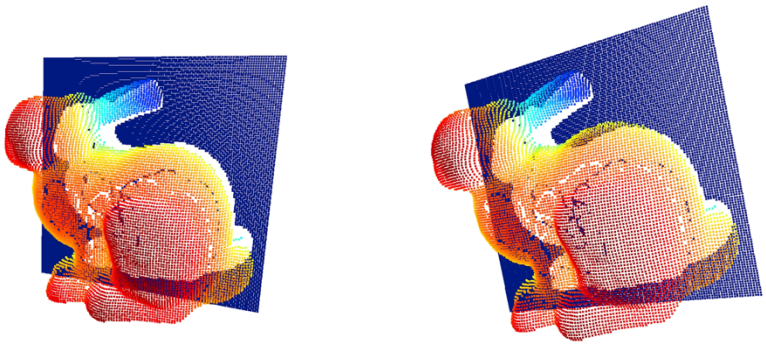
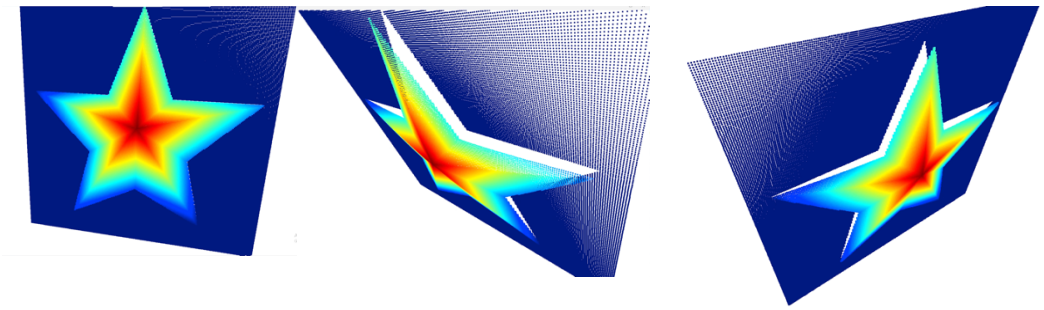
Photometric Stereo
HW1 - Report

1. Reconstruction

Bunny

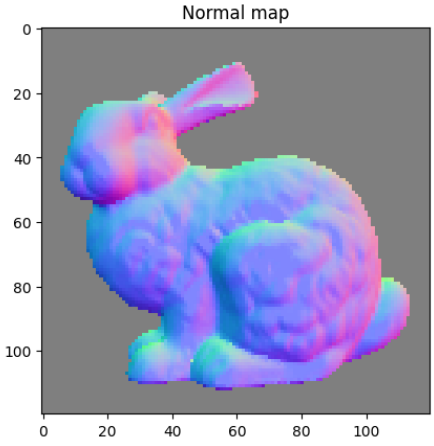


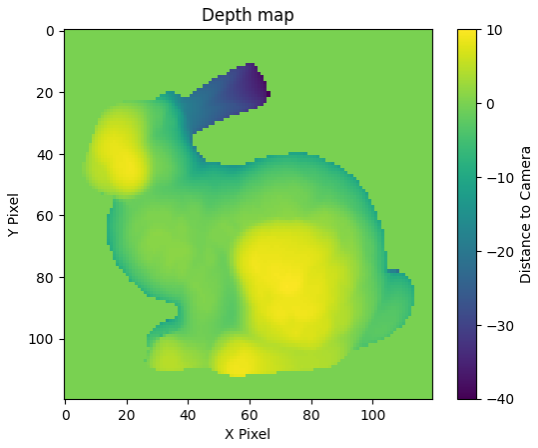
Star



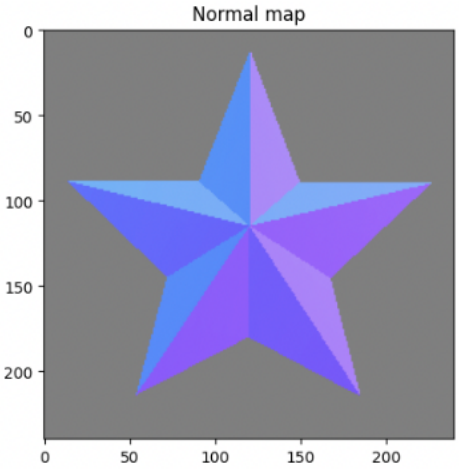
2. Normal maps and depth maps

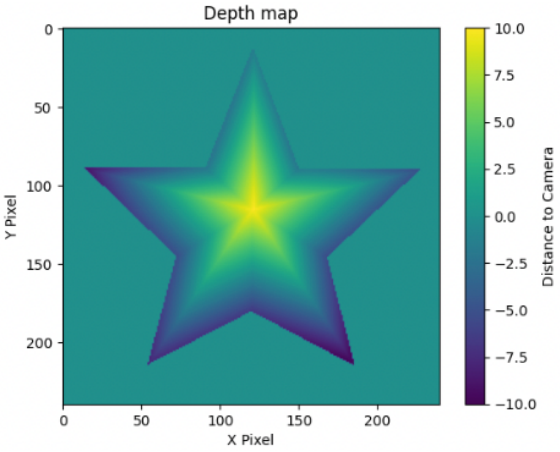
Bunny



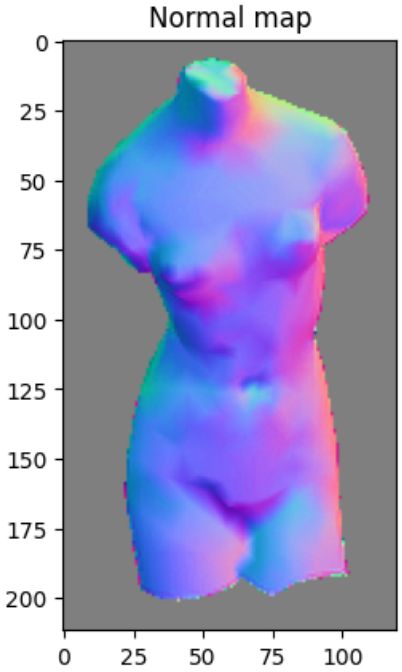


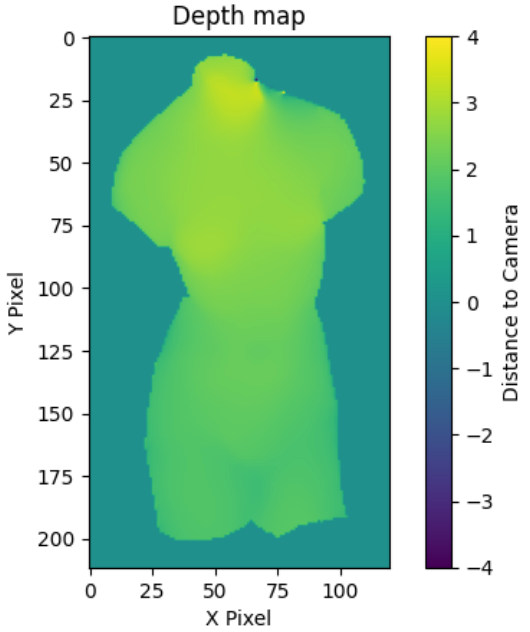
Star


Normal map
0
50
100
150
200
0
50
100
150
200


Depth map
Y Pixel
X Pixel
Distance to Camera
10.0
7.5
5.0
2.5
0.0
−2.5
−5.0
−7.5
−10.0

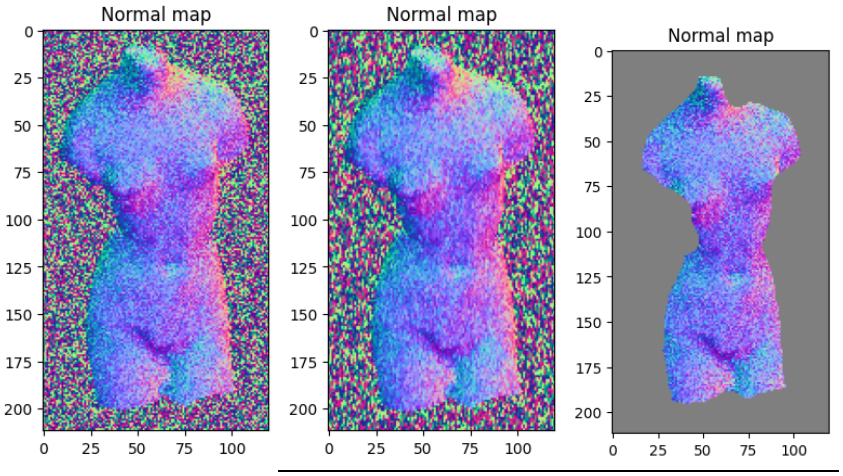
Venus


Normal map
0
25
50
75
100
125
150
175
200

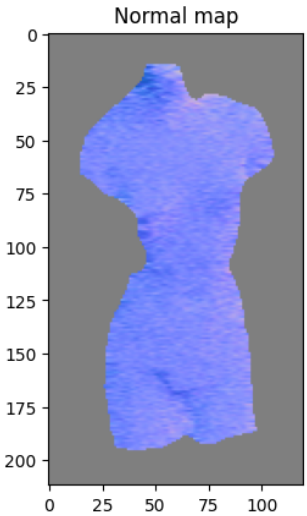

Depth map
Y Pixel
X Pixel
Distance to Camera
4
3
2
1
0
−1
−2
−3
−4

Noisy_Venus

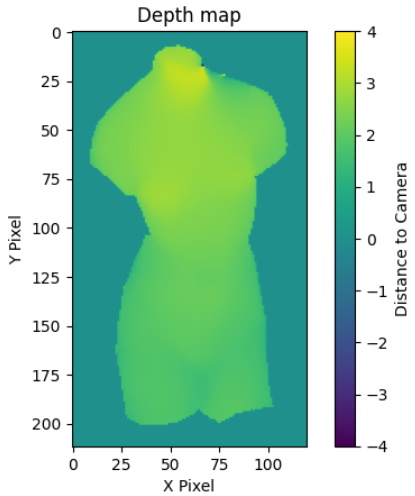
In the fist Image to the left is normal map without any filter In second picture, I process preliminary noise first in third picture I then apply a map filter on images



After Gaussian blur step on images



Depth map



3. **Explanation of the implementation and "method" used to enhance the result.**

Method	Explanation	Upsides	Downsides
Least-squares	Minimizes sum of squared differences between observed and estimated gradient fields.	- Simple and widely used. - Efficient computation.	- Sensitive to outliers, leading to inaccuracies in noisy data.
L1 residual minimization	Minimizes L1 norm of residual between observed and estimated gradient fields.	- Robust to outliers and noise. - Potentially more accurate in noisy environments.	- Computationally intensive. - May require parameter tuning.
Sparse Bayesian Learning	Promotes sparsity in normal map solution using Bayesian techniques.	- Handles noise and outliers effectively. - Provides uncertainty estimates.	- Computationally complex. - Requires careful hyperparameter selection.
Robust PCA	Separates input into low-rank structure and sparse noise, applicable to normal map estimation.	- Effective in separating structured components from noise and outliers. - Handles a range of noise types.	- Computationally demanding. - Parameter tuning may be necessary.

4. **Reconstruction of surfaces of venus** (This case you may need to find some ways to deal with some extrem normal result, or you wont's get full score.) **and explain in report. (we may treat "venus" more strictly than "bunny" & "star")**
I applied Gaussian smoothing to the input image before computing the normal map. Smoothing helps to reduce noise and fine details that may lead to extreme normal results.

5. **Reconstruction of surfaces of noisy venus where Gaussian noise has been applied to the input images.**
In the first step, I process preliminary noise first and then apply a map filter on images.

After greying the image, I tried applying equalize histogram to the image, this allows the areas in the image with lower contrast to gain a higher contrast. Then I blur the image to reduce the noise in the background. Next apply edge detection on the image, when noise is sufficiently Lastly, I apply closing (dilation then erosion) on the image to close all the small holes inside the words.

Reconstructed noisy venus