

WRITTEN EXAM February 13, 2017

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	1 2	3	4	5	6	7	8	9	Total
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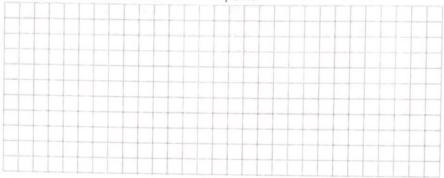
Supervised:

Student: _

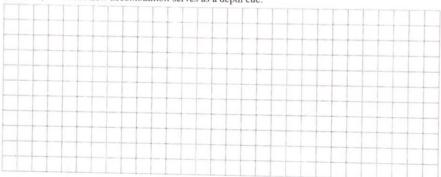
Date: _

lame:				lm	matr.N	0.:					Virtual Rea Winter 201	
1. (10 Point												
(a) (3 P	oints) Con	nplete the f	following	g stateme	nt:							
Virt	ual Reality	(VR) is _										
	ser can											
expe	erience it w	ith their _										
(b) (5 P	oints) Nan	ne 5 milest	ones in t	he history	of VR	with the	eir year	of inv	ention (± 5 yea	urs).	
								H				
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									-	+-		-
(c) (2 Pe	oints) State	the minin	num fran	ne rate tha	it should	be ach	ieved f	or VR	renderii	ıg.		

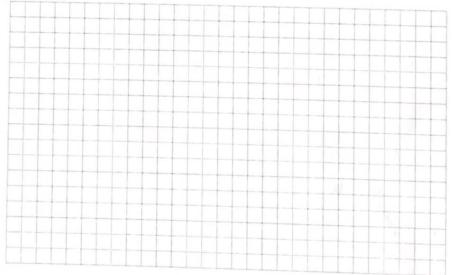
- 2. (10 Points) Depth Cues
 - (a) (3 Points) Describe how stereo vision serves as a depth cue.



(b) (2 Points) Describe how accomodation serves as a depth cue.



(c) (5 Points) Describe how (con)vergence and accomodation can interfere with each other in a virtual environment.



		Virtual Reality
Name:	Immatr.No.:	Winter 2016/17

3. (10 Points) Field of View

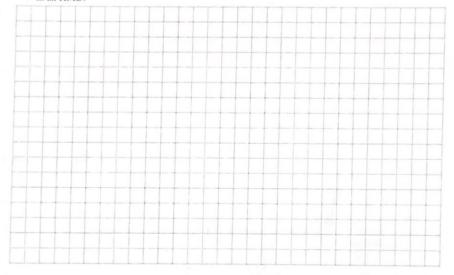
(a) (4 Points) Characterize a human's field of view at eye level:

Horizontal: ______

Vertical: _____

Horizontal stereoscopic field: _____

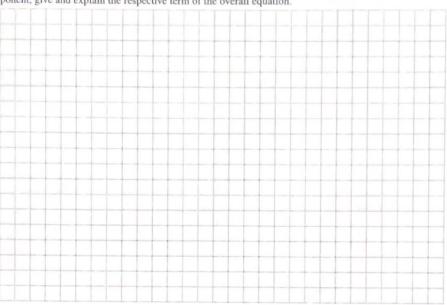
- (b) (6 Points) Discuss the fields of view and the fields of regard
 - in a CAVE and
 - · in an HMD.



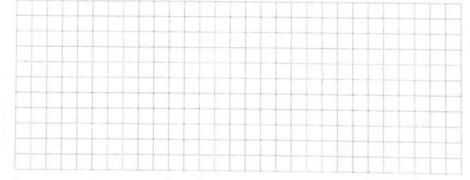
4. (12 Points) Illumination, Shading

(a) (6 Points) Name and describe the individual components of the Phong reflection model. For each component, give and explain the respective term of the overall equation.

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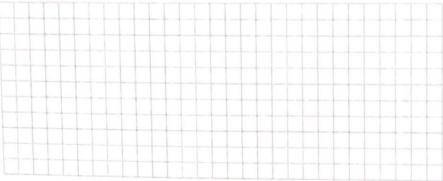


- (b) (2 Points) Which shading model(s) support(s) specular highlights inside polygons?
 - □ Flat shading
 - ☐ Gouraud shading
 - □ Phong shading
- (c) (4 Points) Compare Gouraud and Phong shading in terms of the number of computations to be done.

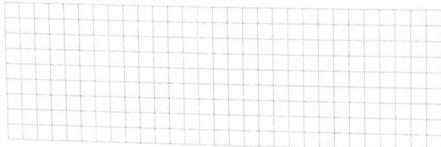


5. (12 Points) Technology

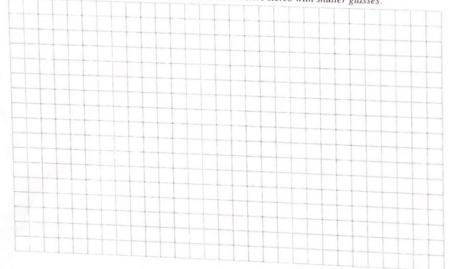
(a) (4 Points) Discuss the pros and cons of passive stereo with polarization and active stereo with shutter glasses in a projector-based VR system.



(b) (3 Points) Compare *polarization* and *INFITEC* in terms of their colour fidelity. State why is there a difference, if one exists.



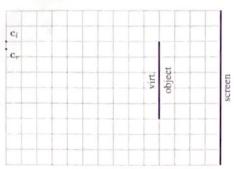
(c) (5 Points) Compare and discuss the different requirements and results with respect to the gain of the screen material for passive stereo with polarization and active stereo with shutter glasses.



6. (12 Points) Viewer-Centered Perspective

Consider the following situation (top view for one wall in a CAVE).

Use the second figure as a backup if you need to correct your drawing.



viri, viri, object

 c_l : position of virtual left-eye camera

 c_r : position of virtual right-eye camera

- (a) (3 Points) Construct and draw the projection of the virtual object onto the screen as seen from the virtual *left-eye* camera (into the above figure). Use solid lines.
- (b) (2 Points) Now consider the virtual *right-eye* camera. Where will the projection of virtual object be located on the screen? Just give a textual answer in relation to the above result. Do not construct it.

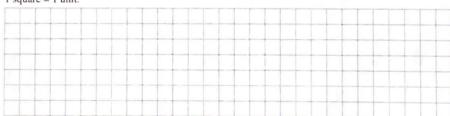


(c) (4 Points) Consider the following perspective projection matrix and the above figure:

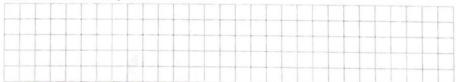
$$\begin{bmatrix} \frac{2n}{r-l} & 0 & -\frac{r+l}{r-l} & 0 \\ 0 & \frac{2n}{t-b} & -\frac{t+b}{t-b} & 0 \\ 0 & 0 & \frac{n+f}{n-f} & -\frac{2nf}{n-f} \\ 0 & 0 & 1 & 0 \end{bmatrix} \quad , \quad \text{with } n=-7$$

Determine the values for r and l for the virtual left-eye camera. Comment on your choice of values. Use dashed lines if you need to draw into the above figure.

1 square = 1 unit.



(d) (3 Points) Name the technical system that is required in order to create the viewer-centered perspective. What measurment does it provide?

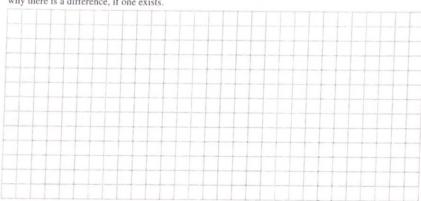


7. (10 Points) Photometry

(a) (2 Points) Compute an approximation of the solid angle Ω that a projection screen (4 m by 3 m) spans with respect to the projector. Let the screen be placed 6 m in front of the projector, with the projector shining orthogonally onto the screen's center.



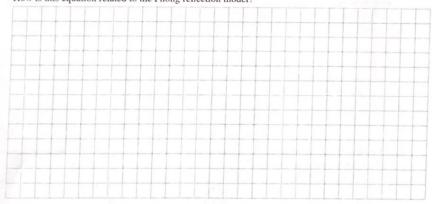
(b) (4 Points) In which units are the "brightness levels" of projectors and monitors specified? Comment on why there is a difference, if one exists.



(c) (4 Points) Consider the following equation for computing the illuminance E_v at a surface patch with area A and a given luminous intensity I_v of a light source:

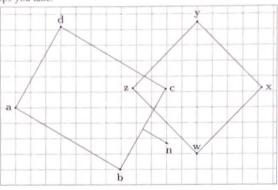
$$E_v = \frac{I_v \Omega}{A}$$

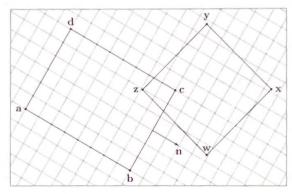
How is this equation related to the Phong reflection model?

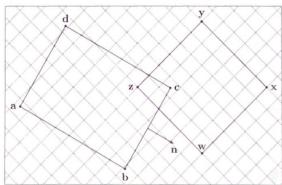


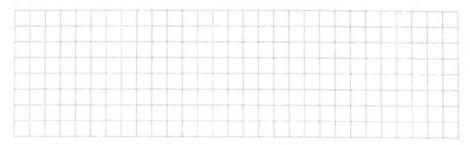
8. (12 Points) Collision Detection

(a) (5 Points) Consider two oriented bounding boxes a, b, c, d and w, x, y, z. Conduct an overlap-test with respect to the normal n (arrow) on face b, c. Choose the most sensible figure to construct the test. Comment on the steps you take.

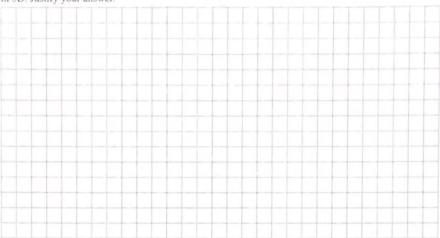




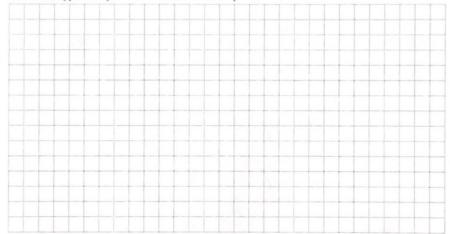




(b) (3 Points) How many axis tests need to be performed at most when testing two OOBBs for intersection in 3D. Justify your answer.

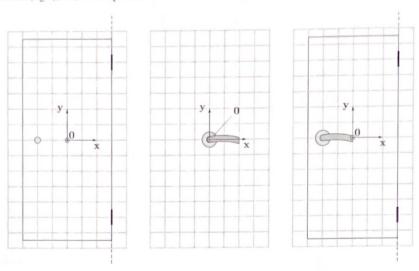


(c) (4 Points) Describe the terms "broad phase" and "narrow phase", and their distinctions. Take into account the types of objects that are checked in each phase.



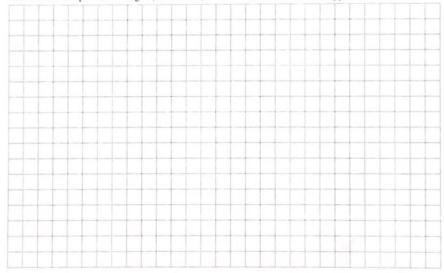
9. (12 Points) Transformation, Scene Graph

Consider a model of a door (left), a model of a handle (middle), each in their local coordinate space, and the final scene (right), i.e., the complete door:

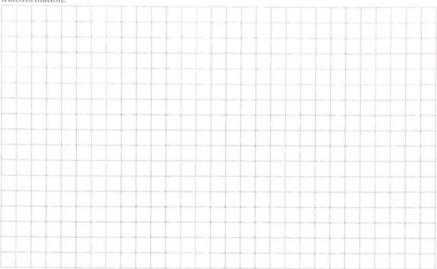


1 square = 1 unit. Matrices shall multiply column vectors. Do not compute the result of any matrix product. The z-axis is pointing towards you.

(a) (4 Points) List the individual transformation steps in their correct order that are required to open/close the door with respect to its hinges (dashed line). Construct the matrix D that applies this transformation.



(b) (4 Points) List the individual transformation steps in their correct order that are required to push the handle and to bring it to its intended position on the door. Construct the matrix H that applies this transformation.



(c) (4 Points) Construct a scene graph that creates a usable door from the individual parts.

