Abu Butt / 3097
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CSc 47100

Assignment 1

1. Writing Assignments:

1) How does an image change (e.g., objects' sizes in the image, field of view, etc.) if the focal length of a pinhole camera is varied?

Answer: The size of an object image depends on the focal length of a pinhole camera. As the focal length of a pinhole camera increases, the size of an object image also increases. Same rule applies, the focal length decreases the object image size decreases as well.

2) Give an intuitive explanation of the reason why a pinhole camera has an infinite depth of field.

Answer: As the depth of field increases, its wideness decreases, since pinhole has a very small camera hole, so the camera depth will be large and image could be unclear.

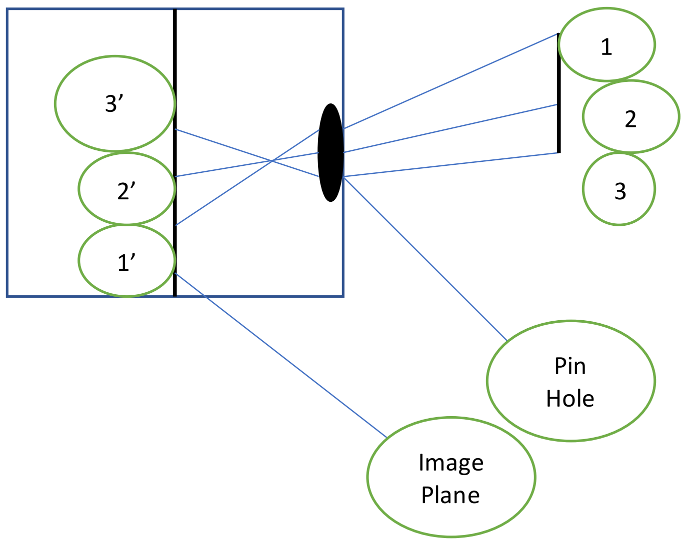
3) In the thin lens model, 1/o + 1/i = 1/f, there are three variables, the focal length f, the object distance o and the image distance i (please refer to Slide # 19 of the Image Formation lecture). If we define Z = o-f, and z = i-f, please write two a few words to describe the physical meanings of Z and z, and then prove that Z*z = f*f given 1/o + 1/i = 1/f.

Answer: Z = o-f => means distance difference of an object and a focal point from the lens. So, it is a lens.
z = i-f => means distance difference of an image and a focal point from the lens. So, it is a lens.

To prove: Z*z = f*f
lens*lens = focal length * focal length

Explanation: The size of the lens depends on the length of focal point. Means as the focal point length increase from lens, the length of the lens also increases. Same point when the length decreases. So, Z*z = f*f.

4) Prove that, in the pinhole camera model, three collinear points (i.e., they lie on a line) in 3D space are imaged into three collinear points on the image plane. You may either use geometric reasoning (with line drawings) or algebra deduction (using equations).

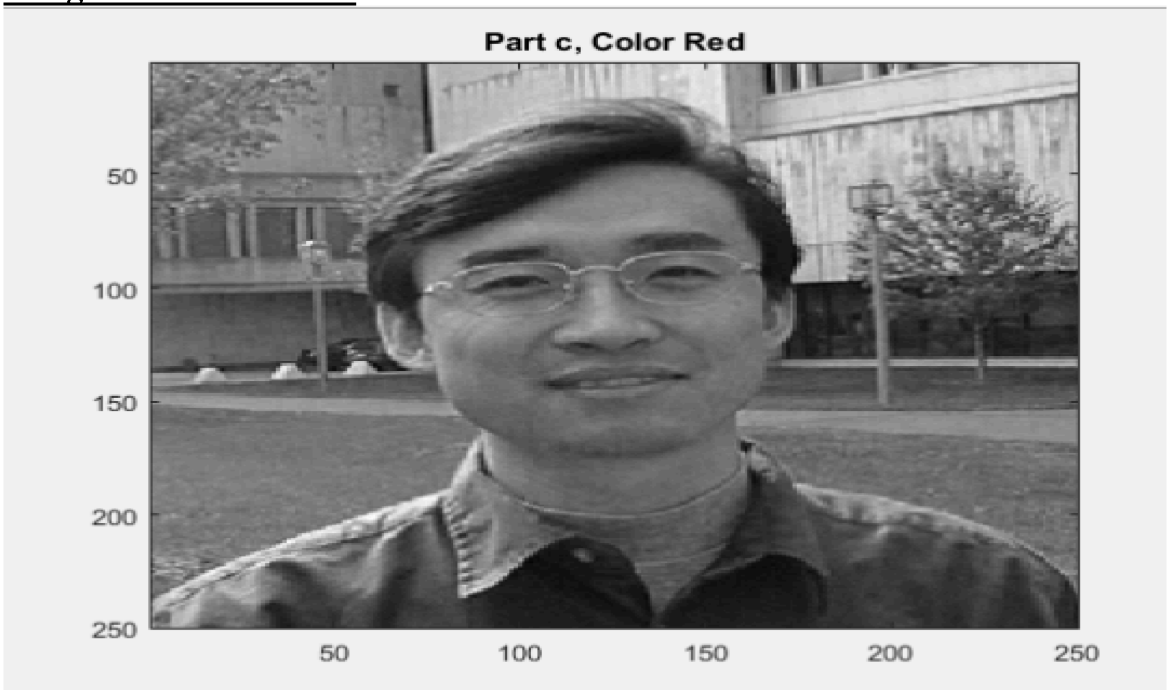


<u>Explanation:</u> We can say that all the lights coming through pin hole are depicts after the pin hole on the image plane. Therefore, the lines are straight before and after the pinhole.

2. <u>Programming Assignments:</u>

c) Generate an intensity image I(x,y) and display it. You should use the equation I = 0.299R + 0.587G + 0.114B (the NTSC standard for luminance) and tell us what are the differences of the intensity image thus generated from the one using a simple average of the R, G and B components.

<u>Image with Red Color:</u>



<u>Image with Blue color:</u>

Image with Green Color:

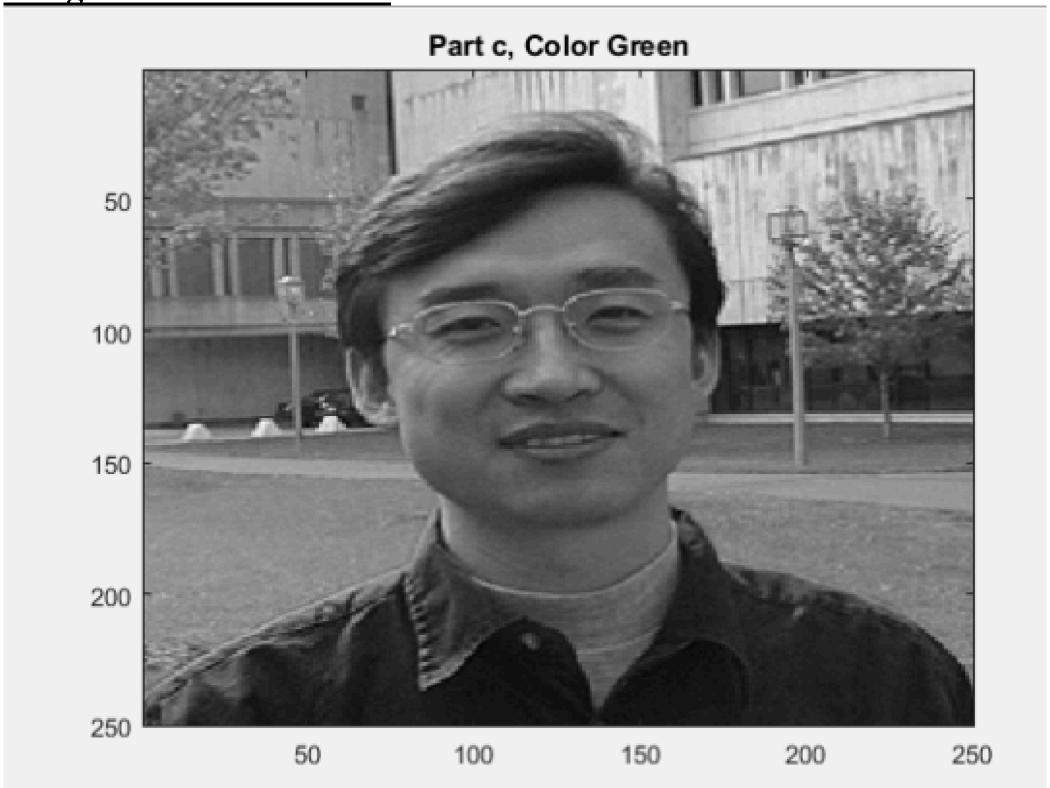


Image with Green, Blue, Red colors:

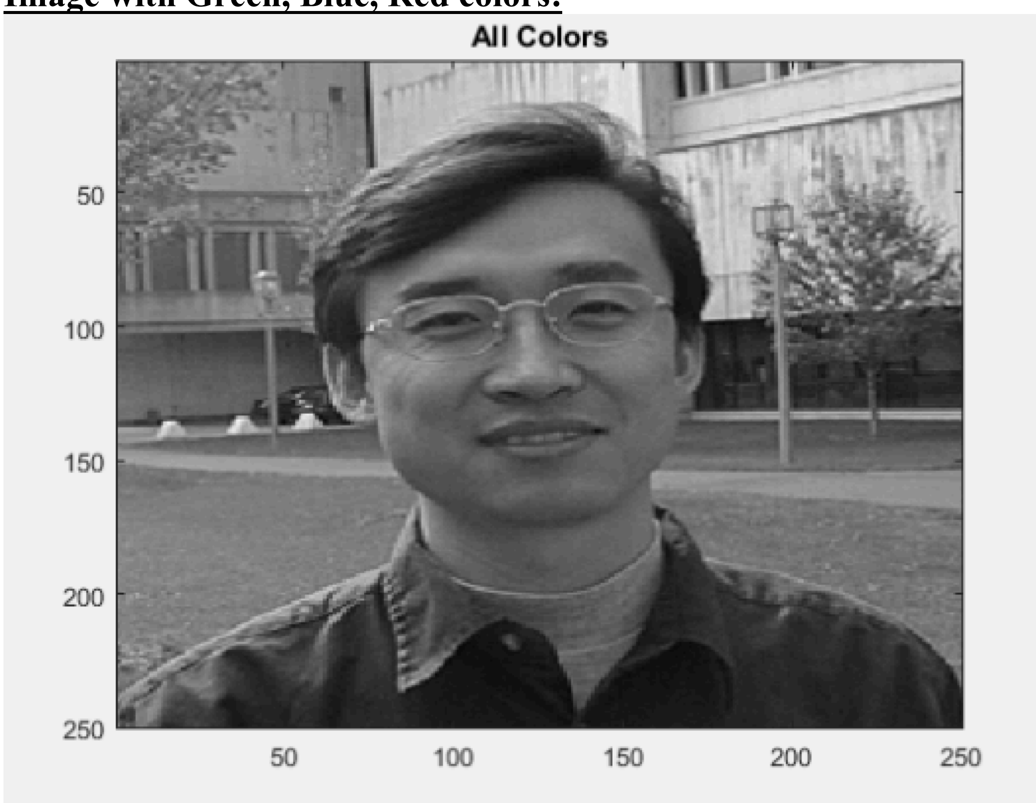
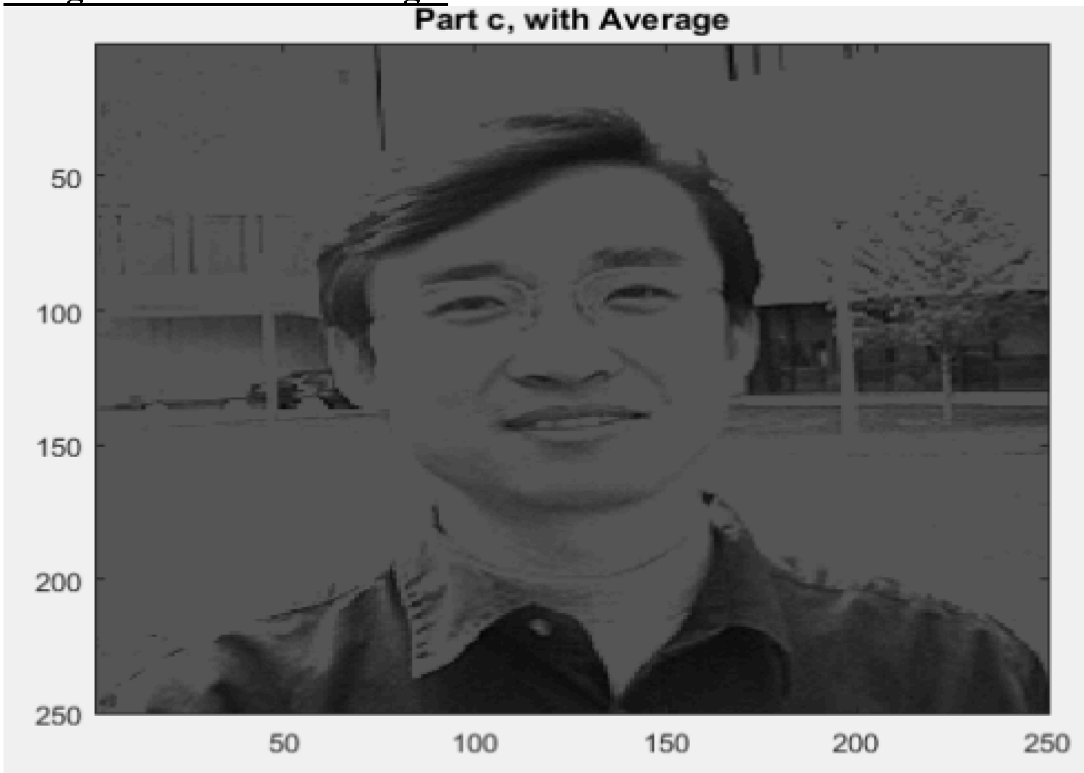


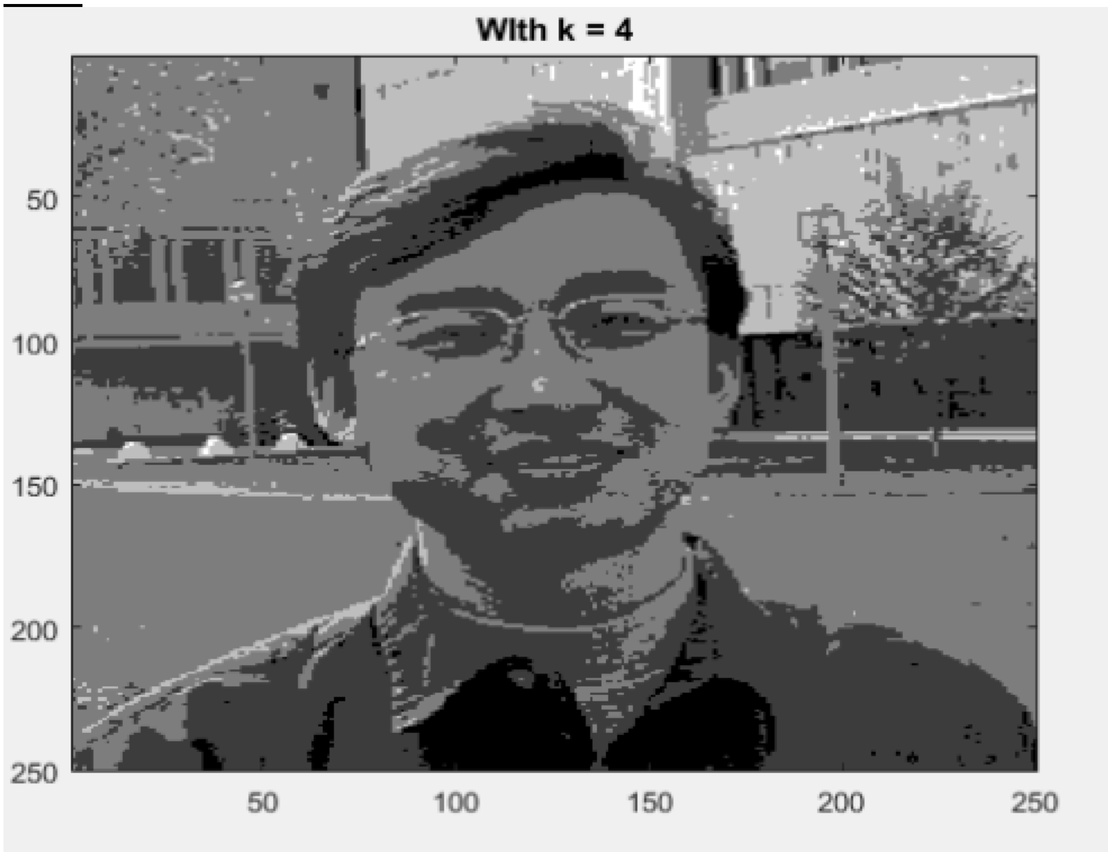
Image with Color's Average:



Explanation: As you can see all the pictures from the C part. The display and resolution of each image is different when different or all colors are applied. Image with the average of the colors is more dark than other images. From the RGB color, the image with red color is darker than the other 2 colors. The image with RGB/all colors looks like the original image.

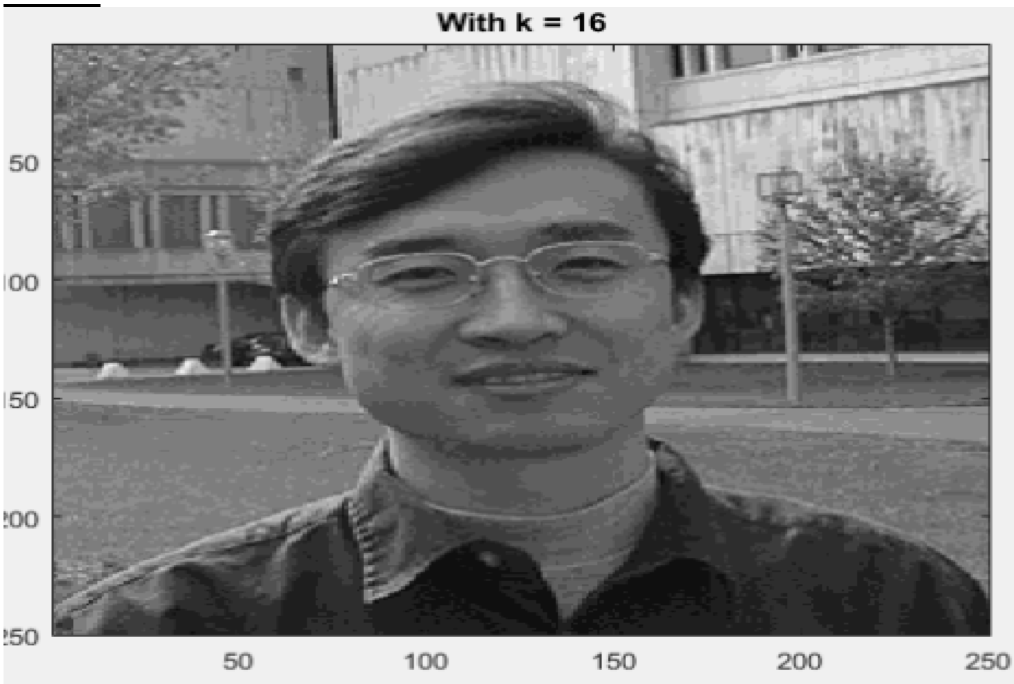
d) The original intensity image should have 256 gray levels. Please uniformly quantize this image into K levels (with K=4, 16, 32, 64). As an example, when K=2, pixels whose values are below 128 are turned to 0, otherwise to 255. Display the four quantized images with four different K levels and tell us how the images still look like the original ones.

K=4:



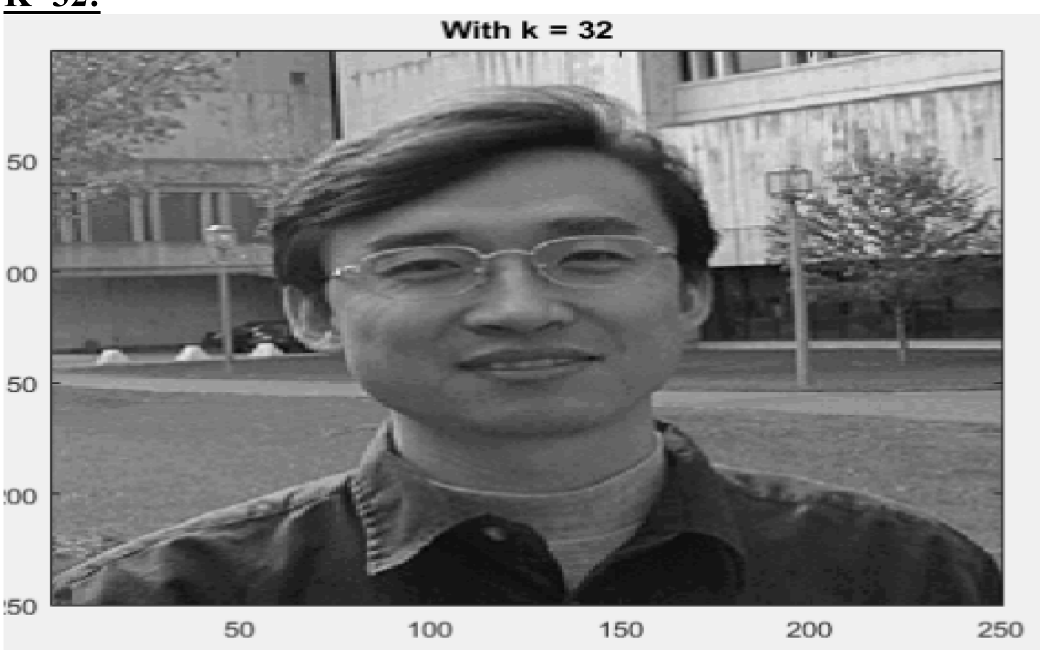
Since k = 4, which means it has 4 levels. Each level has 3 colors and total colors that can be generate in this image are 4^3 = 64 colors. Because it has less levels, which make the image unclear.

K=16:



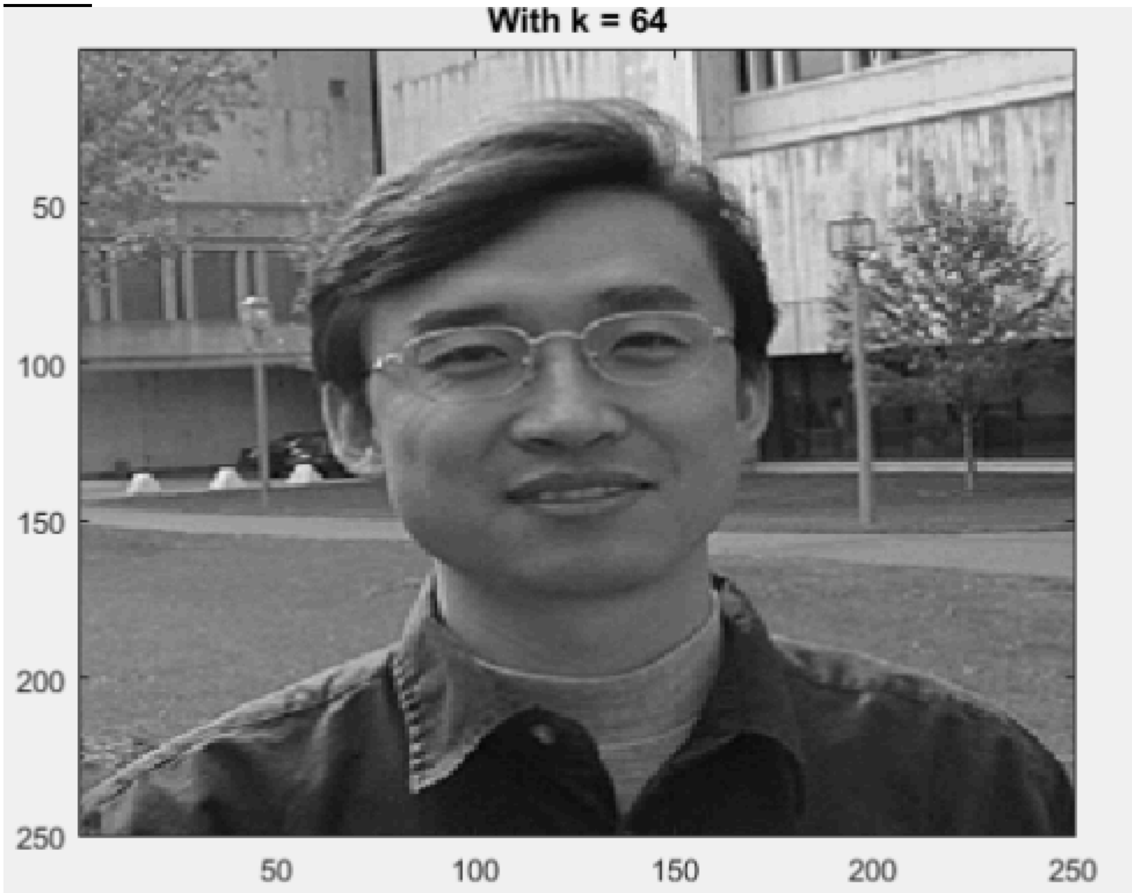
Since k = 16, which means it has 16 levels. Each level has 3 colors and total colors that can be generate in this image are 16^3 = 4096 colors. Since it has 16 levels, the image is much clear than, k = 4 levels.

K=32:



Since k = 32, which means it has 32 levels. Each level has 3 colors and total colors that can be generate in this image are 32^3 = 32768 colors. Since it has 16 levels, the image is much clearer than, k = 4 and k = 16levels.

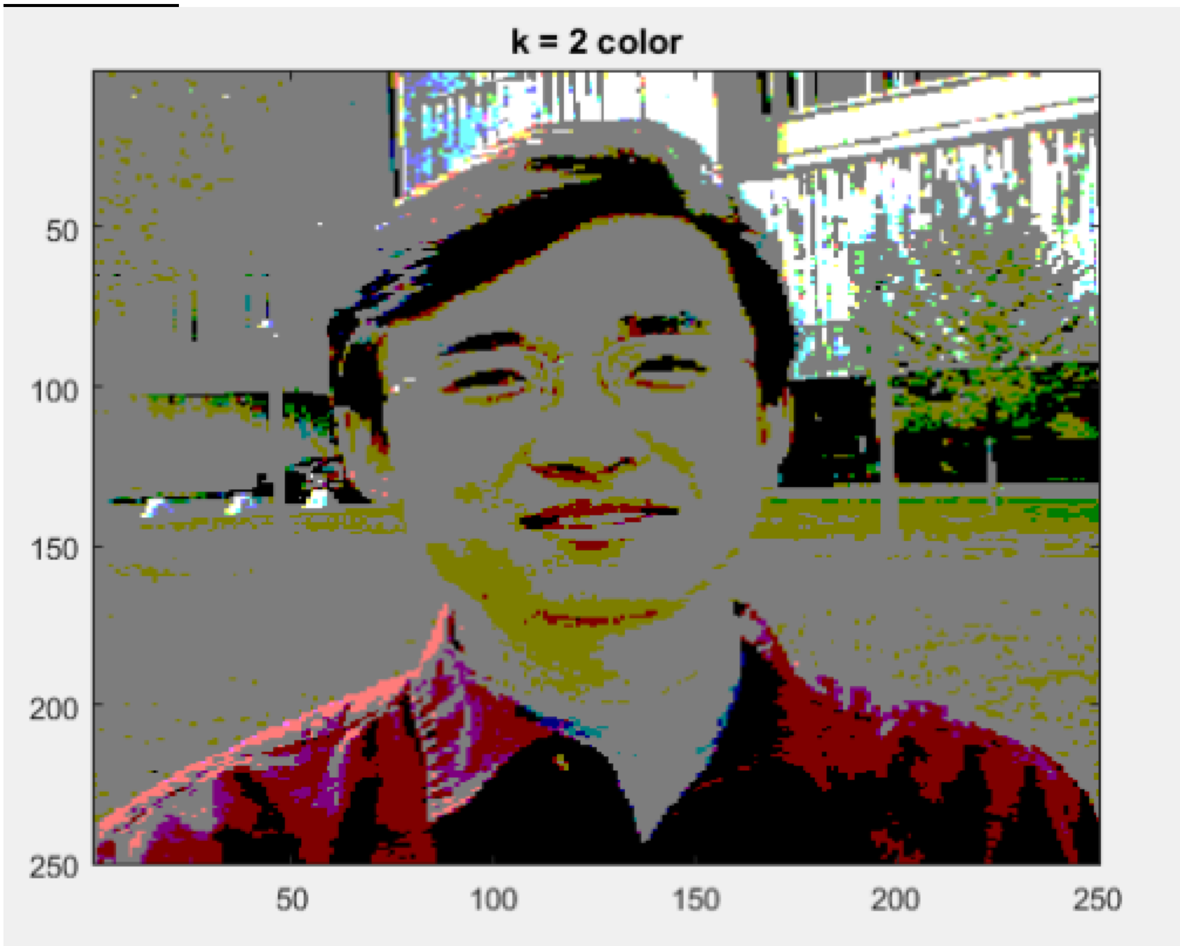
k=64:



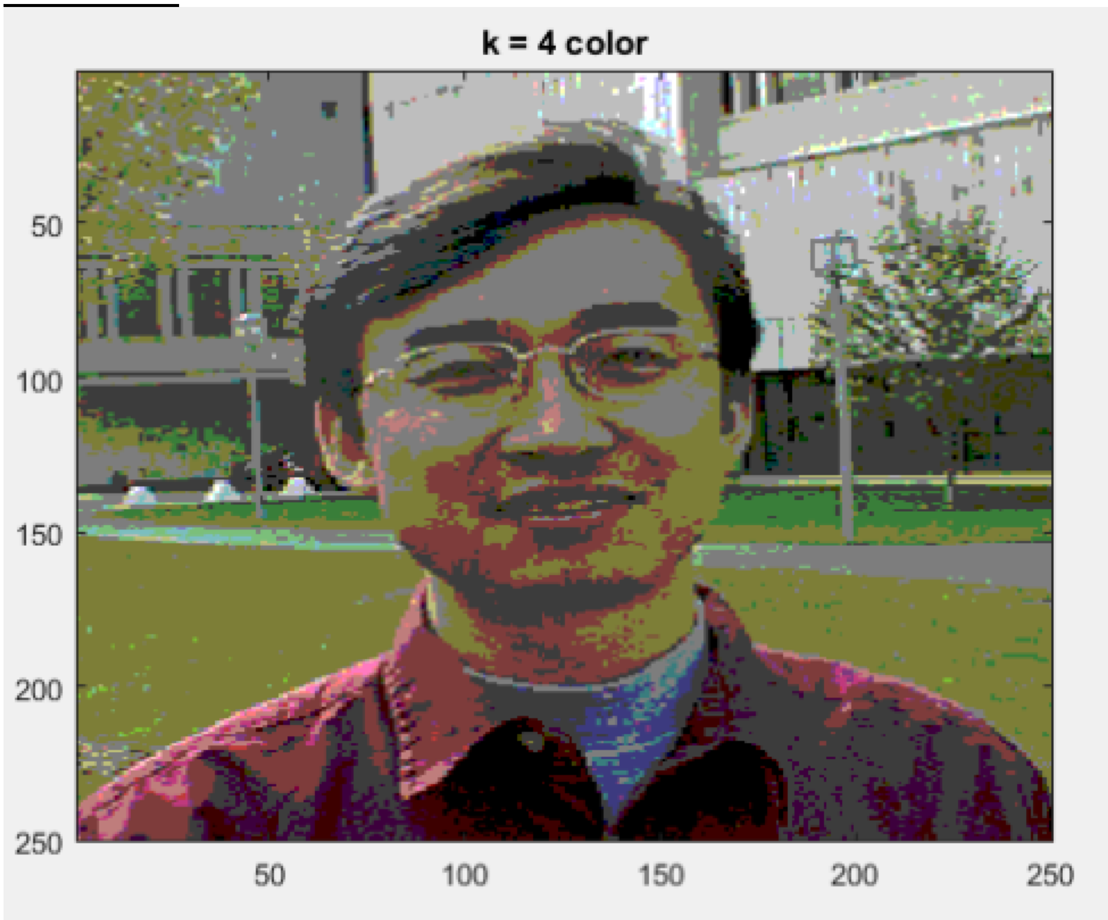
Since k = 64, which means it has 64 levels. Each level has 3 colors and total colors that can be generate in this image are 64^3 = 262144 colors. Since it has 16 levels, the image is clearer than, k = 4, k =16 and k =32 levels.

e) Quantize the original three-band color image C1(x,y) into K level color images CK(x,y)= (R'(x,y), G'(x,y), B'(x,y)) (with uniform intervals) , and display them. You may choose K=2 and 4 (for each band). Do they have any advantages in viewing and/or in computer processing (e.g. segmentation)?

K=2 Color:



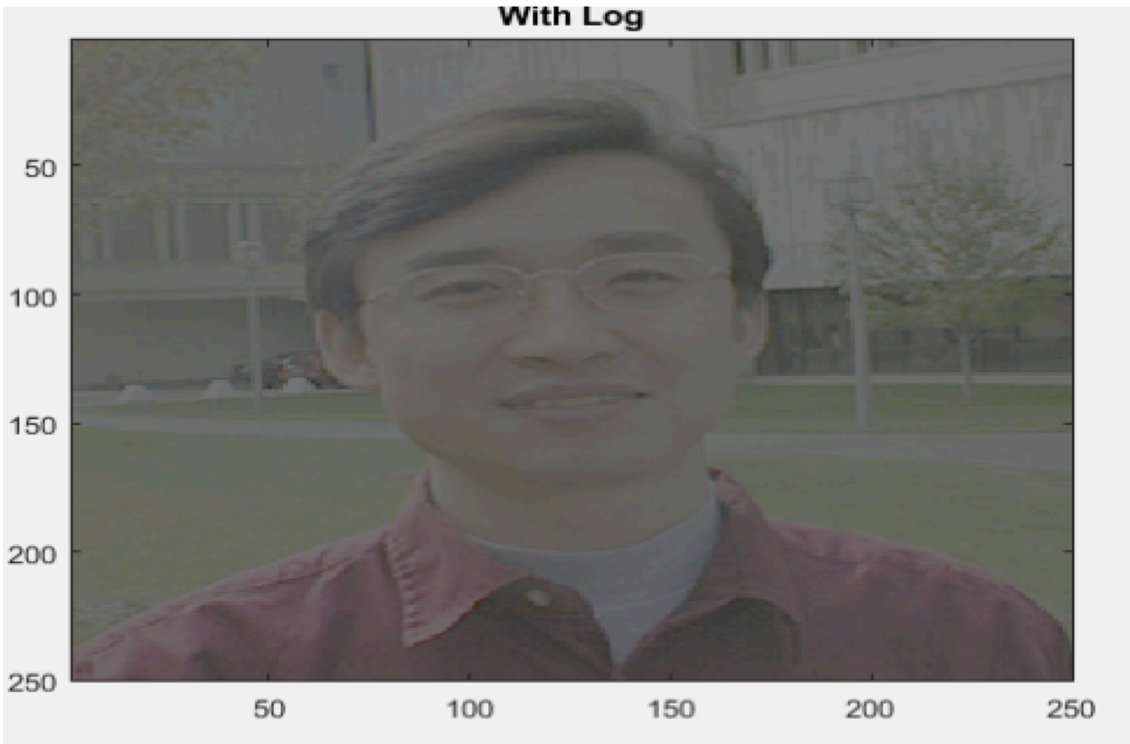
K=4 Color:



Explanation:

As you can both images with k=2 and k=4, the pictures are unclear. These images are little bit blurry. Since the numbers of levels are low, which makes the image, very hard to see. As the number of level increases, the image becomes more clearer.

f) Quantize the original three-band color image C1(x,y) into a color image CL(x,y)= (R'(x,y), G'(x,y), B'(x,y)) (with a logarithmic function) , and display it. You may choose a function I' =C ln (I+1) (for each band), where I is the original value (0~255) , I' is the quantized value, and C is a constant to scale I' into (0~255), and ln is the natural logarithm. Please find the best C value so for an input in the range of 0-255, the output range is still 0 - 255. Note that when I = 0, I' = 0 too.



This is the image that was generated with logarithmic function. As you can see the image in the background is same, it just looks like the image is being seen through a black screen.