Section I - Cover Page

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ELEE-5920-image-processing

Project 0

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Abstract

This project contains two parts, part 1 and part 2. I had some fun using the C++ mex and engine APIs, but time started winding down so I completed the project using standard matlab, but was able to create custom MEX functions and use the engine API successfully. Part 1 uses the **`mesh`**, **`surf,`** and **`image`** command to generate a 256x256 image with 32 even steps. Part 2 is to generate a 2D gaussian distribution which obtains its maximum of 255 in the center of the image.

Section II - Technical Discussion

Part 1

Part 1 was very straightforward. Most of the complexity for me stemmed from lack of familiarity with Matlab. I think in future projects, I will have more detail and discussion here. The approaches for the **`mesh,image`**, and **`surf`** functions were nearly identical. I'm not exactly certain of the difference between the **`mesh/image`** functions beyond how they default edge coloring. I created a 256x256 matrix and set the values according to the X index so that columns all had the same value. Then, I used an element wise operation to divide each value by 8 and rounding down to the floor of the step.

Part 2

Part 2 had a little more complexity, but was also relatively straightforward. The only hiccup I really had was using the **`stdx`** value in the example. I got some sort of **`NOT FOUND`** error. Instead, I replaced it with the standard deviation of 10. If this is an incorrect assumption, which I'm starting the believe to be the case, please correct me. The formula applied for a 2D gaussian distribution:

$$f_{xy}(x,y) * f_{y}(y) = \left(\frac{1}{\sigma_x\sqrt{2\pi}} e^{-\frac{\left(x-E(x)\right)^2}{2\sigma_x^2}}\right)\left(\frac{1}{\sigma_y\sqrt{2\pi}} e^{-\frac{\left(y-E(y)\right)^2}{2\sigma_y^2}}\right)$$

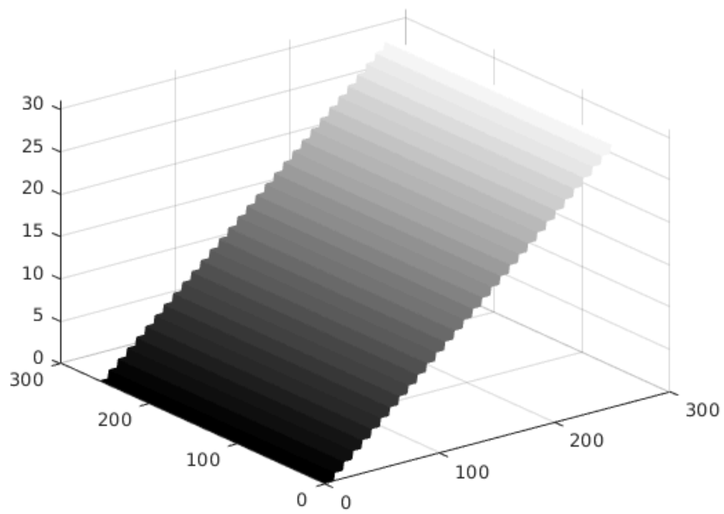
Section III - Solution/Results

Part 1

Similarly to Section II, I don't have too much to discuss here since the solutions are quite simple. I created a 256x256 matrix, assigned values based on the X index. The **`meshgrid`** command made this quite simple. Then, I divided each element in the matrix by 8 and rounded down to the floor. The number 8 was chosen because $256 \div 32 = 8$, so to get 32 even steps, each step set should have 8 members. The code for all three operations was virtually the same, besides some minor modifiers to normalize behavior.

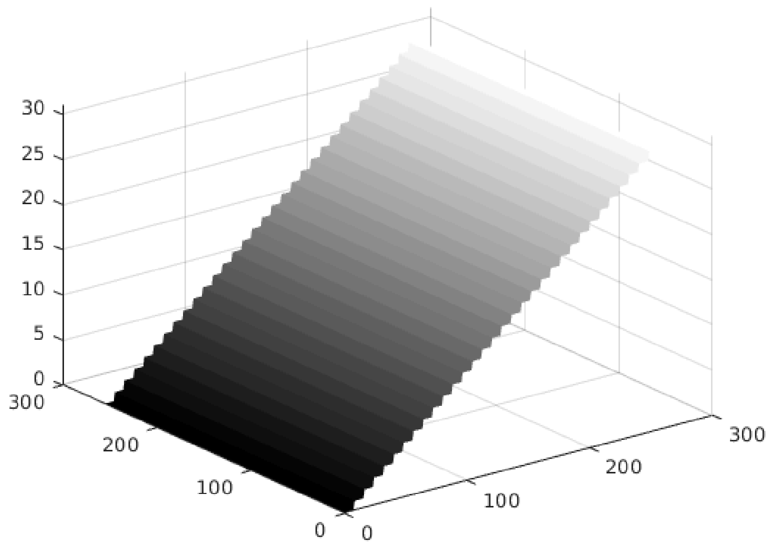
Mesh

```
% Set the colormap to gray. Default behavior is RBG spectrum.
colormap('gray')
% Create a 1x256 vector [0,1,2,... n = 255]
z = 0:255;
% Turn the vector into a 2d array 256x256 where rows are copied from the original
Z = meshgrid(z);
% Divide each element by 8 and simulate integer division by rounding to floor
Z = floor(Z/8);
% Plot
mesh(Z);
```



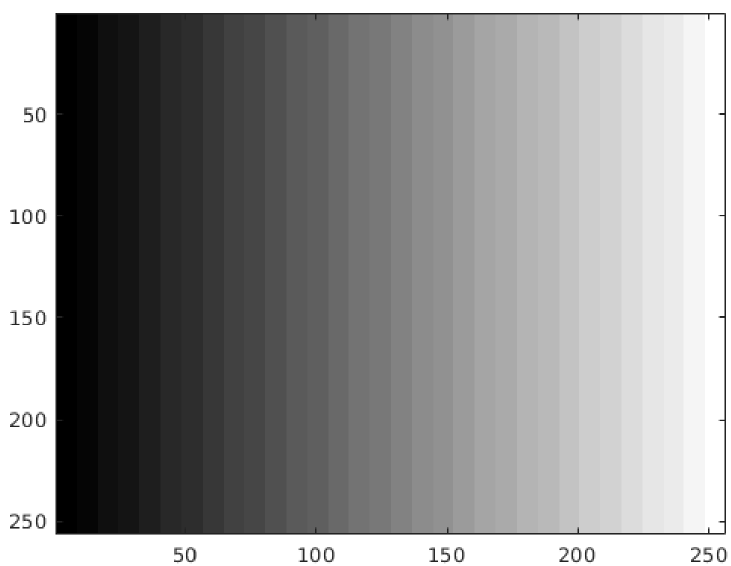
Surf

```
% Set the colormap to gray. Default behavior is RBG spectrum.
colormap('gray')
% Create a 1x256 vector [0,1,2,... n = 255]
z = 0:255;
% Turn the vector into a 2d array 256x256 where rows are copied from the original
Z = meshgrid(z);
% Divide each element by 8 and simulate integer division by rounding to floor
Z = floor(Z/8);
% Plot and set EdgeColor to none to override default behavior
surf(Z, 'EdgeColor','none');
```



Image

```
% Set the colormap to gray. Default behavior is RBG spectrum.
colormap('gray')
% Create a 1x256 vector [0,1,2,... n = 255]
c = 0:255;
% Turn the vector into a 2d array 256x256 where rows are copied from the original
C = meshgrid(c);
% Divide each element by 8 and simulate integer division by rounding to floor
C = floor(C/8);
% Plot and override default behavior to show scaling.
imagesc(C, 'CDataMapping','scaled' )
```



Part 2

The solution here was pretty straigthforward as well and an application of the formula discussed in Section II. In the code below, you can see that I create vectors X and Y and both are 1x256. I use the **meshgrid** command to convert them into 256x256 arrays. Then, I apply the formula and scale the Z value accordingly. I am not as confident in the solution because my plot looks a little different than the example.

```
% Create a 1x256 vector [0,1,2,... n = 255]
x = 0:255;
% Create a 1x256 vector [0,1,2,... n = 255]
y = 0:255;
% Turn the vectors into 2d arrays 256x256 where rows are copied from the originals
[X,Y] = meshgrid(x,y);
% Apply the formula for 2d gaussian distribution
Z = exp(-((X-127).^2+(Y-127).^2)/(2*(10.^2)));
Z = Z * 255;
% Plot
mesh(X,Y,Z)
```