Write-Up

Describe in words how phase-unwrapping works:

The clearest example given to me out of the two given articles came from the chart at the end of section 2.3 of **"Structured-light 3D surface imaging: a tutorial"** by Jason Geng listed below:

Figure 7

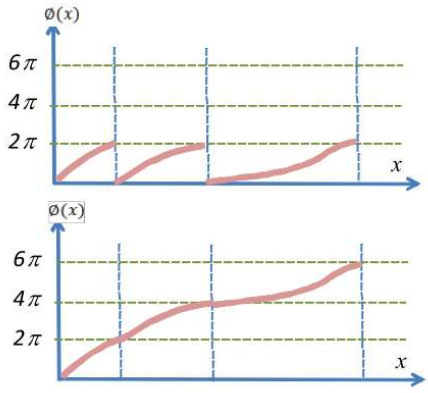


Illustration of the phase unwrapping process.

The top graph shows a signal that is still wrapped as there are still discontinuities at each 2pi intervals the process of unwrapping from my understanding is to remove these discontinuities by padding each segment with the appropriate amount of 2pi scales. This would explain why the formula for unwrapping contained a 2pi before the round as that was the building block to pad the signal. The relationship between low res and and high res pictures is a scalar value between the wavelength of signal. For this homework that scalar value was labeled G but in "**Phase unwrapping error reduction framework for a multiple-wavelength phase-shifting algorithm**" by Song Zhang that scalar value was labeled F. His paper says that since the wavelength is scaled by a scalar value so can the phase when the low res image/signal is scaled up to the scale of the high res image/signal the difference in magnitude is calculated and then divided by 2pi and then rounded to determine why integer of 2pi should be padded to the highres picture to unwrap.

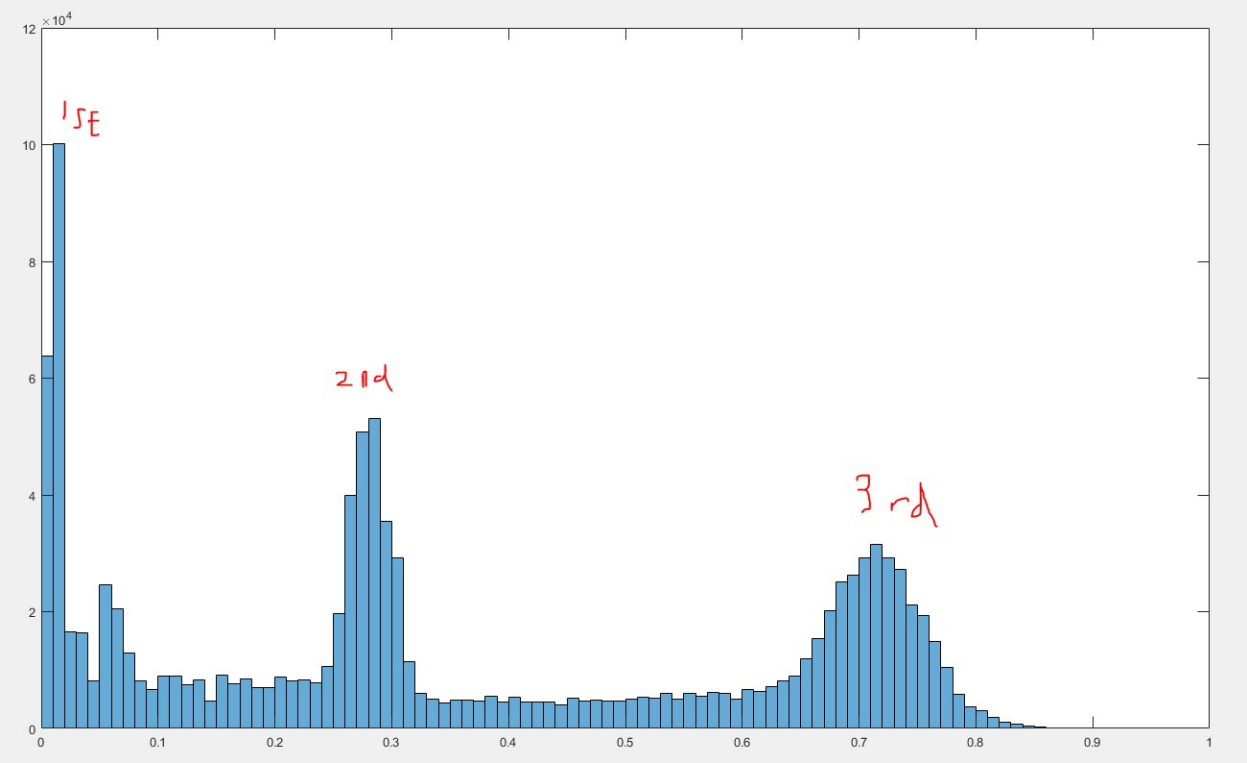
What are the largest and smallest values in the unwrapped phase map?

The largest value is 16.7223x2pi the smallest value is -0.4797x2pi

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

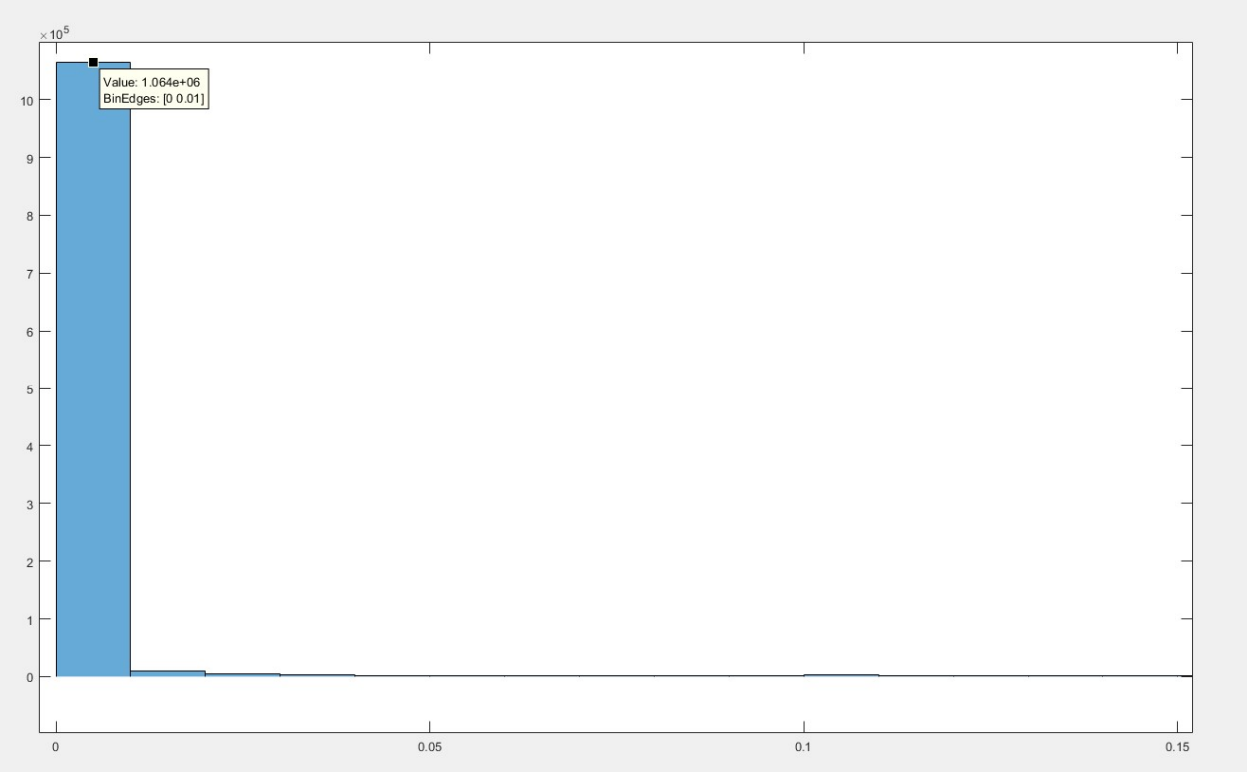
I chose 0.025 as my threshold by making a histogram of "img" as it was being normalized from 0 to 1 from the histogram I saw there where 3 signigicant sections where there were many data

points. So, I tested thresholds before and after these sections of importance as any threshold I chose would affect these the most. I also examined the given code and saw that the function is meant to remove pixels that are set lower then my threshold value so this forced me to choose a smaller number moving away from the two clusters to the right as this would delete more pixels then desired. So, I settled to a threshold right before the left most data cluster this function then successfully removed the shadows cast by objects closer to the camera that blocked the light from the projector. Below is the histogram:



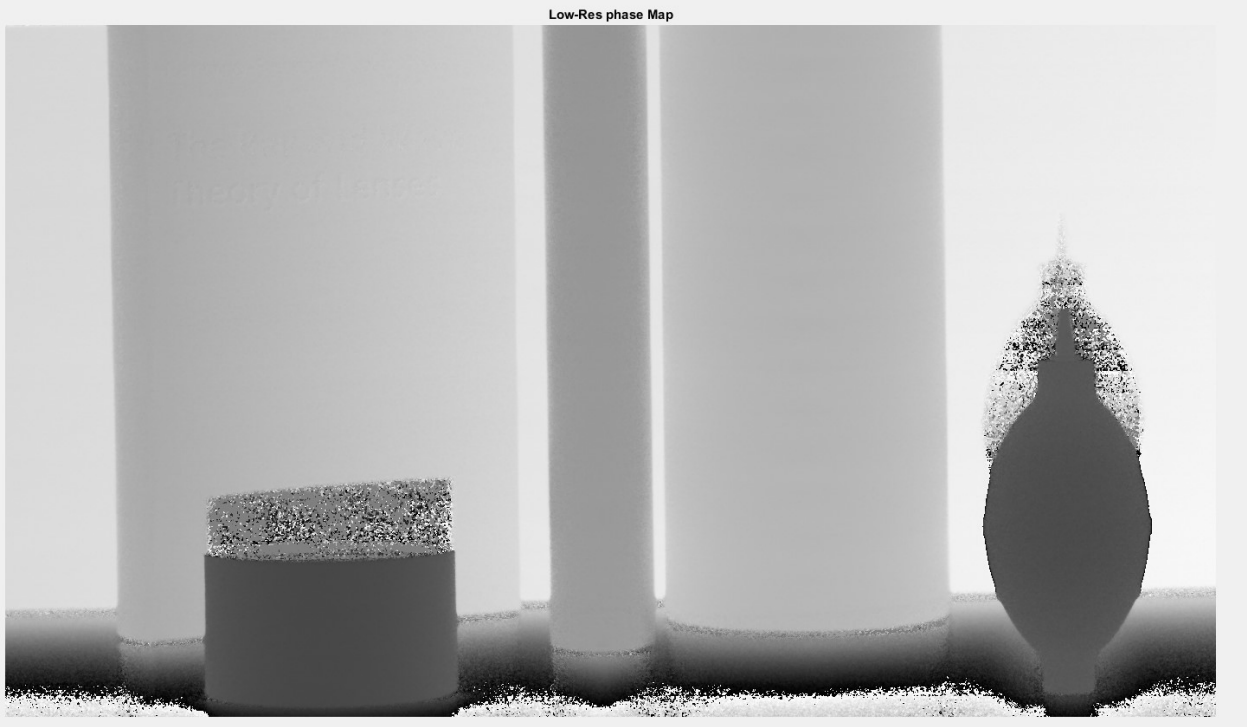
Threshold T_2: Describe how you chose the threshold T_2 for the MATLAB function mask_flying_pixels(…)

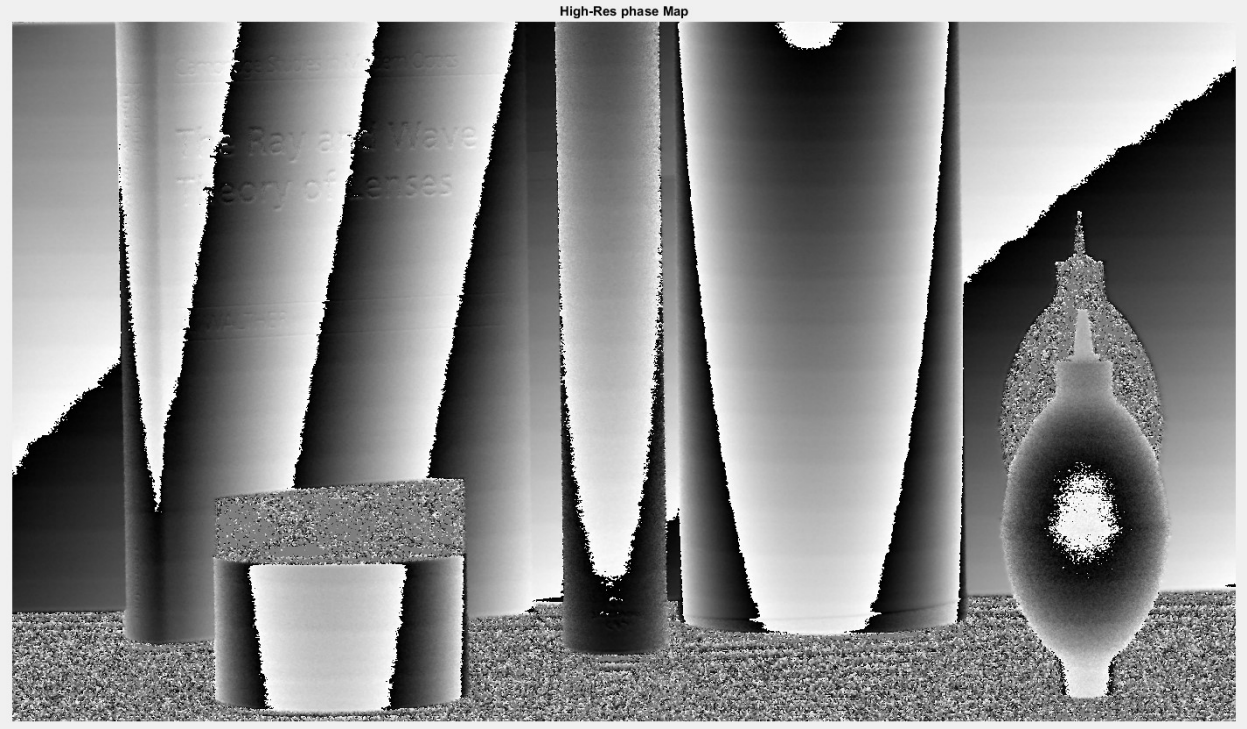
I chose the threshold for T_2 the same way I chose the threshold for T_1, I made a histogram shown below:



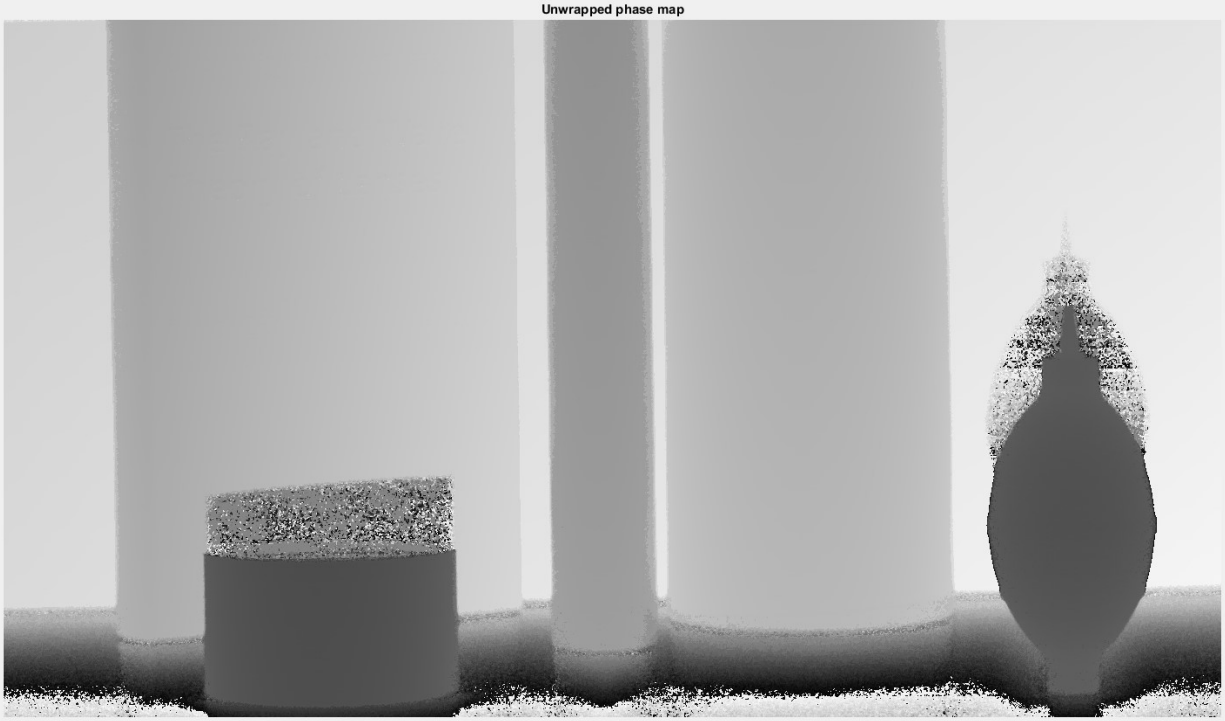
This time the function would cancel out any pixels that had a local (3x3) area that had a standard deviation higher than my threshold so whatever threshold I picked the pixels on the histogram right of the threshold would be removed. This is a simple edge detection method the edges would result a spike in standard deviation as either side of the edges would have different depths. So I started with 0.01 but noticed that there were no discernable edges so I corrected by lower the threshold by a factor of 10 until the edges started showing. That's when I settled on 0.0009 as my threshold.

Screenshots:

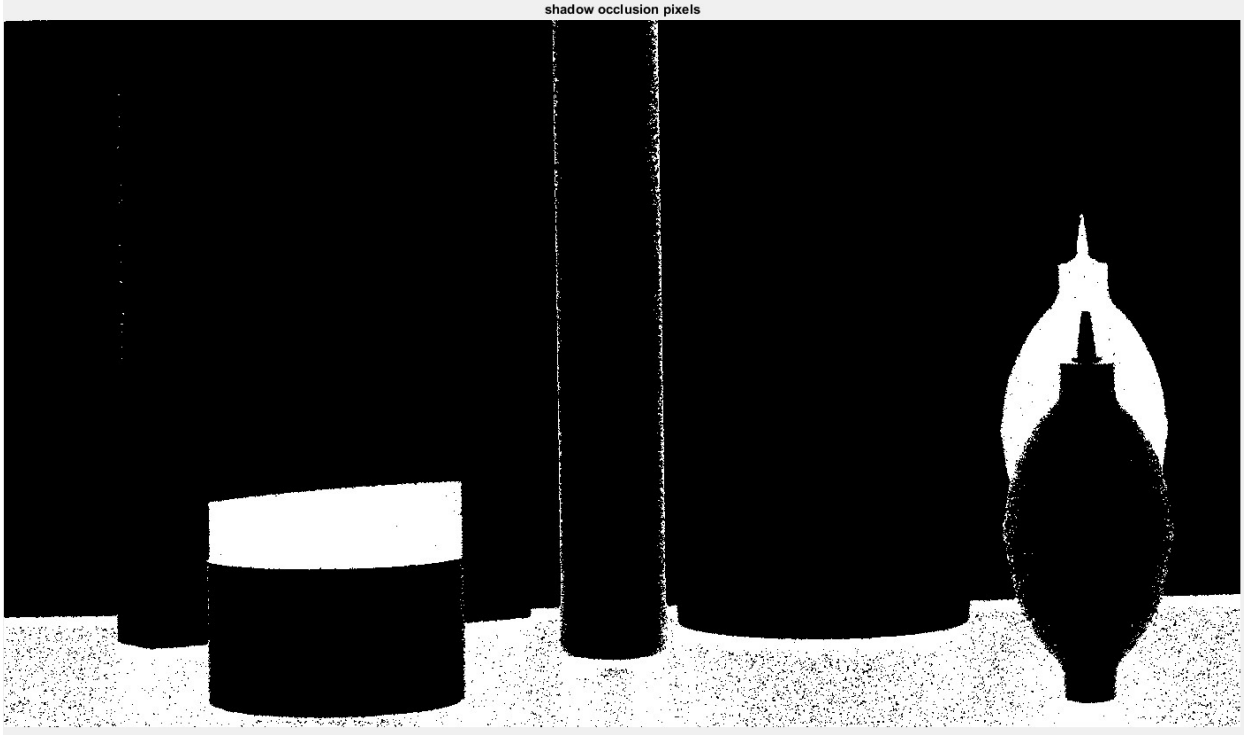


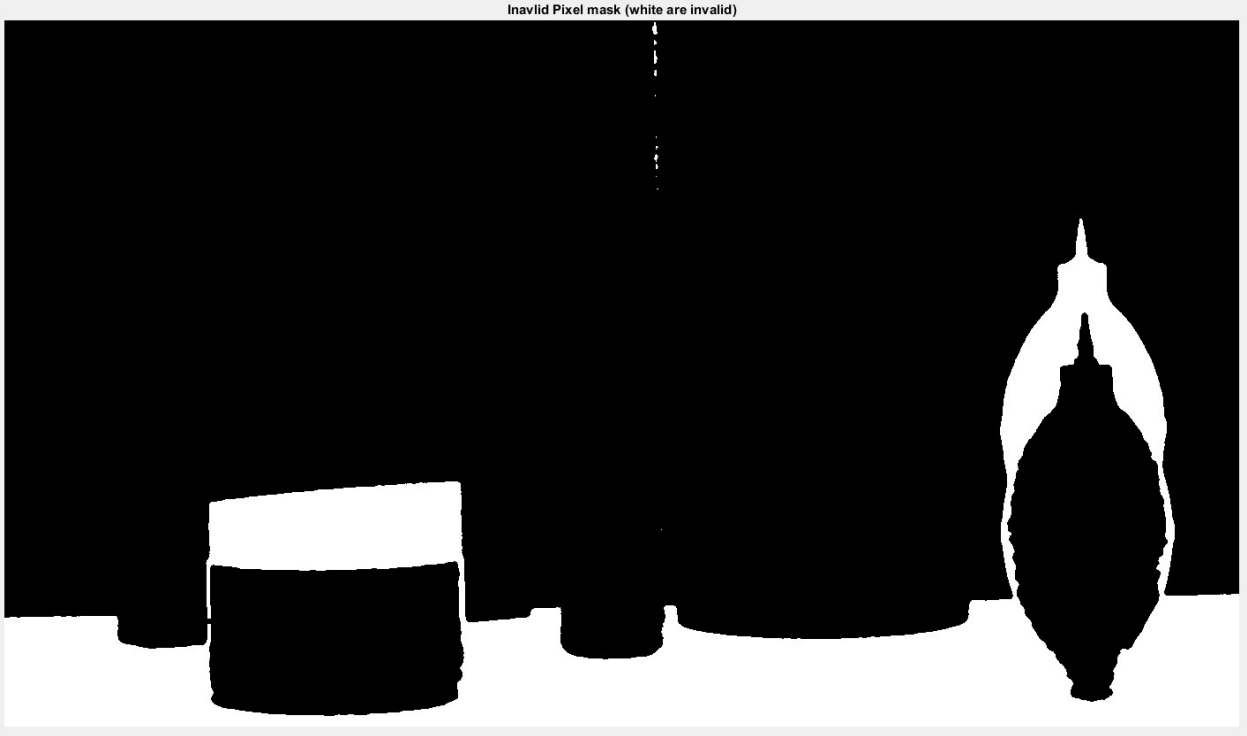


Unwrapped phase map

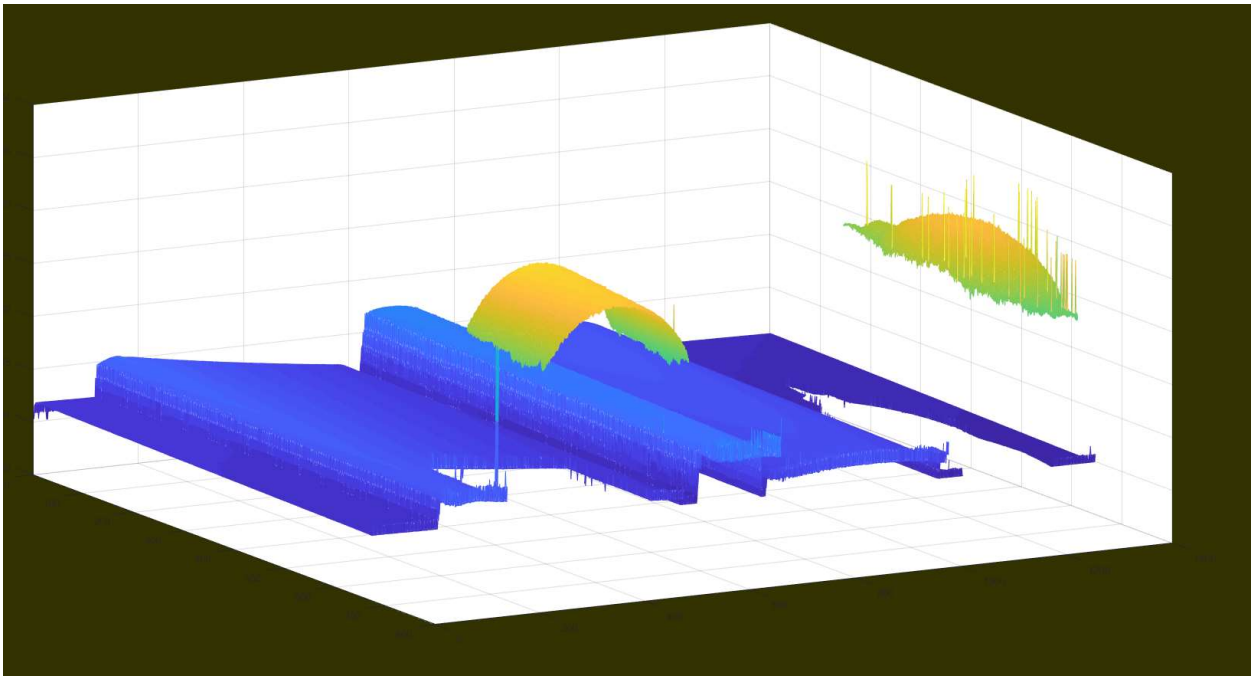


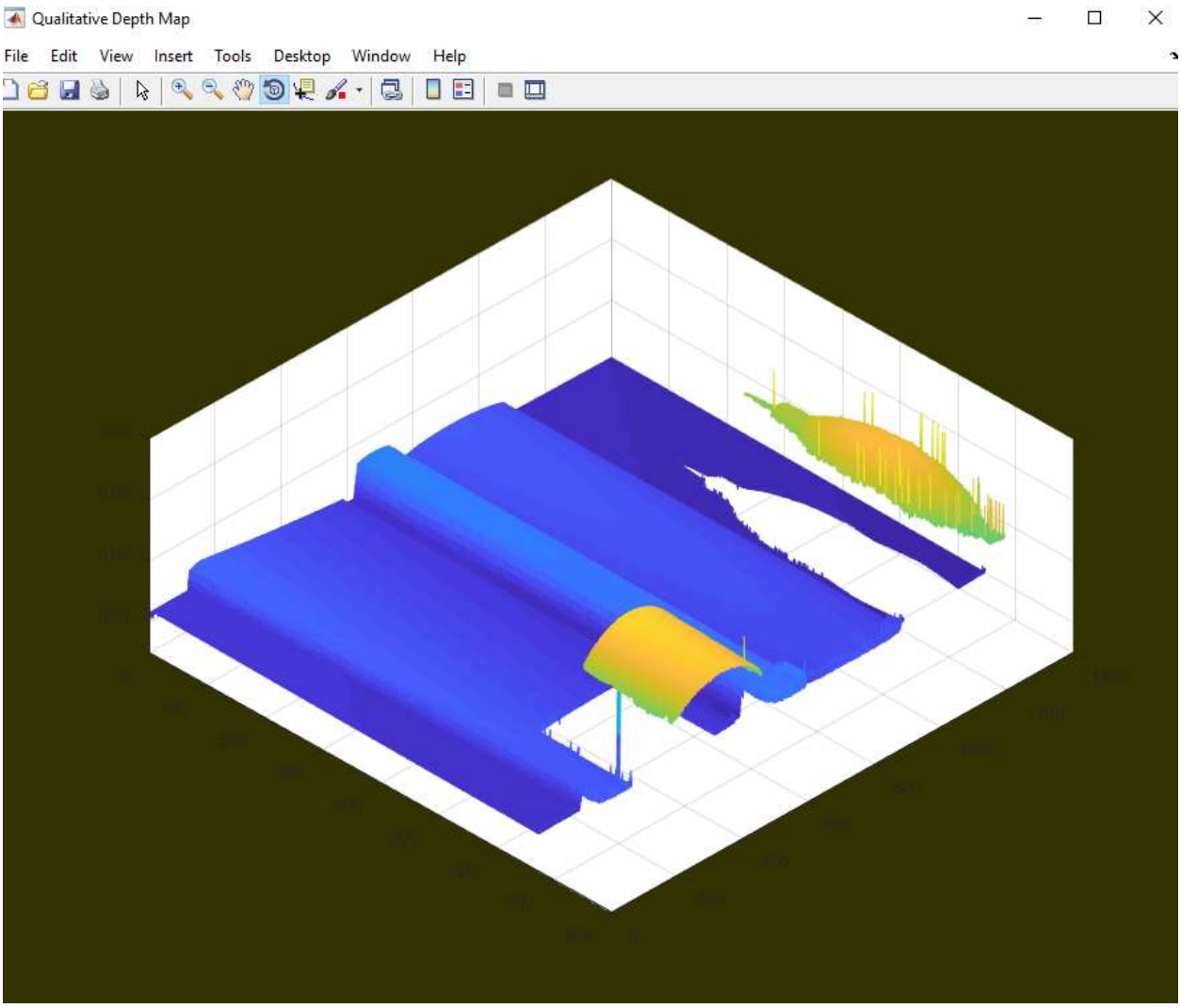
shadow occlusion pixels





3D rendering (2 views)




Qualitative Depth Map
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