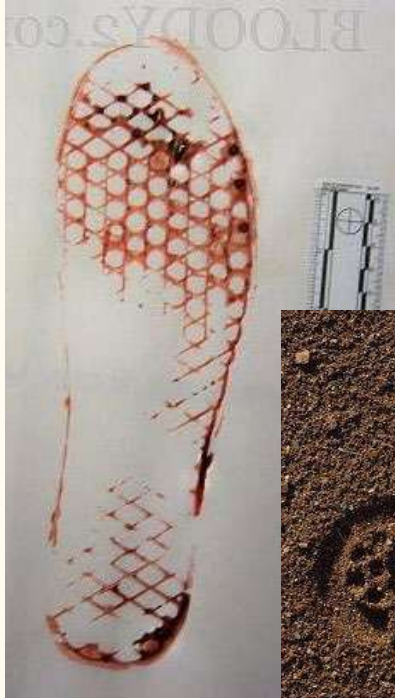


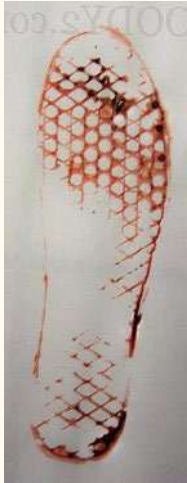
Predicting Shape, Reflectance and Impressions from Photos of Shoe Treads

Samia Shafique, Charless Fowlkes

Crime Scene Shoe Prints



Matching Print to Shoe

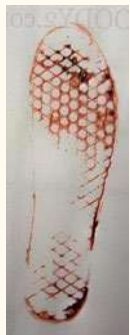


Crime Scene Print

Shoes

Which class of shoe left the print?

Matching Print to Shoe



Lab Impressions



Shoes

Previous work

- Cross-Domain Image Matching with Deep Feature Maps, IJCV 2018

Improvements

- Complete set of shoes
 - New shoes every month
- Automatic print generation

Shoe Tread Images from Online Retailers

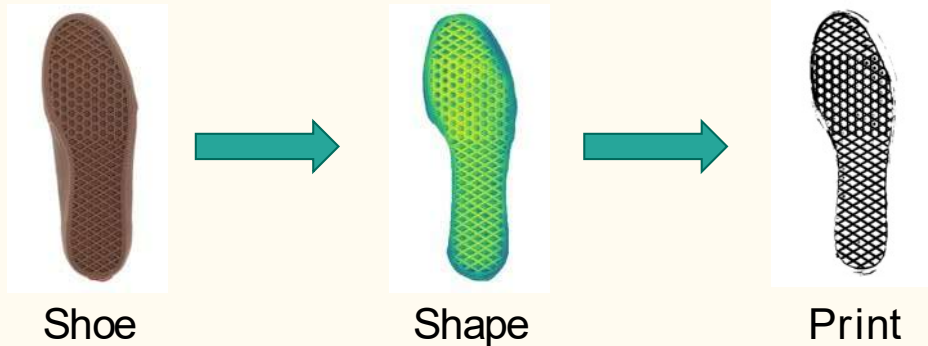


Constant stream of data from
online retailers

How can we use this?

Photos of Shoe Treads from Online Retailers

Dataset of Shoe and Corresponding Print



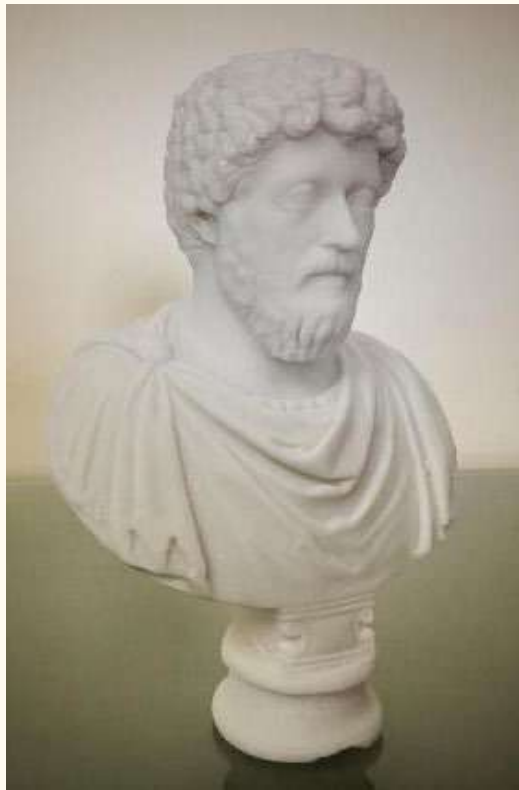
- Learn shape and print from shoe tread images



- Create one to one mapping of shoes and prints using online retailer images

Related Work

Shape From Shading (SFS)



- Strong assumptions
 - a. Known point light source
 - b. Lambertian surface
 - c. Known reflectance

Inverse Rendering

1. Infer shape, color and lighting from images
2. Ill posed problem
3. Retinex model (Land 1967)
 - Smooth variation in lighting
 - Sharp transitions in color
1. Learning based approaches can utilize statistics of data distribution to disambiguate the problem

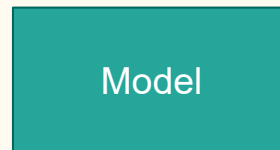


Machine Learning

- Regression model - given input X , predict output Y
- Train the model using
 - Example (X_i, Y_i) pairs
 - Model learns to predict output for other similar input
 - Loss function
 - Measure of how well the ground truth (Y_i) matches model output prediction ($\hat{Y}_i = f(X_i)$)



Shoe



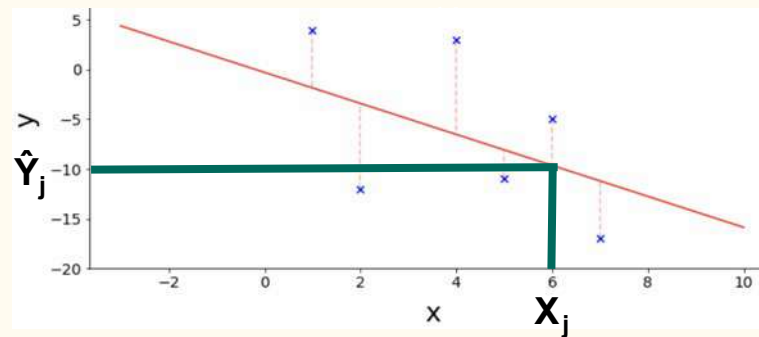
Color



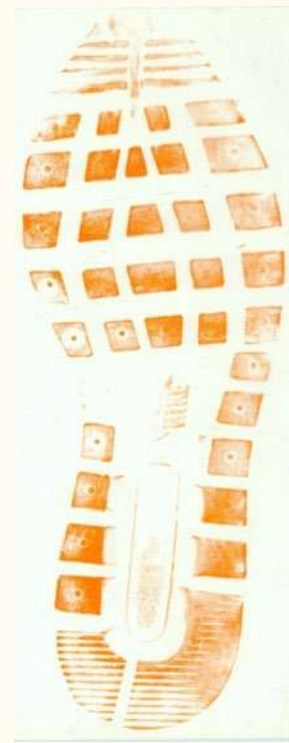
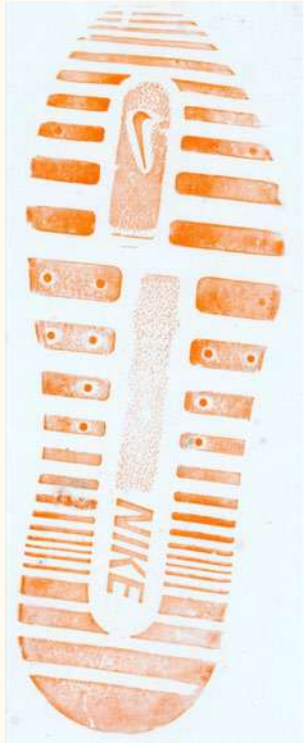
Shape



Light

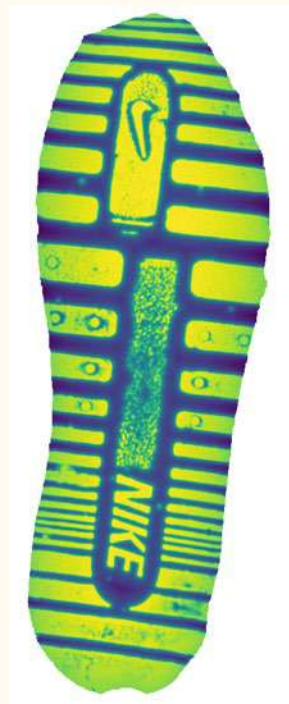
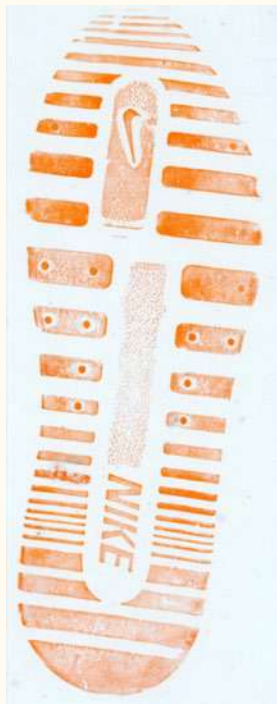


Synthetic Data Generation

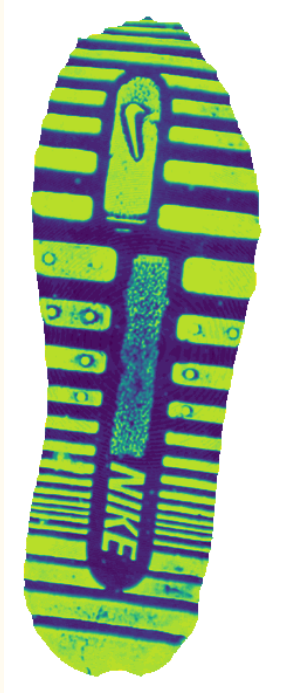


Shoe prints

Generating Depth Maps



Generating Color Maps



Shape from
depth map

+



Color scheme from
online shoes

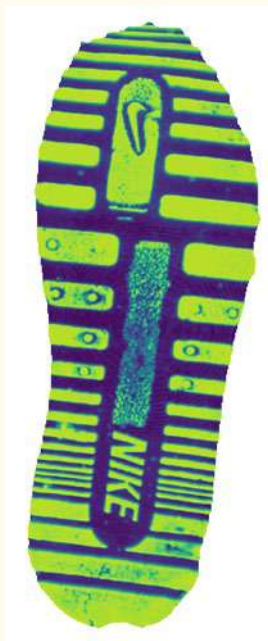


Color map

Rendering Shoes



Color map



Depth map



Light
environment



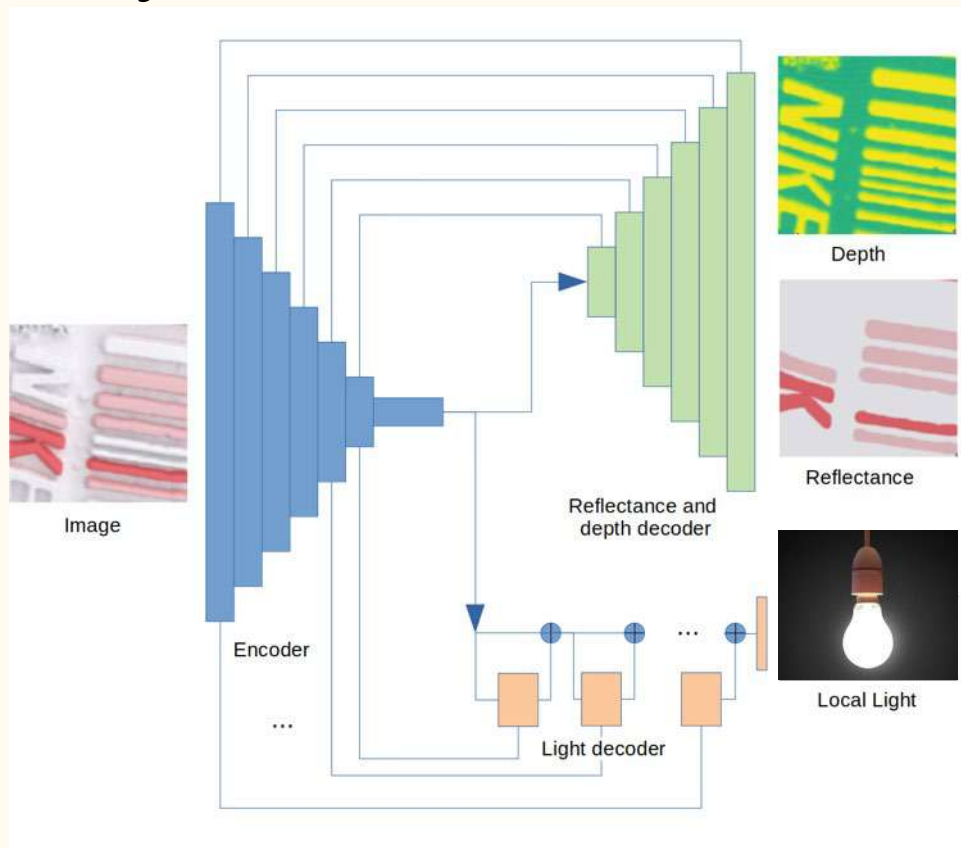
Rendered Image

Rendering Shoes

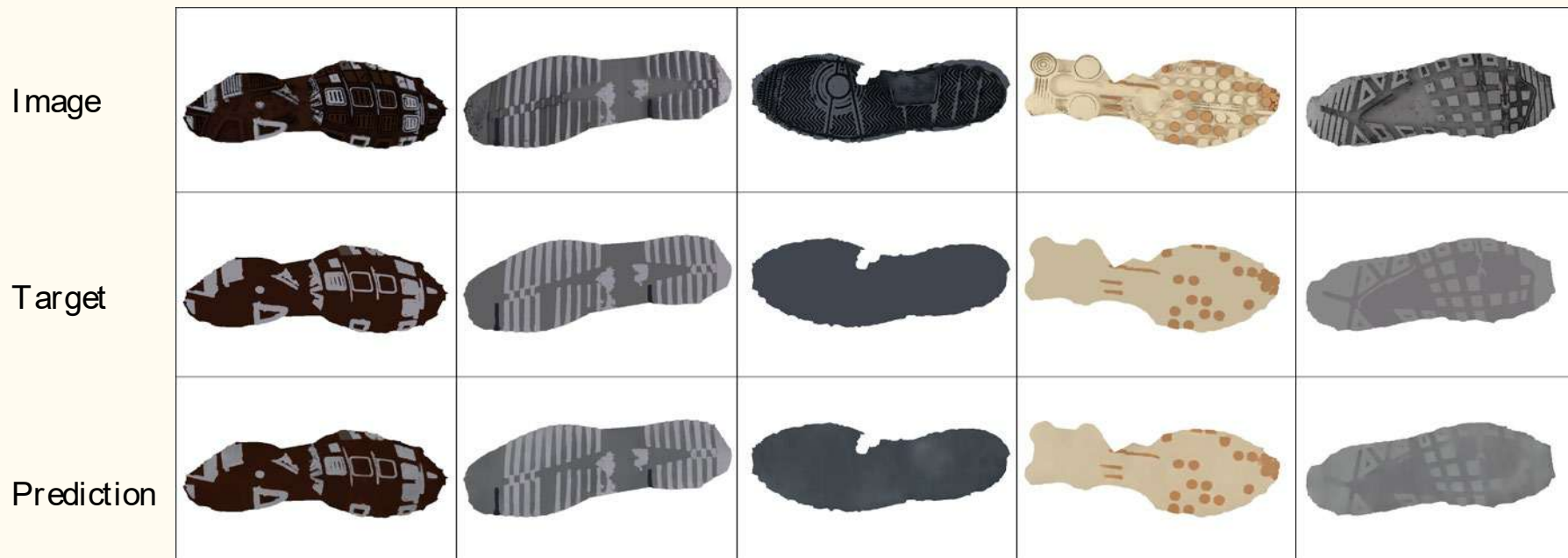


Training Model

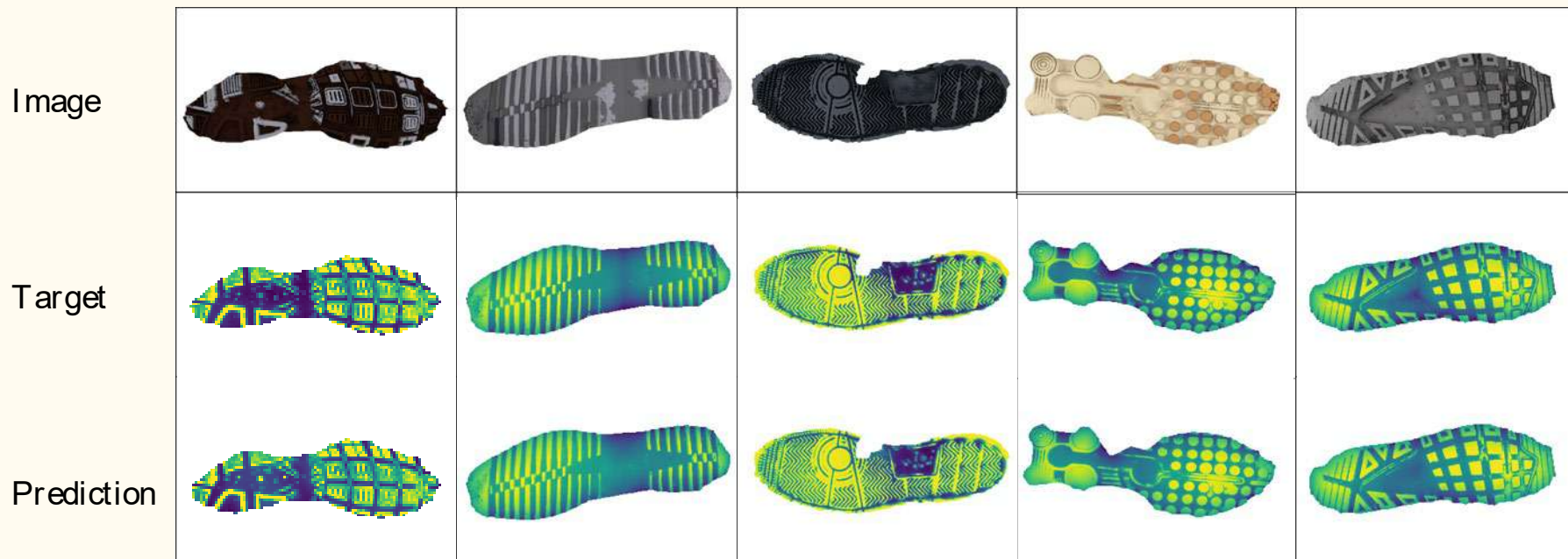
Training on Synthetic Shoes



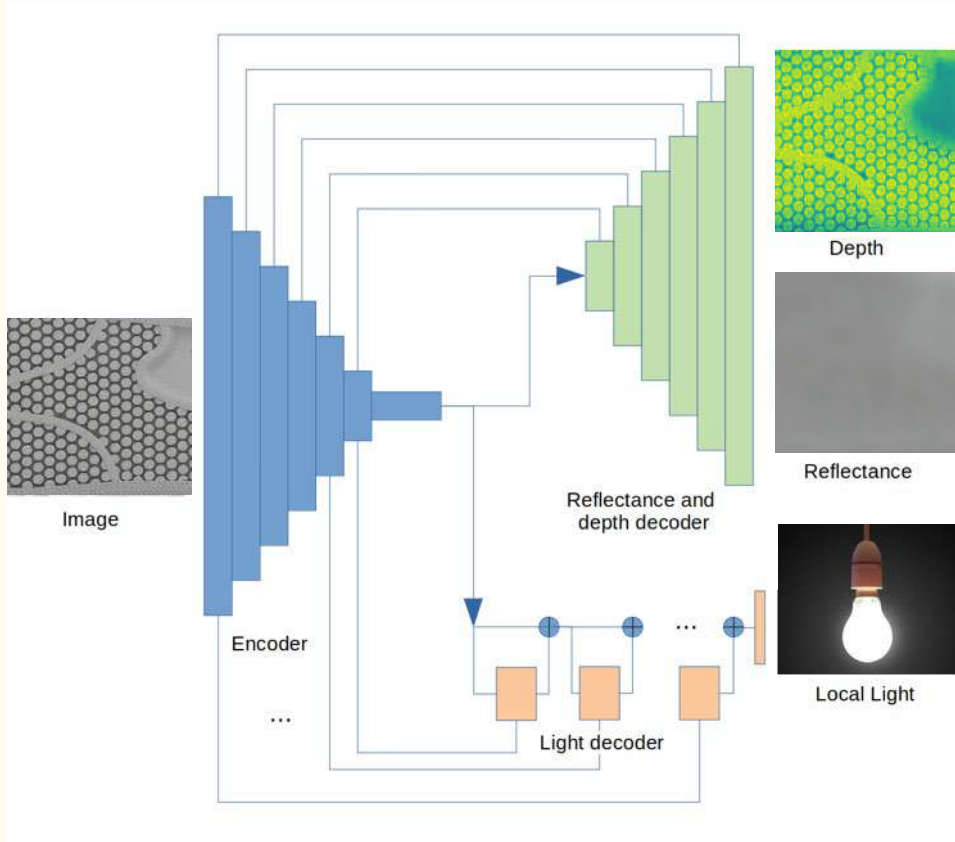
Results on Synthetic Shoes - Color



Results on Synthetic Shoes - Depth

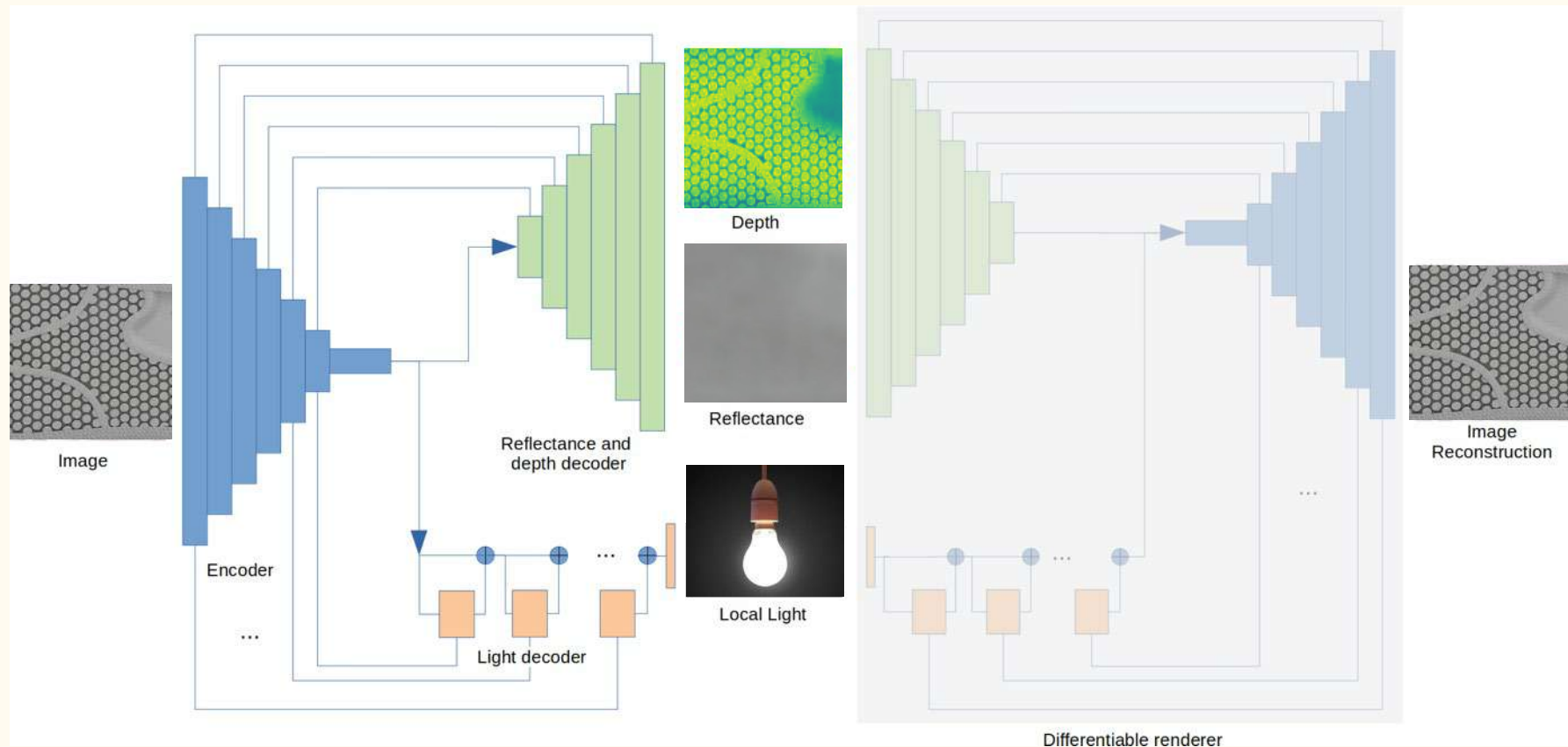


Training on Real Shoes



Estimating color of real shoes using a variant of Mean Shift algorithm

Training on Real Shoes



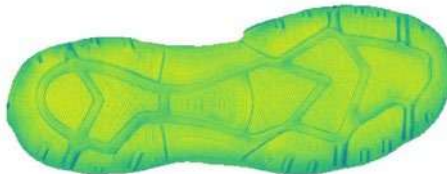
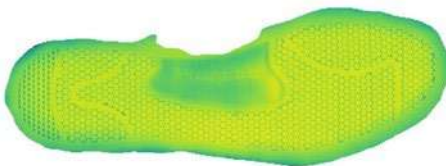
Results on Real Shoes

Results on real shoes

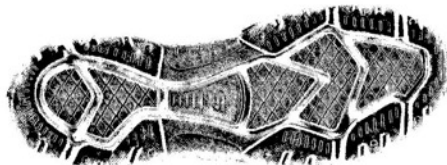
Shoe tread image



Depth map prediction



Our print prediction

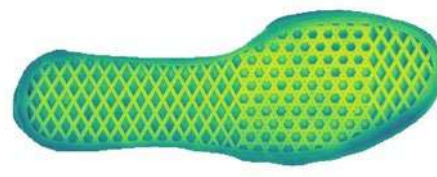
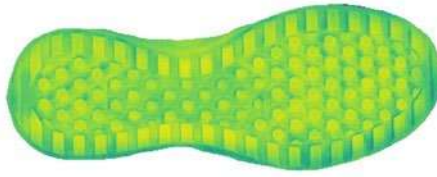


Results on real shoes

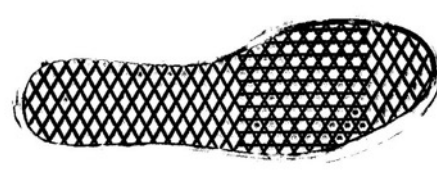
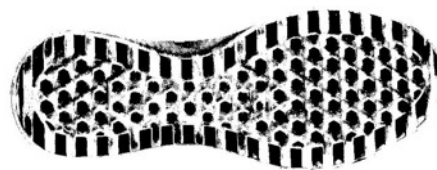
Shoe tread image



Depth map prediction



Our print prediction

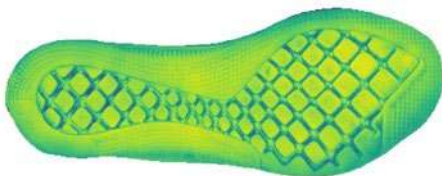


Results on real shoes

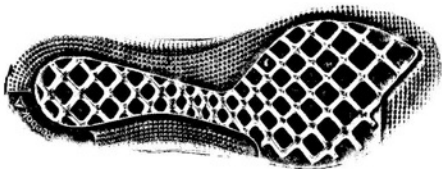
Shoe tread image



Depth map prediction



Our print prediction

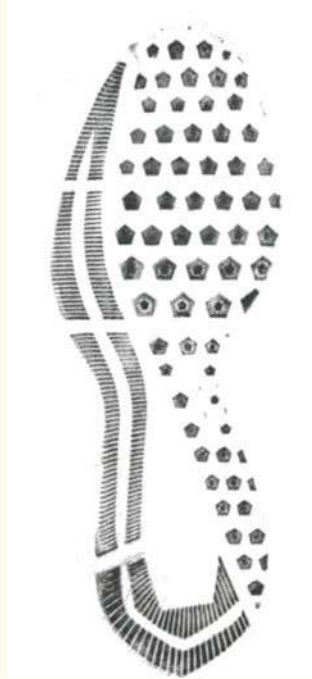


Ongoing Work

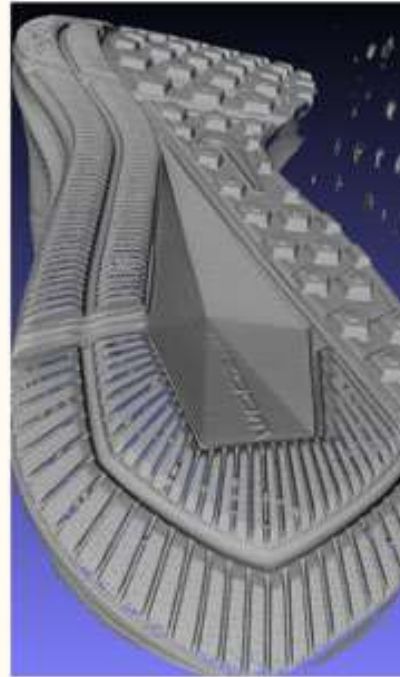
Collecting Lab Impressions and 3D Scans



Shoe sole image



Lab Impression



3D shape

Conclusion

- Predict impressions from photos of shoe treads
- Leverage the online retail images
- Match crime scene prints to real shoes sold online

Thank You!