EE 8374: Fundamentals of Computer Vision

Homework-6

Mingze Sun

Depth from Sinusoidal Structured Light [50 points]

Questions

1. Describe in words how phase-unwrapping works:

There is discontinuity of the arc tangent function at 2π, so we need use phase unwrapping to remove it by adding multiples of 2π on the phase value. Besides, we need to detect correct integers from neighborhood points.

In this assignment, low frequency fringe stripe is no need for phase unwrapping because the single fringe covers the whole area.

For the high frequency, we need to do unwrapping and correct integers should be detected. And we have $\xi_H = G \times \xi_L, \eta_H = G \times \eta_L$, integer m = round $\left(\frac{G\varphi_L(x,y) - \varphi_H(x,y)}{2\pi}\right)$. The we can add 2πm to wrapped high frequency phase $\varphi_H(x,y)$ and get unwrapping phase.

References: "**Phase unwrapping error reduction framework for a multiple-wavelength phase-shifting algorithm**" by Song Zhang

2. What are the largest and smallest values in the unwrapped phase map? Please report your answers as a multiple of 2π. So a phase value of 6.2π would correspond to $3.1 \times 2\pi$.

Largest value = 105.1016 = 16.7 x 2π

Smallest value = -3.1416 = -0.5 x 2π

3. *Threshold T_1:* Describe how you chose the threshold T_1 for the MATLAB function **mask_shadow_and_occlusion_pixels(…).**

Describe in words what you think the function is trying to accomplish.

This function is trying to figure out the shadow then set the shadow pixel to 1.

I chose the T1 by assigning the **nrmld_modln_strength** in function to workspace and looking for pixel at the edge of shadow.

799x1399 double

	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157
367	0.5982	0.4915	0.3644	0.2264	0.1152	0.0395	0.0177	0.0125	0	0.0125
368	0.5501	0.4193	0.2741	0.1581	0.0760	0.0250	0	0.0125	0.0125	0
369	0.5028	0.3606	0.2050	0.0976	0.0451	0.0125	0	0.0125	0.0177	0
370	0.4155	0.2637	0.1305	0.0673	0.0280	0.0125	0	0.0125	0	0.0125
371	0.3414	0.1957	0.1008	0.0625	0.0250	0	0	0	0	0.0125
372	0.2704	0.1526	0.0707	0.0395	0.0125	0.0125	0.0125	0	0	0.0125
373	0.2264	0.1152	0.0515	0.0280	0.0177	0.0125	0.0125	0	0	0.0125
374	0.1581	0.0760	0.0280	0.0177	0.0177	0.0177	0	0	0.0125	0.0125
375	0.1152	0.0559	0.0280	0.0125	0	0.0125	0.0125	0	0.0125	0.0177
376	0.0673	0.0354	0.0280	0.0177	0.0125	0.0125	0	0	0.0177	0.0125
377	0.0500	0.0280	0.0280	0.0125	0.0177	0.0177	0	0.0125	0.0177	0.0125
378	0.0395	0.0125	0.0125	0.0125	0.0177	0.0125	0	0	0	0.0125
379	0.0354	0.0177	0.0177	0.0125	0.0125	0	0	0	0.0125	0

I noticed that the pixels in shadow are always 0.0125 or 0.0175, and the pixels beyond the shadow are more than 0.025, so I chose T1 as 0.025.

4. Describe how you chose the threshold T_2 for the MATLAB function **`mask_flying_pixels(...)`**. Also describe in words what you think the following lines in its implementation are trying to accomplish **10 points**

```
std = stdfilt(Z,ones(3));
mask(std > T) = 1;
```

same with question 3, I assign the std in function and looking for pixel at the edge of shadow.

799x1399 double

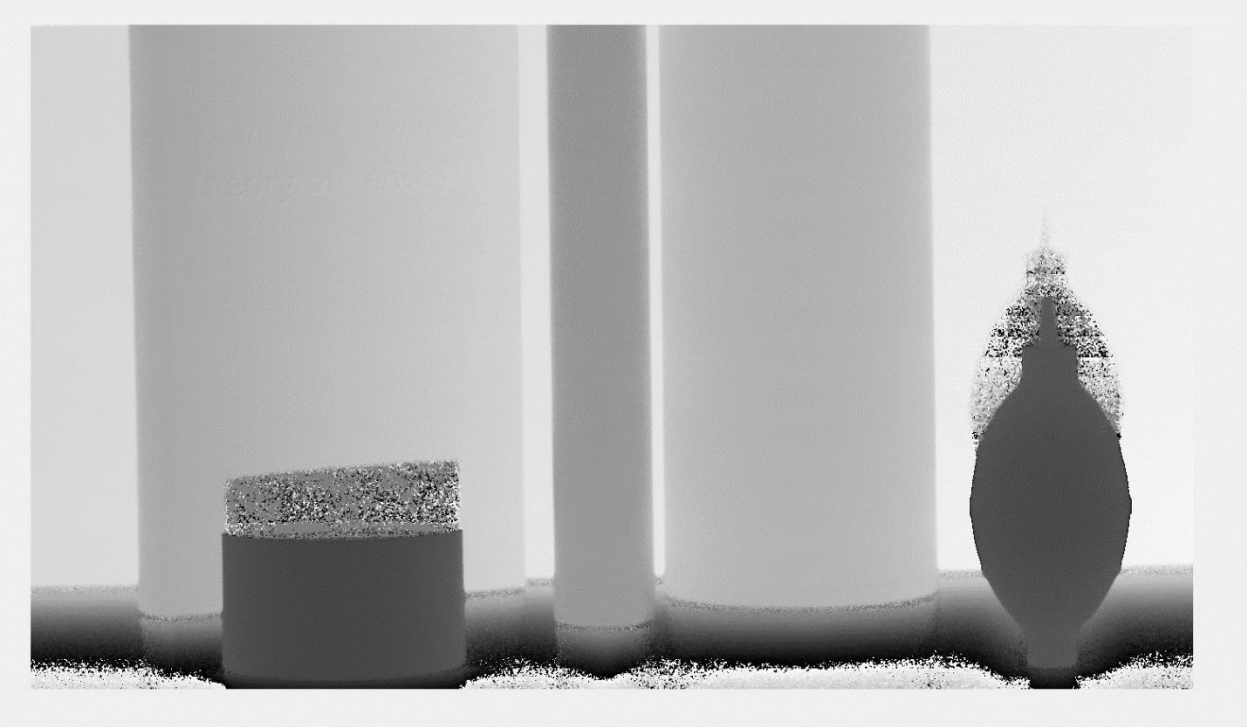
	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	
358	0.0046	0.0109	0.0118	0.0135	0.0127	0.0109	0.0079	0.0027	0.0019	9.9201e-05	5.4
359	0.0041	0.0119	0.0128	0.0132	0.0121	0.0105	0.0077	0.0028	0.0019	9.0563e-05	5.1
360	0.0043	0.0115	0.0129	0.0121	0.0089	0.0037	0.0031	0.0028	0.0019	1.0367e-04	7.9
361	0.0045	0.0039	0.0031	0.0022	0.0025	0.0033	0.0021	0.0023	0.0019	1.4817e-04	1.1
362	0.0029	4.5142e-04	5.9546e-04	0.0032	0.0038	0.0054	0.0030	0.0021	0.0014	1.5258e-04	1.0
363	2.0016e-04	0	2.5268e-05	0.0031	0.0042	0.0060	0.0031	0.0014	1.4510e-04	1.3959e-04	1.0
364	1.7841e-04	5.1605e-04	5.1741e-04	0.0030	0.0050	0.0061	0.0025	1.1827e-04	9.1007e-05	8.4147e-05	6.0
365	0.0026	0.0027	5.1605e-04	0.0112	0.0110	0.0098	0.0012	1.8475e-04	7.6398e-05	5.7415e-05	6.8
366	0.0026	0.0027	5.1605e-04	0.0112	0.0111	0.0097	5.8470e-04	1.6682e-04	6.0581e-05	4.9167e-05	9.6
367	0.0026	0.0026	0.1426	0.1403	0.1389	0.0155	5.0474e-04	1.5297e-04	5.7891e-05	4.8859e-05	9.9
368	0.0198	0.0150	0.1414	0.1392	0.1377	0.0139	4.3799e-04	8.1588e-05	8.8599e-05	6.8155e-05	1.0
369	0.0205	0.2667	0.2824	0.2767	0.1349	0.0130	1.6193e-04	7.2960e-05	7.2960e-05	7.0085e-05	6.9
370	0.3950	0.6274	0.6320	0.5037	0.0216	0.0039	9.4267e-05	6.8790e-05	6.8595e-05	6.1073e-05	8.5

I noticed that the pixels beyond the shadow will suddenly change to more than 0.002, so I chose T1 as 0.002

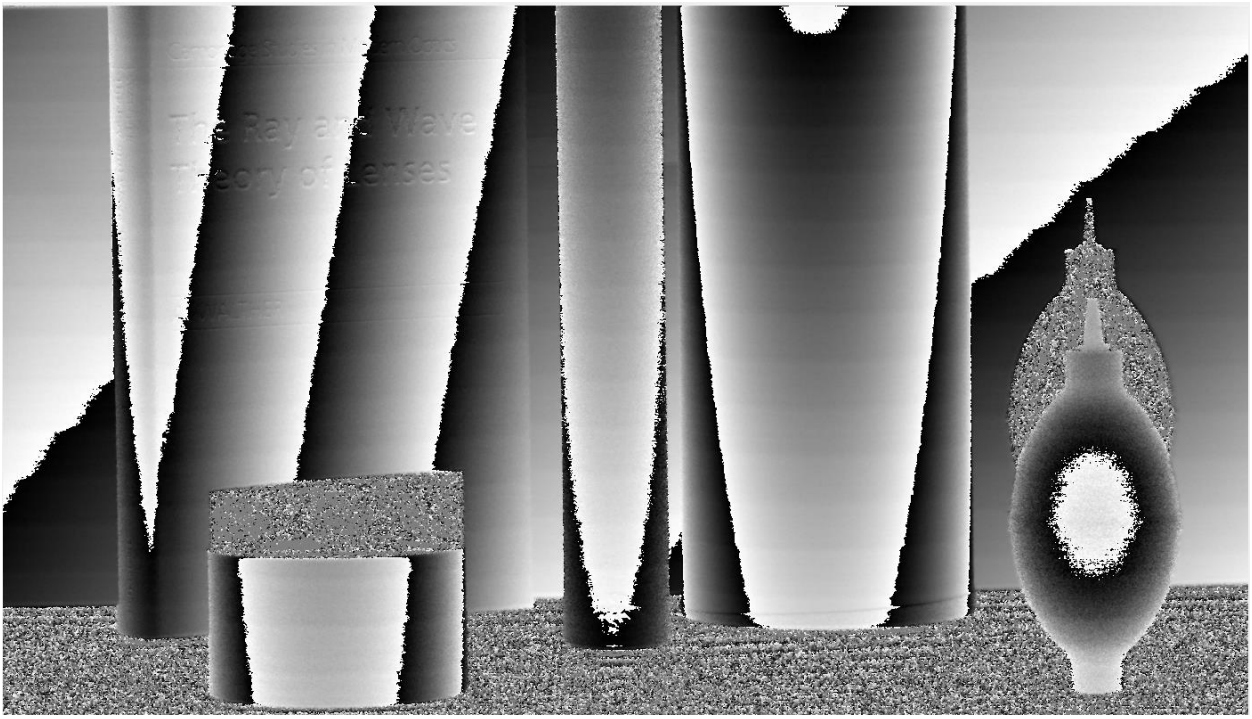
Stdfilt calculates the local standard deviation of the input image, then mask(std>T)=1 is trying to mask the shadow and noise to 1.

5. Include screenshots of the following in your write-up.

Low-resolution phase map $\varphi_L(x, y)$



High resolution phase map $\varphi_H(x, y)$



Unwrapped phase map $\varphi_{\text{unwrapped}}(x, y)$

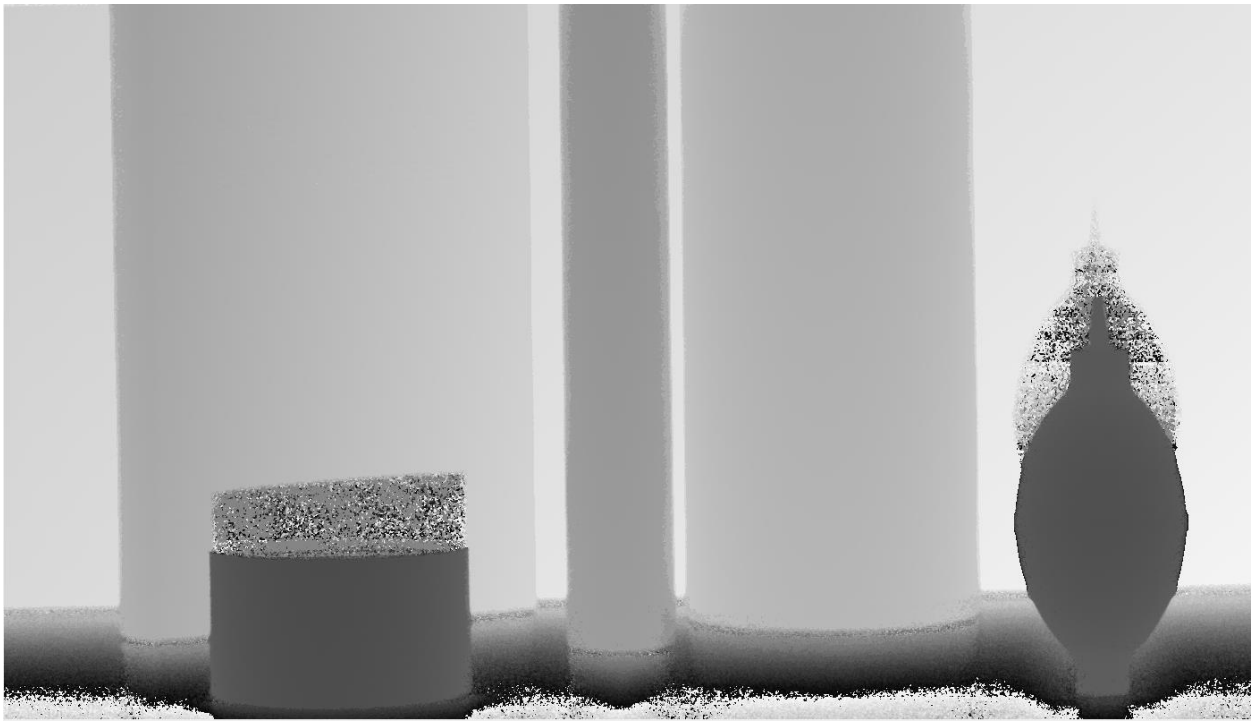
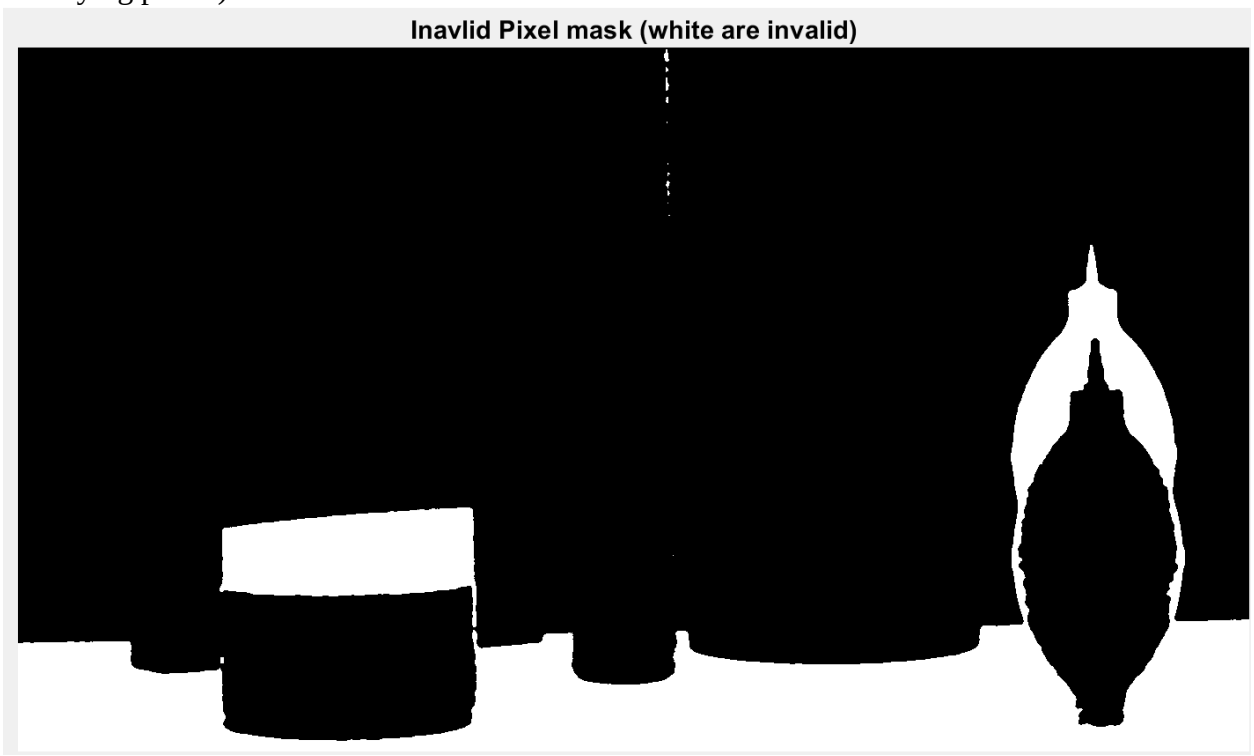


Figure window 101 corresponding to the Binary mask of invalid pixels (shadow, occlusion pixels and flying pixels)



3D rendering of scene in Figure window 102