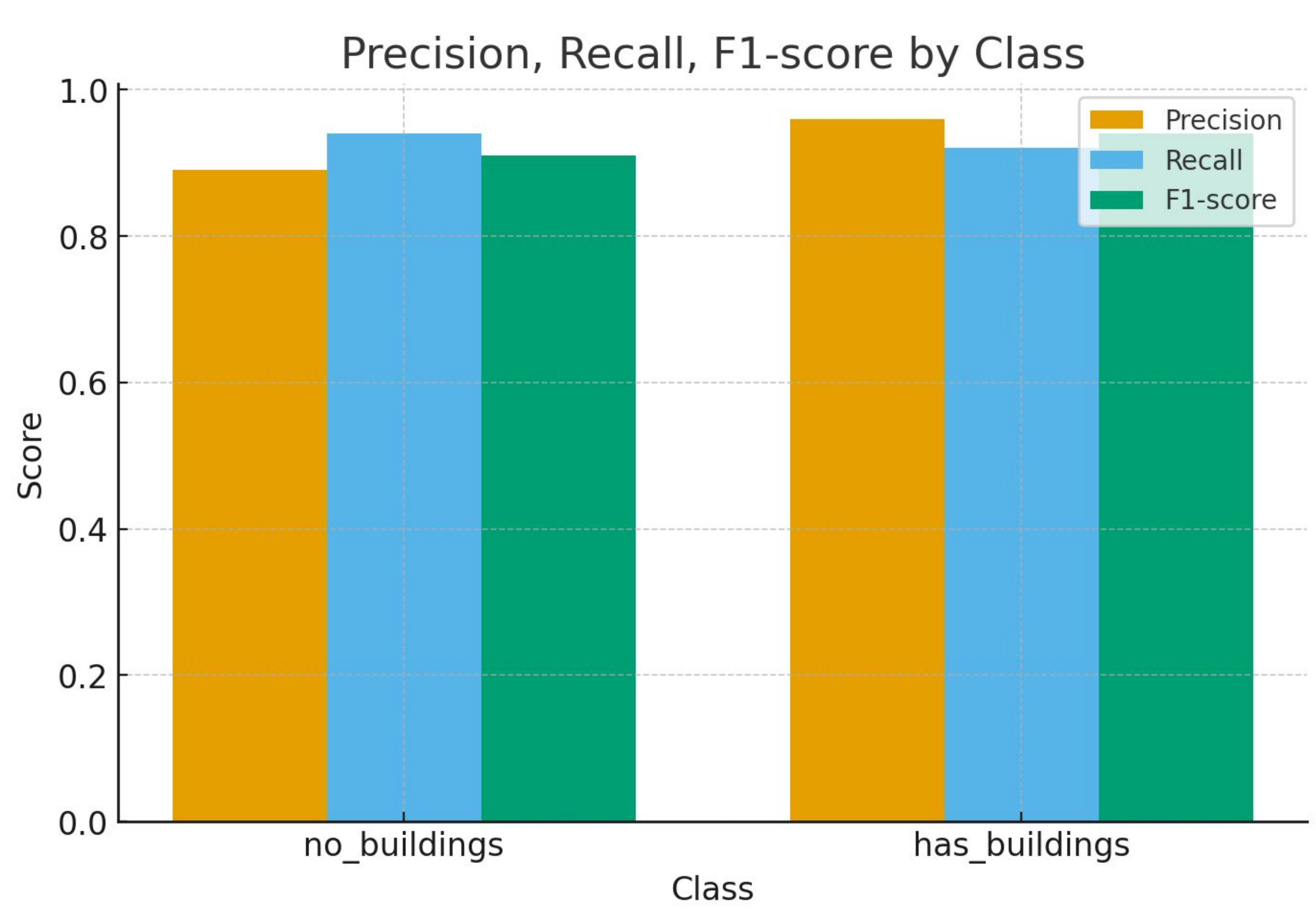
Data

Our project uses the xView2 dataset, consisting of 850,736 labeled buildings from six disaster types across 15 countries. The data is in the form of satellite imagery with corresponding pre and post-disaster images and buildings labeled with damage severity class.
Each building is annotated using the Joint Damage Scale from 0 to 5 (No building, no damage, minor damage, major damage, destroyed, unknown). We tiled the 1024x1024 images into 512x512 chips. For the binary (no building/building) classifier, we

classified images 0 or 1 to identify the presence of a building. For the damage classifier we classified images 0 to 5 to identify the damage level.

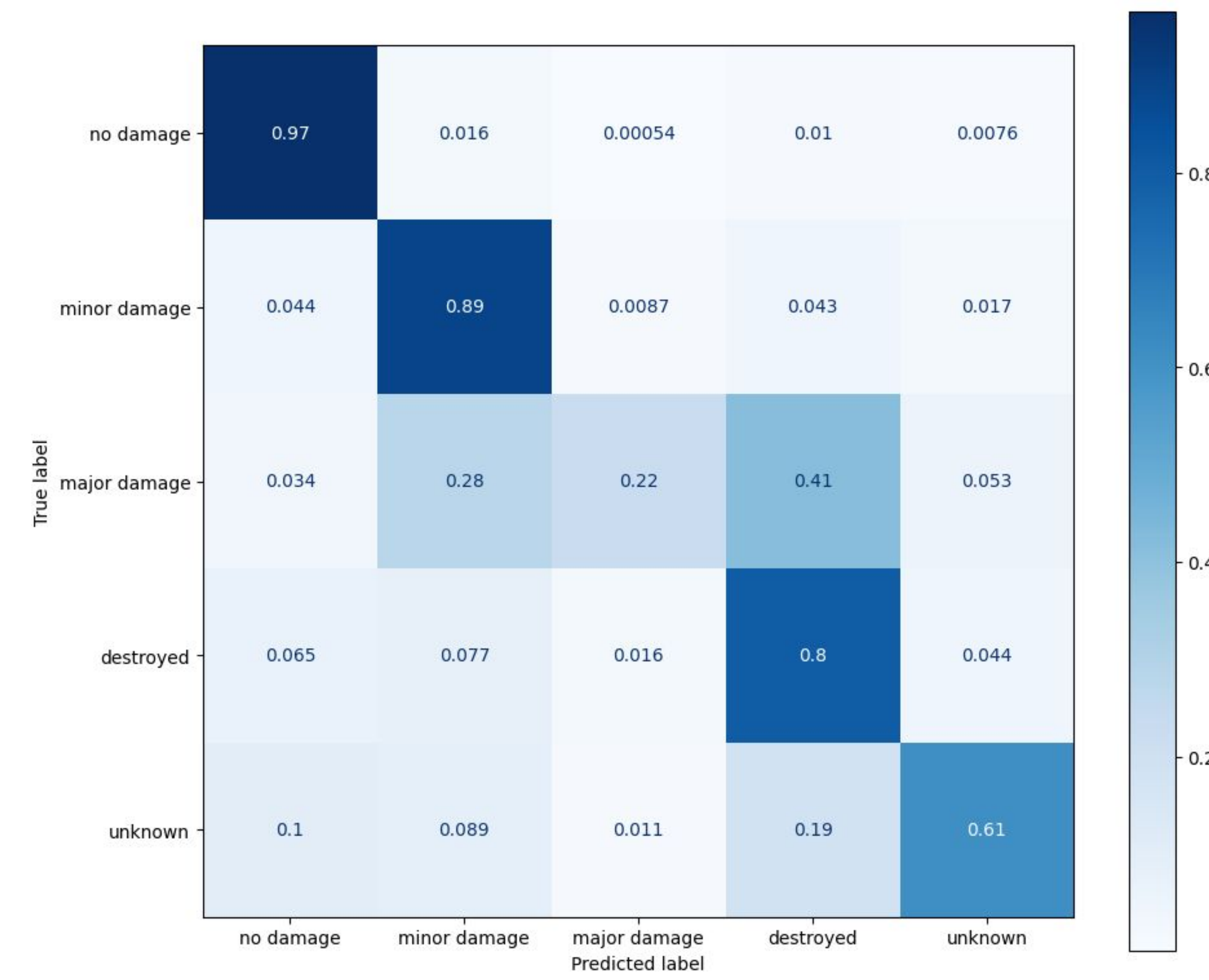
Results

The building detection model achieved 96% overall accuracy in identifying whether an image contained a building and had 96% average precision, recall, and f1-score on the validation set.



Binary Model Classification Report

The damage classifier returned a 76% accuracy on our validation dataset. We can see that the model performs significantly better on "no damage," "minor damage," and "destroyed" buildings with poorer performance on "unknown" and "major damage."



Damage Classifier Confusion Matrix

Classification report:

	precision	recall	f1-score	support
no building	0.89	0.96	0.93	1862
no damage	0.74	0.88	0.81	1158
minor damage	0.66	0.21	0.32	279
major damage	0.49	0.79	0.61	502
destroyed	0.78	0.58	0.67	762
unknown	0.60	0.27	0.37	475
accuracy			0.76	5038
macro avg	0.69	0.61	0.62	5038
weighted avg	0.76	0.76	0.74	5038

Damage Classifier Classification Report

Methods

We began with a model to serve as a binary classifier to determine if an image contains buildings or not.
Model 1: Building Presence Classifier

- Model: ResNet-18 binary classifier (ImageNet pretrained)
- Goal: Classify whether or not the satellite image contains buildings
- Output: Building probability (0-1).

However, we moved to a different model to analyze the highest amount of damage in an image post-disaster
Model 2: Image Damage Severity Classifier

- Model: ResNet-18 Multiclass Classifier (ImageNet pretrained)
- Goal: Classify the highest severity of damage found in an image.
- Output: Values from 0 - 5 (No building, no damage, minor damage, major damage, destroyed, unknown)

Conclusion

This work demonstrates a framework for automated post-disaster building damage assessment using satellite imagery. Using this model, humanitarian responders can run satellite imagery through the damage classification to identify critical areas in need of support.

This matters because rapid and objective structural evaluation is essential for emergency response and government recovery planning. Automated damage mapping can accelerate rescue coordination and resource allocation, especially when access to affected areas is limited and manual assessment is too tedious.

Works Cited

https://www.ibm.com/think/insights/the-xview2-ai-challenge