Computer Graphics
CSE 457

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Homework 1

Received: Mon, Oct. 4
Due: Mon, Oct. 18

DIRECTIONS

Please provide short written answers to the questions in the space provided. If you require extra space, you may staple additional pages to the back of your assignment. Feel free to talk over the problems with classmates, but please answer the questions on your own.

NAME: ________________________________

Problem 1 - 14 Pts. (2 each)

True or False (justify your answers)

(a) A color printer can reproduce the exact same colors that can be shown on a monitor.

(b) Two colors with the same RGB values always have identical spectra.

(c) The color gamut of a CRT is the range of color that the object can produce through combinations of its three principal colors.

(d) Two colors with identical coordinates in CIE color space have the same spectra.

(e) A median filter is a convolution filter.

(f) A median filter will eliminate salt and pepper noise better than a mean filter.

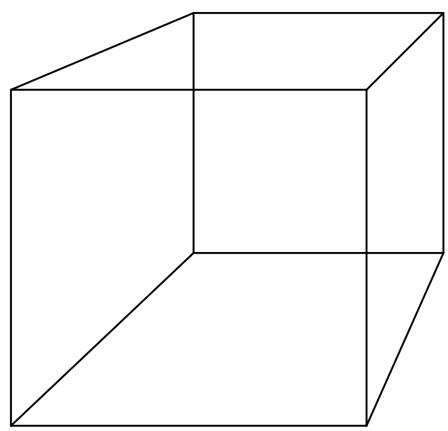
(g) The human eye handles a large light intensity range due to at least three types of adaptation.

Problem 2 – 20 Pts.

There are many different color spaces that can be used in computer graphics. Two of the different color spaces are RGB (red, green, blue) and HSV (hue, saturation, value).

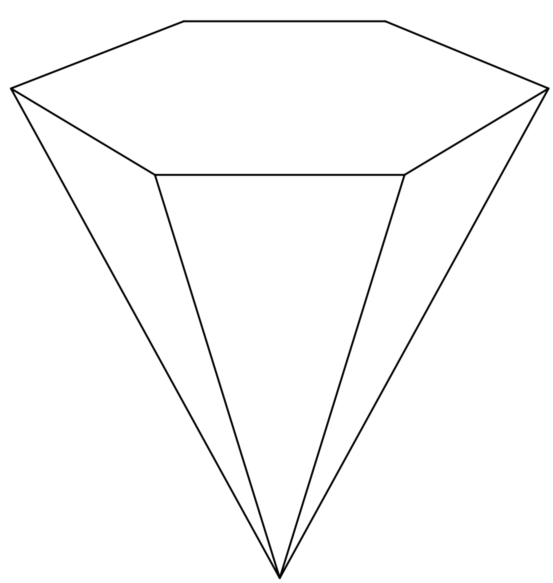
(a) 4 Pts.

Label the eight vertices of the RGB cube below with appropriate color names, and indicate where all the gray values lie:



(b) 4 Pts

Label the seven vertices of the HSV hexcone below with the appropriate colors, and indicate where all the gray values lie:



(c) 6 Pts.

Can the RGB color space define every possible color? Why or why not? (Hint: use the CIE chromaticity diagram)

(d) 6 Pts.

If we perform a linear interpolation between two colors in RGB color space, is the result the same as when we perform the interpolation in HSV color space? Support your answer.

Problem 3 – 20 Pts. (10 each)

(a) Convolution filtering can modify images in a variety of ways. Describe the expected effect of filtering an image using the following convolution kernel. Justify your answer.

1	**3**	**1**
3	**-15**	**3**
1	**3**	**1**

(b) Suppose we have an image that contains some salt and pepper noise. Which of these mean filters will better eliminate the noise? Which will provide a blurrier, or "softer", effect? Why?

A

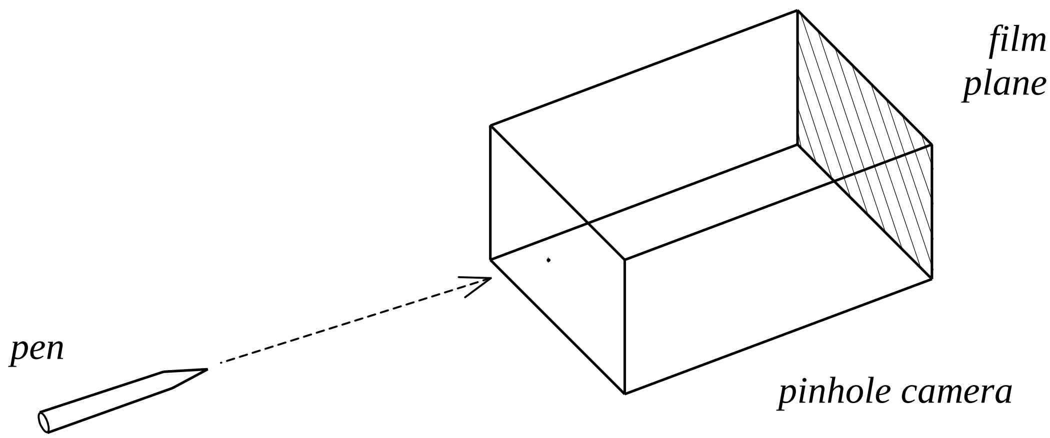
0	1	0
1	2	1
0	1	0

B

0	0	1	0	0
0	1	2	1	0
1	2	3	2	1
0	1	2	1	0
0	0	1	0	0

Problem 4 – 24 Pts. (8 each)

Your pinhole camera is not collecting enough light, so you decide to create a "penhole" camera by poking the barrier with your ballpoint pen. This creates a round aperture with a 1cm diameter. You proceed in viewing a scene of various objects through your camera.



(a) You notice after the "penhole" modification that the objects on the file plane became blurry. Which became blurrier: far away objects or close objects?

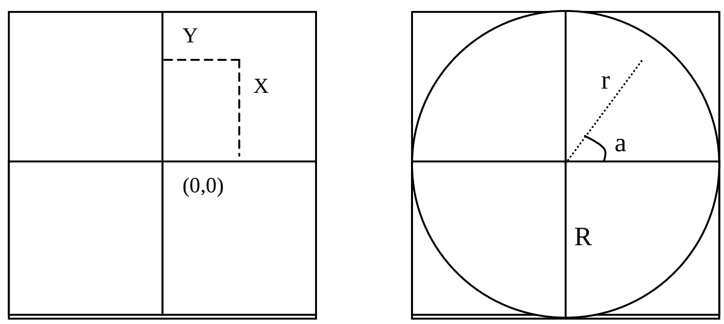
(b) Assume that a given object, when struck by light, reflects it equally in all directions. Will the film receive more total energy from a point on the object if the object is close or if it is far away?

(c) Suppose that the film plane is 12cm from the aperture, and you have an object 1m away from the aperture (on the other side, of course). How big a spot will a point on the object project to on the film?

Problem 5 – 25 Pts. (5 each)

Quite a few intriguing image transformations can be accomplished with simple manipulations using polar coordinates. Let the origin of an image be its center, define the position of each pixel according to its distance from the origin r, and its angle a with respect to a fixed horizontal line (measured in degrees), as shown below. Also, let R be the maximum radius of the image.

Cartesian Coordinates



Polar Coordinates

We took images of famous and not-so-famous individuals and altered them according to the following rules:

```
new_image_one[r,a]     =   image_one[sqrt(r*R),a]
new_image_two[r,a]     =   image_two[r, a+r/3]
new_image_three[r,a]   =   image_three[(r*r)/R,a]
new_image_four[r,a]    =   image_four[r, a+image_four[r,a]/8]
new_image_five[r,a]    =   image_five[(r/32)*32, (a/32)*32]
```

The divisions above are integer division with truncation (as in C).

In which figure in the following pages do each of these image appear:

a) Image one?
b) Image two?
c) Image three?
d) Image four?
e) Image five?

Figure A: Before and after.

Figure B: Before and after.

Figure C: Before and after.

Figure D: Before and after.

Figure E: Before and after.

Problem 6 – 20 Pts. (10 each)

In addition to the standard 12 compositing operations, Porter and Duff defined the following:

$$\text{darken}(A, \rho) = (\rho R_A, \rho G_A, \rho B_A, \alpha_A)$$
$$\text{fade}(A,\delta) = (\delta R_A, \delta G_A, \delta B_A, \delta\alpha_A)$$
$$A+B = (R_A+R_B, G_A+G_B, B_A+B_B, \alpha_A+\alpha_B)$$

a) Suppose we want to make the colors in image A 50% brighter. What operation(s) would we use?

b) Suppose we are producing an animation sequence that consists of a series of still images, and we want the current image to fade out at the same time the next image is fading in. To do that, we need to smoothly blend from image A to image B through time t. How would we do that using the above operations?