Activity 13 - Photometric Stereo

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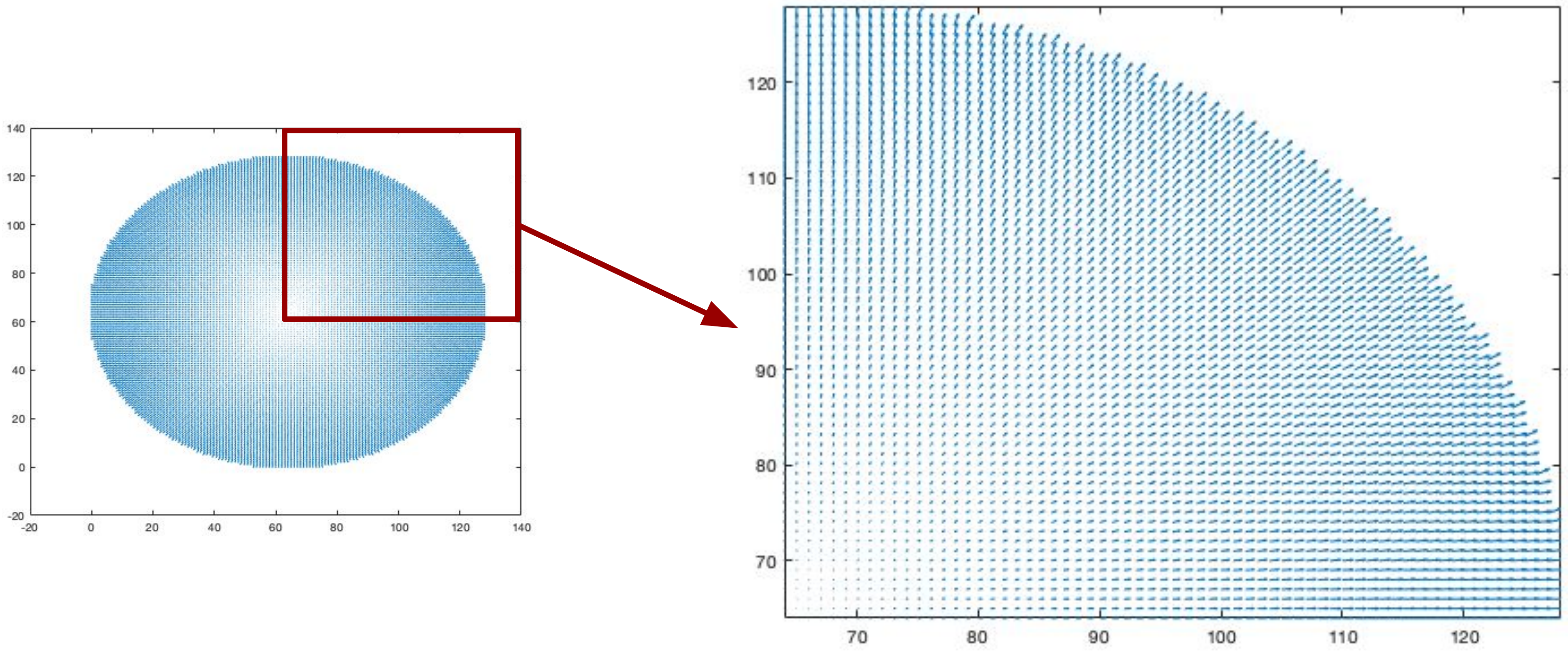
Computing the surface normals

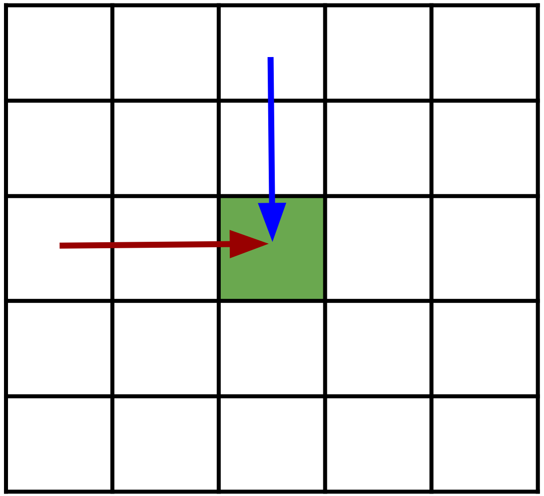
I calculated the surface normals by following eqns. (8) to (11) in the activity instructions. When plotted, the surface normals look like the figure below (in 2D).



Calculating the elevation z: Method 1

I obtained the partial derivatives of f using the normals, from the equation: $\frac{\partial f}{\partial x}=\frac{-nx}{nz};\frac{\partial f}{\partial y}=\frac{-ny}{nz}$

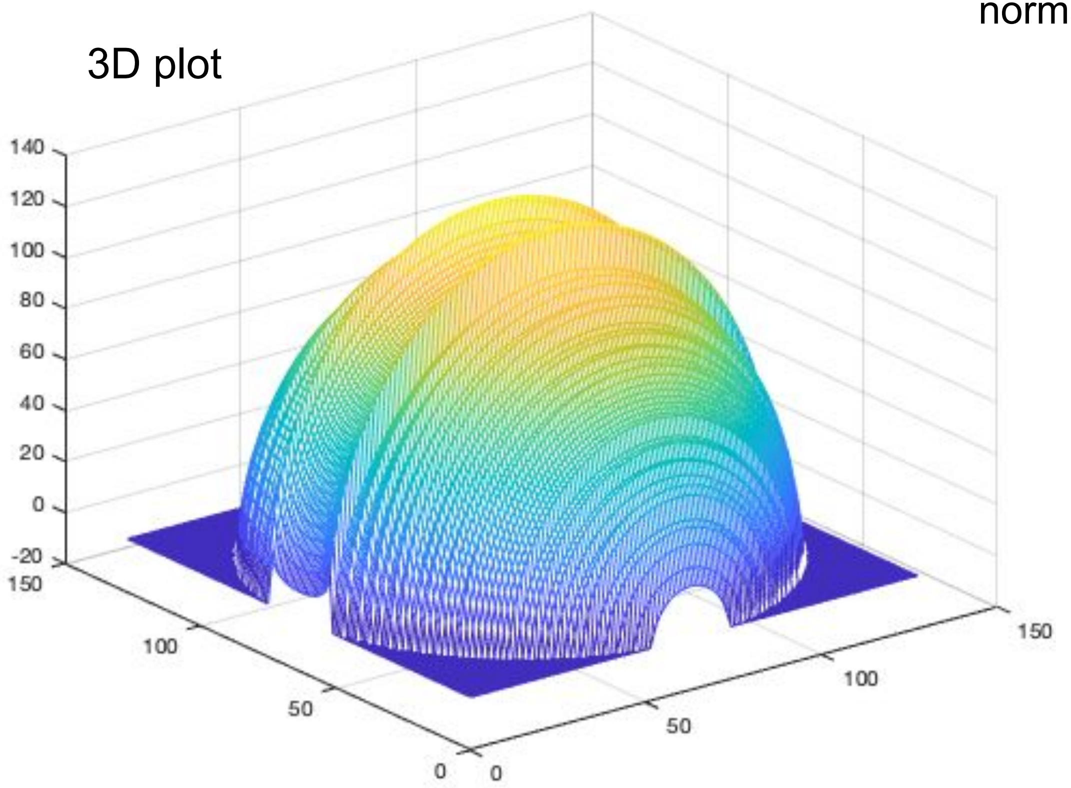
A simple method for solving for the elevation was discussed in class. For example, the goal is to calculate z at the green pixel. The first term is equal to the cumulative sum of partial derivatives denoted by the red arrow. The second term is equal to the cumulative sum of the partial derivatives denoted by the blue arrow. Redo this for all pixels, and the surface can be reconstructed.



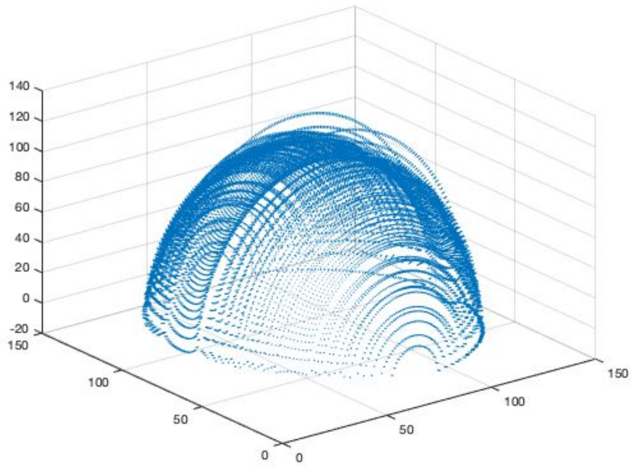
$$f(u,v)=\int_0^u\left(\frac{\partial f}{\partial x}\right)dx+\int_u^v\left(\frac{\partial f}{\partial y}\right)dy$$

Calculating the elevation z: Method 1

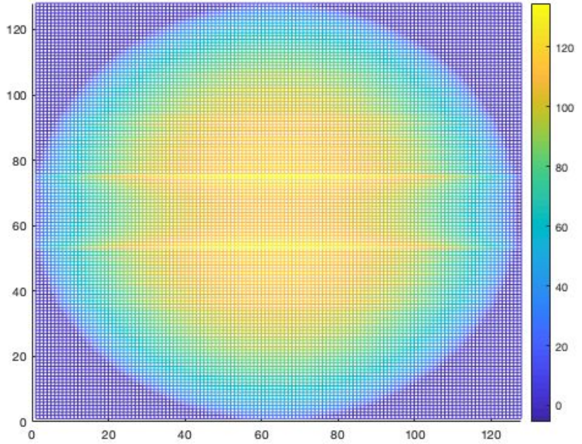
3D plot



surface normals

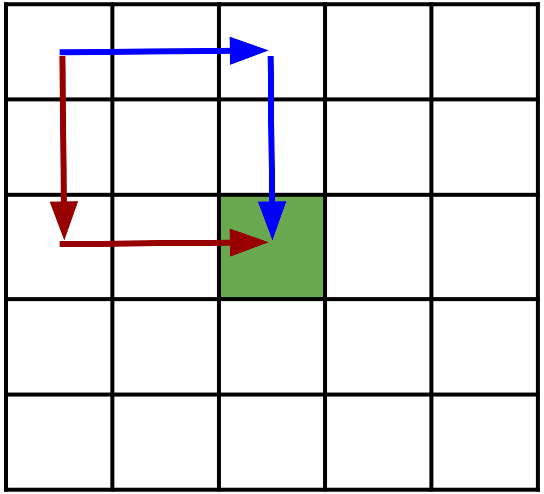


2D heat map



Calculating the elevation z: Method 2

This method came from the third reference in the activity instructions. It looks similar to the first method, except that this method uses a reference pixel. For simplicity, I set the reference to be the upper leftmost pixel. The first term is equal to the cumulative sum of partial derivatives denoted by the red arrows. The second term is equal to the cumulative sum of the partial derivatives denoted by the blue arrows.

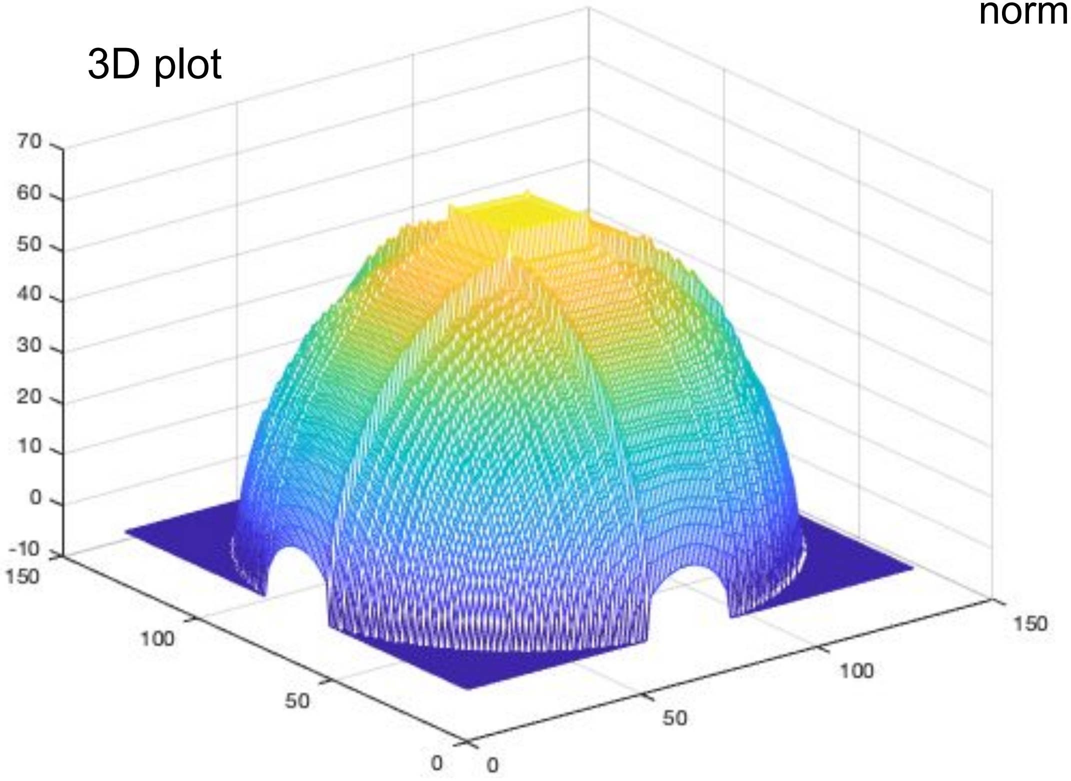


$$z(P) = z_0 + \frac{1}{2}\int_{\substack{P_0 \\ (L_1)}}^{P} (p\,dx + q\,dy) + \frac{1}{2}\int_{\substack{P_0 \\ (L_2)}}^{P} (p\,dx + q\,dy)$$

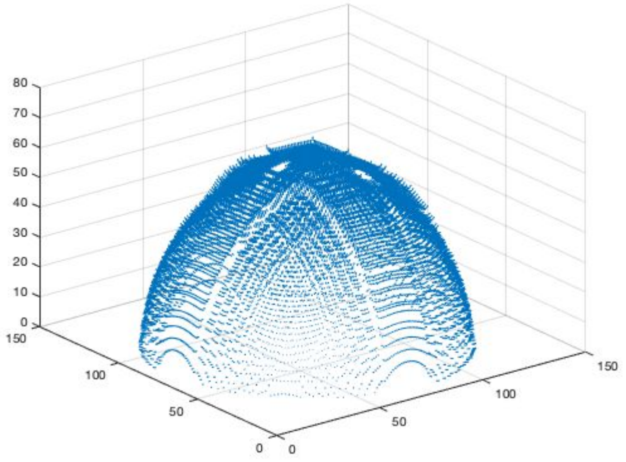
Acknowledgements: Reinier Mendoza explained to me the method presented in the third reference.

Calculating the elevation *z*: Method 2

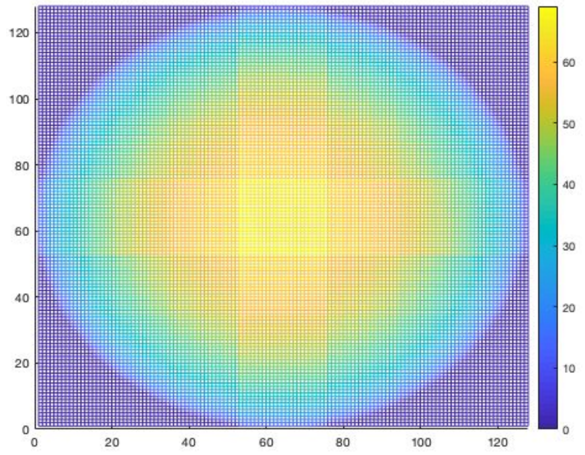
3D plot



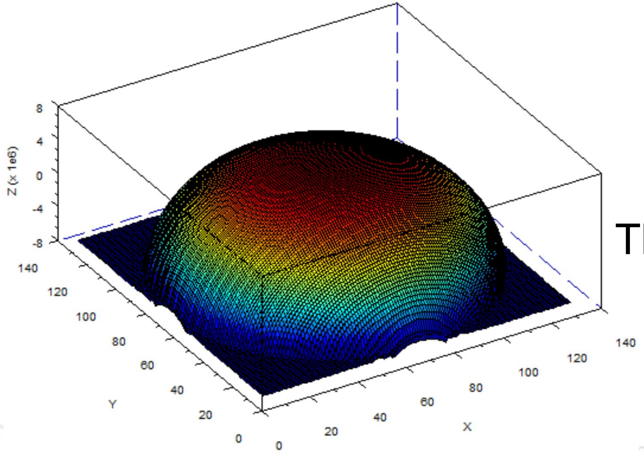
surface normals



2D heat map

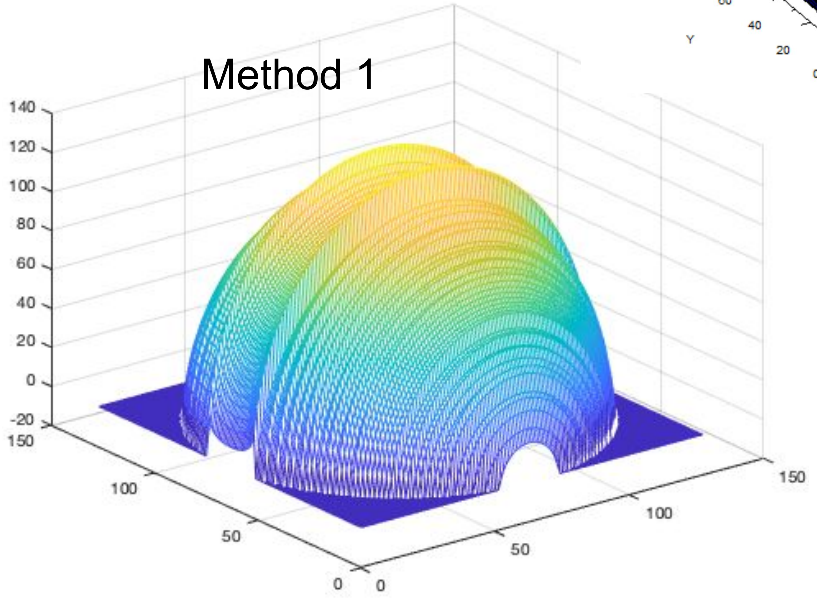


Comparisons



Theoretical

Method 1



Method 2