IPR Project Report

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1 Implementation Detail

Data Generation Steps

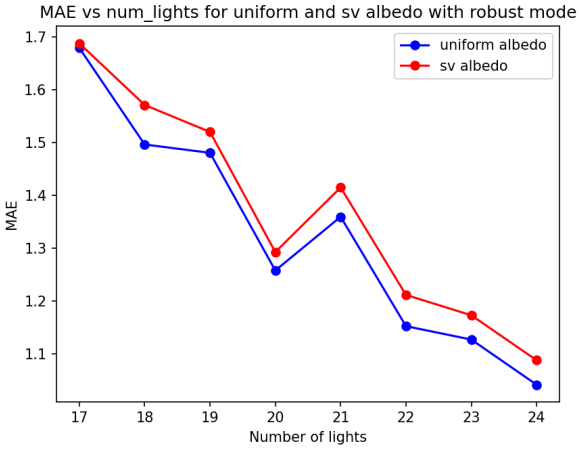
1. **Generate Surface Normals**: Generate random upward-facing, normalized surface normals.
2. **Generate Lighting Directions**: Generate random lighting directions to avoid shadows.
3. **Compute Intensity Measurements**: Simulate Lambertian reflection to compute light intensity due to varying light sources.
4. **Generate Reflectance Maps**: Create spatially varying or uniform reflectance maps for multiple wavelengths.
5. **Render Synthetic Images**: Combine surface normals, lighting, and reflectance to render synthetic images.

Code files and folders

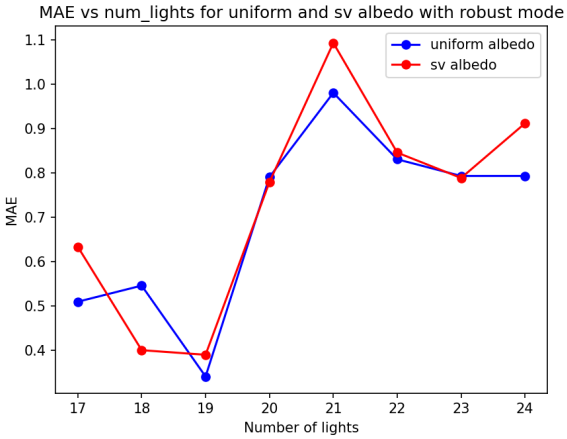
1. **MPS_SCPS.py and MPS_SCPS_robust.py:** Estimates surface normals and reflectance using normal and robust method respectively.
2. **MPS_SCPS_robust_part2.py:** Estimates surface normals and reflectance using normal and robust method respectively with new IRLS approach.
3. **generateLight.py:** Simulates and visualizes lighting in a 3D space.
4. **render.py:** Generates synthetic data based on Lambertian reflection models. Renders final image with the lighting and albedo conditions.
5. **eval.py:** Evaluates the accuracy of estimated surface normals compared to ground truth normals.
6. **albedo.py:** Generates spatially varying albedo.
7. **err_maps.py and testplot.py:** Testing files to output results.
8. **err_maps_part2.py and testplot_part2.py:** Testing files to output results using IRLS.
9. **Folders - bunny and sphere:** These contain files to generate bunny and sphere synthetic images.
10. **Folder - lights:** Stores different lighting condition files.

2 Results and Comparison

Here rob (original) and rob (irls) are the original and improved approaches respectively. IRLS outperforms the original thresholding approaching on all stable lighting conditions (num_lights more than 16).



Results for rob (original)

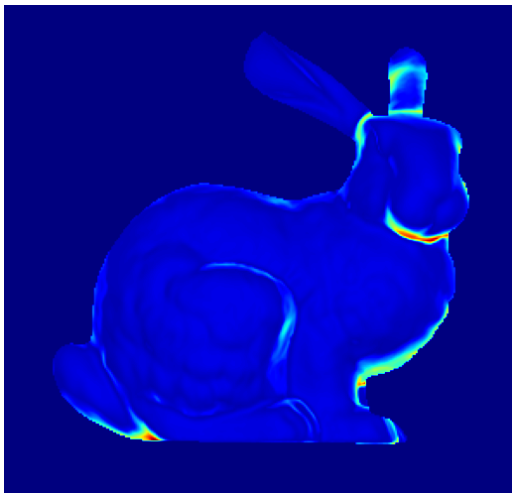


Results for rob (irls)

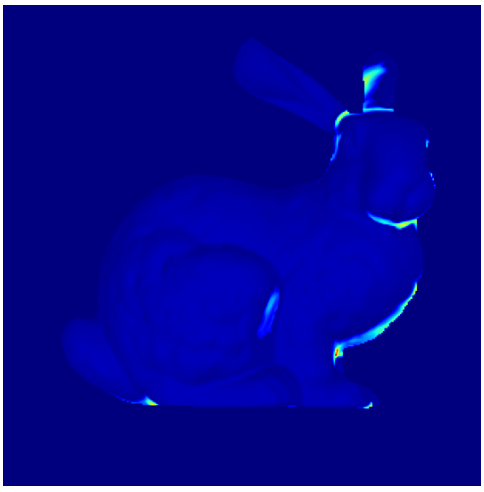
Graphs

Mode	num_lights	MAE
rob (original)	24	1.08
rob (irls)	24	0.91

MAE Values on spatially varying albedos.



rob (original),24



rob (irls),24

Error Maps on sv albedo (Mode, num_lights)

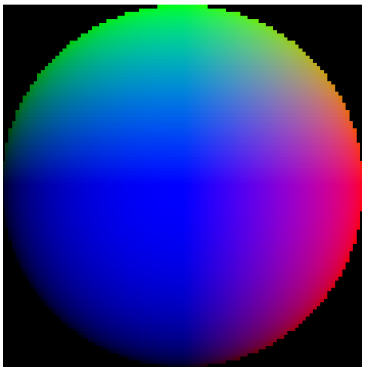
3 Dataset Description

Generates synthetic dataset. We generate two images - sphere and bunny. The normal.npy and mask.npy files are provided for both. To render final image we further provide albedo and lighting conditions. Shown below are the inputs to synthesize the images -

bunny mask

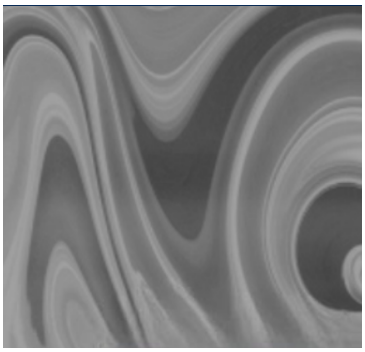
bunny normals

sphere mask

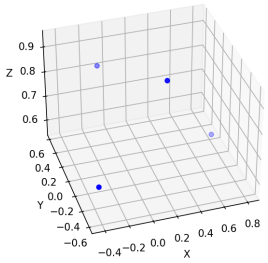


sphere normals

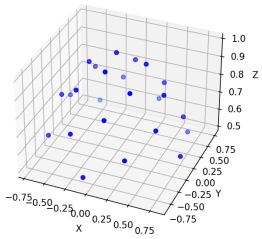
uniform albedo



spatially varying



4 lights positions



24 lights positions