University of California San Diego
Department of Computer Science
CSE190: Virtual Reality Technology
Spring Quarter 2019
Midterm Examination
Thursday, May 23rd, 2019

Name:_____

This is closed book exam. You may not use electronic devices, notes, books or other written materials.

Good luck!

Do not write below this line

Problem	Max.	Points
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
Total	80	

1. Depth Cues (10 Points)

a) Name and briefly describe three monocular depth cues – these are cues which help us judge the distance of objects from our eyes, even if we're only using one eye. (6 points)

b) Describe the difference between accommodation and convergence. (2 points)

c) Describe what is meant by the "accommodation-convergence mismatch" in the context of most of today's VR displays. (2 points)

2. Human Color Vision (10 Points)

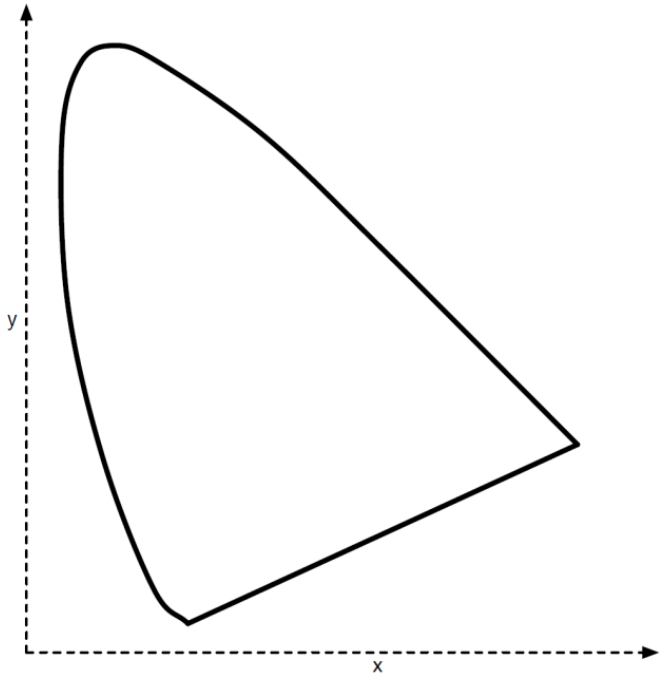
a) How many different types of rods and cones are there in the retina? (2 points)

b) Describe one difference between rods and cones (besides that there are different amounts of types). (2 points)

c) What is the tristimulus theory, and how does it help us with computer graphics? (2 points)

d) Can a VR headset produce all the colors our eyes can distinguish? Why/why not? (2 points)

e) The diagram below shows the the x-y plane of the CIE color space. Mark and label one plausible location each for the red, green, and blue basis colors. Indicate the color gamut for the color basis you have shown. (2 points)



3. VR Displays (10 Points)

a) What is the difference between Field of View and Field of Regard? (2 points)

b) Compare front projected to rear projected screens: describe one advantage of each of them which it has over the other. (2 points)

c) Compare CAVE-type VR displays with head-mounted displays. Name three advantages of each of them which it has over the other. (6 points)

CAVE

-
-
-

HMD

-
-
-

4. The VR/AR Spectrum (10 Points)

a) Put the following VR technologies in the order of **increasing** immersion by assigning them the numbers 1, 2, 3 and 4. 1 being the least immersive, 4 the most immersive. (4 points)

_____ Google Maps directions on Google Glass

_____ VR application on HTC Vive

_____ 360 degree video on smart phone

_____ VR application on Oculus Go

b) Name **and** explain **two** differences between **Virtual** Reality and **Augmented** Reality devices. (4 points)

c) Name two 6 DOF (degrees of freedom) head-mounted augmented reality devices. (2 points)

5. High-End vs. Low-End VR Devices (10 Points)

a) Name and briefly describe 2 High-End (PC-Based) VR devices and 2 Low-End (Mobile) VR devices. (4 points)

b) Pick one High-End and one Low-End device from part a) and name one advantage for each of them which it has compared to the other (except price). (2 points)

c) Imagine that you want to create a VR design software tool for artists to do fast prototyping and visualization. **What** VR device will you design it for and **why** this one? (1 point)

d) Describe one problem today's High-End VR devices have, one for Low-End VR devices and one for both kinds of VR devices. (total: 3 problems) (3 points)

6. Time Warp Algorithm (10 Points)

Describe the **Time** Warp algorithm by answering the following questions.

a) What problem does it address? (2 points)

b) How does it work? Make at least four correct statements. (4 points)

c) What does the asynchronous time warp add to the regular time warp algorithm? (2 points)

d) What does the Space Warp algorithm compensate for that the Time Warp algorithm cannot address? (2 points)

7. Positional Tracking (10 Points)

a) What hardware components are needed for outside-in positional tracking?
Give an example of a HMD (head-mounted display) that uses outside-in tracking. (2 points)

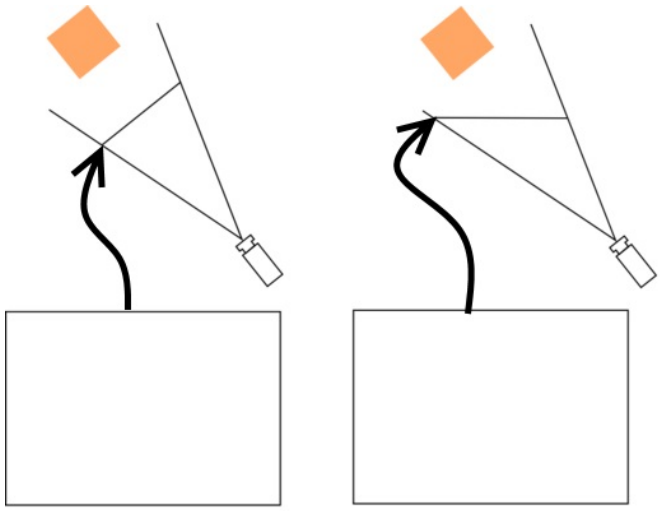
b) What hardware components are needed for inside-out positional tracking?
Give an example of a HMD that uses inside-out tracking. (2 points)

c) Which type of tracking (outside-in or inside-out) is more suited for AR and which for VR? Why? (3 points)

d) What is a SLAM system? Explain with at least 3 correct statements. (3 points)

8. Off-Center Viewing (10 Points)

a) In the section below, draw how the cube should be rendered on the screen. Additionally, explain your drawings. (4 points)



Explanations:

b) Why do we need an off-center projection matrix for rendering to a CAVE? (1 point)

c) How does head tracking affect the images on CAVE screens -- what happens when you:
Change only the head position: (1 point)

Change only the head orientation: (1 point)

d) The off-axis perspective matrix is constructed from $P * M^T * T$. What does each matrix represent? Also, give a high-level explanation of how each one is generated. (3 points)