

Geometry-Informed Material Recognition

*Joseph DeGol, Mani Golparvar-Fard, Derek Hoiem
University of Illinois Urbana-Champaign*

Problem Statement

We want to use image and 3D geometry to recognize materials in real-world scenes.



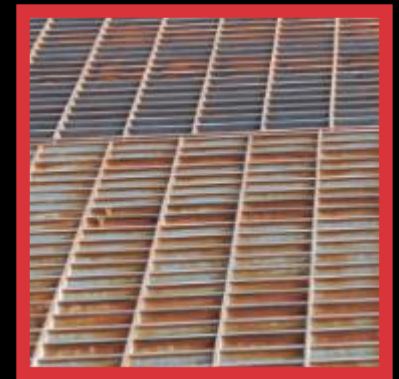
Brick



Concrete



Foliage



Metal

GeoMat Dataset: Focus Scale

19 Material Categories

Multiple Surfaces per Category

8-12 Images per Surface



SFM
PMVS



Surface Normals
Camera Calibration Information

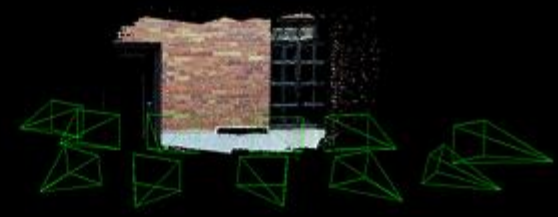


Image Patches at different scales

GeoMat Dataset: Scene Scale

160 Images of a construction site

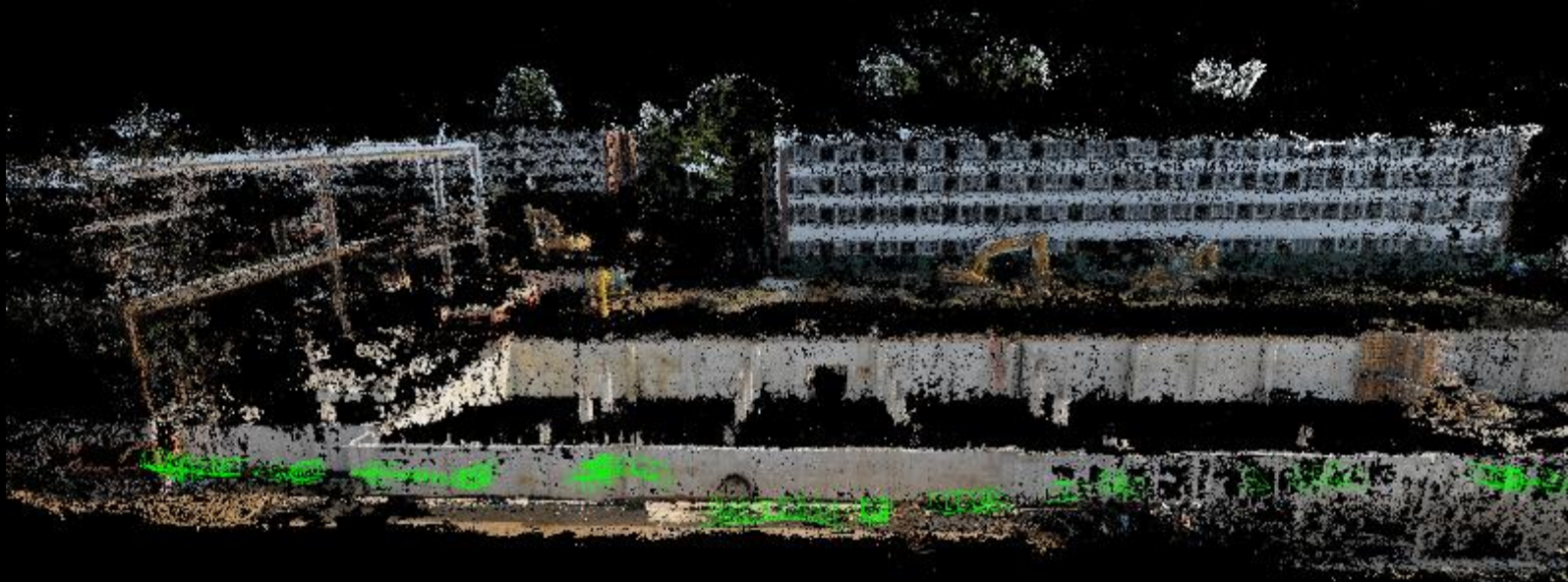


...



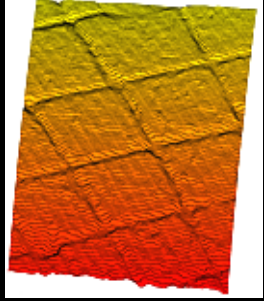
160 calibrated cameras

900,000+ labeled 3D points with normal vectors

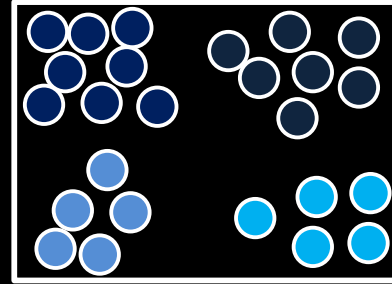


Using Geometry to Aid Material Recognition

Normal Vectors

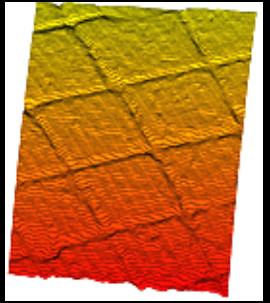


Independent Modeling (N3D)



Using Geometry to Aid Material Recognition

Normal Vectors



Independent Modeling (N3D)

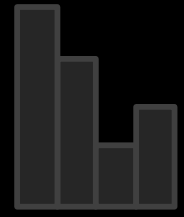
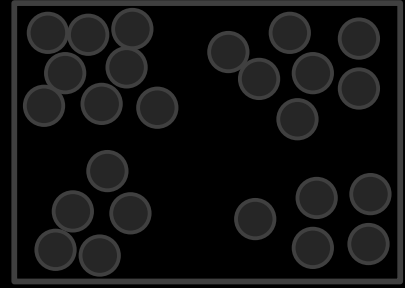
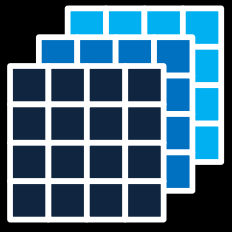
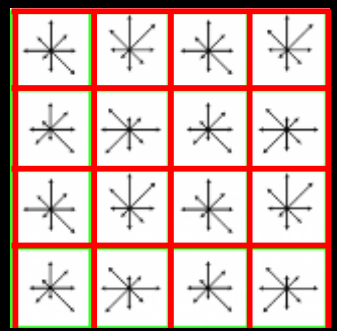
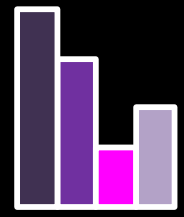
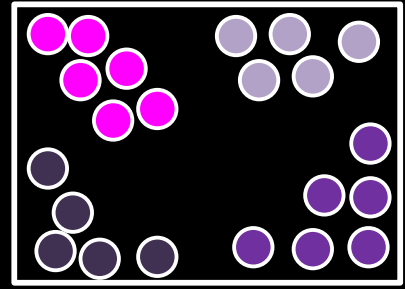
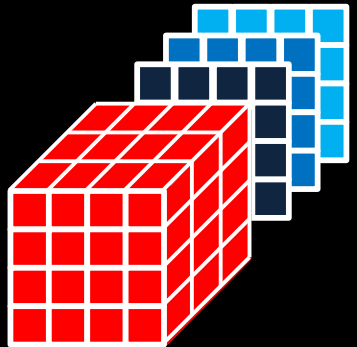


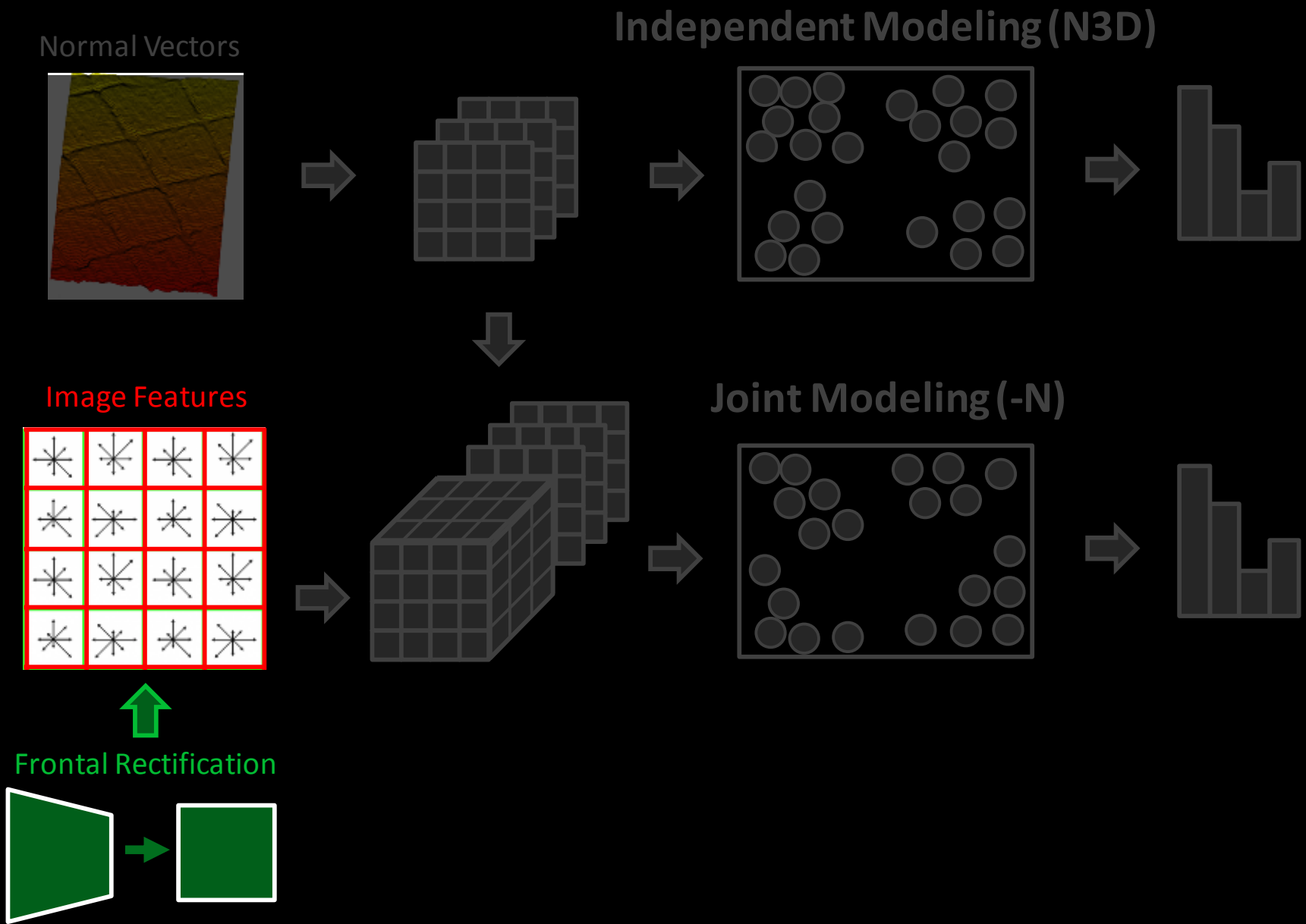
Image Features



Joint Modeling (-N)



Using Geometry to Aid Material Recognition



Results

3D Geometry helps with categories with similar appearance but different geometry.

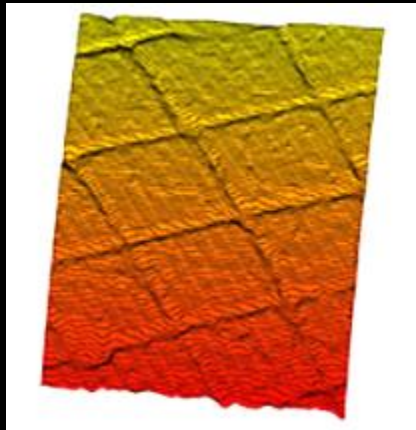
Paving



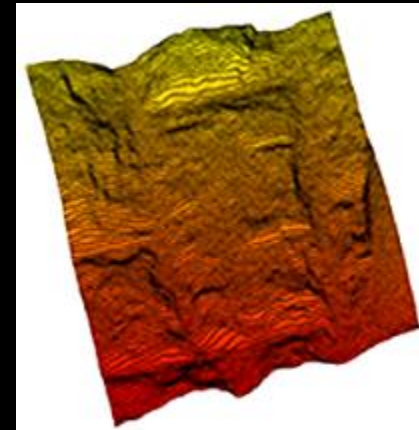
Stone - Limestone



Often confused with 2D



Correctly classified with 3D



Results

Both **joint (-N)** and **independent (N3D)** representations improve mean classification accuracy.

	-	+N3D
FV + CNN	68.92	72.08
FV-N + CNN	73.80	73.84

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Best 2D (FV+CNN)

Best 3D (FV-N+CNN+N3D)

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FV + CNN	68.92	72.08
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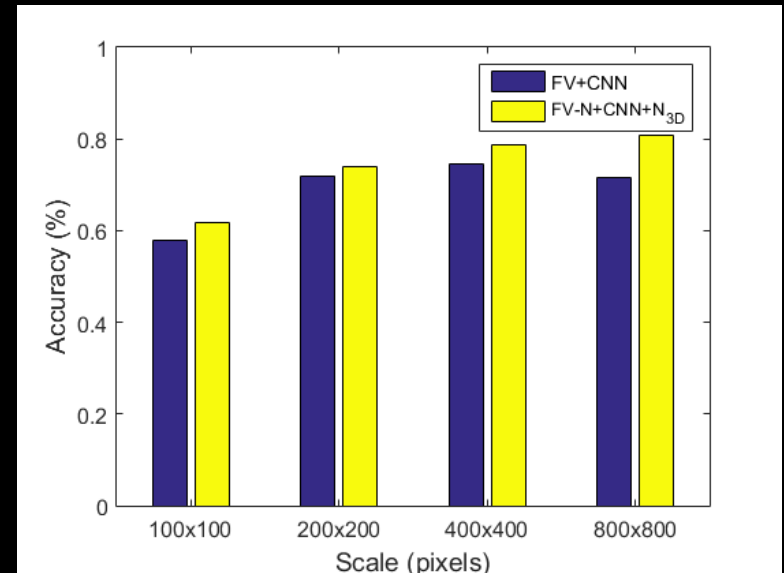
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Best 3D (FV-N+CNN+N3D)

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Geometry improves classification accuracy across scales and viewing directions.



Thanks