

CS 5754, Virtual Environments – Final Exam Spring 2005

Instructions: Read questions carefully before answering. Write all your answers using complete sentences. Put your name and student ID number at the top of the document you turn in. The exam is due by 5:00 PM on May 9. Turn in your exam by attaching an MS Word (preferred) or PDF file to an email and sending it to bowman@vt.edu.

This take-home exam is open-book, open-notes, but you may not consult with others, and you may not plagiarize text or ideas from publications, books, or web pages. You must cite all sources you use to answer the questions (except the lecture notes from this class). If you have any questions about what constitutes plagiarism, ask Dr. Bowman. All work is to be your own.

Please write the following pledge on the last page of your exam: “I have neither given nor received unauthorized assistance on this exam.” Following the pledge, type or sign your name.

Part I: Short Answer. Answer all eight questions. Answers should be 1-2 paragraphs long. If necessary, cite relevant articles or books in your answer. Each question is worth 5 points.

1. When evaluating VEs, there is a wide range of *metrics* that can be used. Name metrics relevant to VE evaluation that are a) subjective and qualitative, b) subjective and quantitative, c) objective and qualitative, and d) objective and quantitative. Give one metric in each category.
2. Why is it easier to study *immersion* in VEs than to study *presence* in VEs? What are some fundamental issues that make presence research problematic?
3. Explain the concept of *dead reckoning*, as it is used in networked VEs. Why does dead reckoning allow distributed VEs to run smoothly even when network resources are not sufficient to deliver all the update messages in a timely fashion? What are the disadvantages of the dead reckoning technique?
4. Compare the *3D depth cues* provided by a) a head-tracked monoscopic HMD, b) a non-head tracked stereoscopic projection screen, and c) a volumetric display that is only capable of rendering colored wireframe models. You may organize your answer as a table if you wish.
5. What is the difference between an *input device* and an *interaction technique*? Give an example of two different interaction techniques that can be implemented using the same input device. Give an example of two input devices that can be used to implement the same interaction technique.
6. How can *polygonal simplification* be used to improve VE rendering performance without sacrificing visual fidelity?
7. Give examples of VE systems that would be: a) local and not collaborative, b) local and collaborative, c) distributed and not collaborative, and d) distributed and collaborative. Give enough detail in your examples so the systems can be clearly distinguished.

8. What, in your opinion, are the two most important obstacles hindering effective VE software development? How can VE software development tools address these issues in the future?

Part II: Essay. Answer three (3) of the four questions. Answers should be approximately 1-2 pages long. Cite relevant sources in your answer. Each question is worth 20 points.

9. Many of the interaction techniques for system control in VEs were designed (implicitly or explicitly) for HMD-based systems. Consider the following three menu techniques – TULIP menus, pen & tablet menus, and ring menus. For each of the techniques, discuss how that technique could be implemented in a CAVE-based system (you may assume any input device(s) you wish). Could the technique be used effectively without any design changes, or would the technique need to be modified in order to be usable in the CAVE? Based on your discussion, draw some general conclusions about migrating interaction techniques between HMDs and CAVEs.
10. VEs often display only to the visual sense. We are getting closer, however, to good 3D displays for the auditory and haptic senses. If you were in charge of allocating research funds, would you fund research on auditory or haptic displays? Support your statement by talking about the relative importance of the two senses, and relevant examples of VE applications or tasks. What would an ideal (haptic/auditory) display provide? What would it take to bring (haptic/auditory) displays to an equivalent level of sensory fidelity with today's high-end visual displays (e.g. the CAVE)?
11. One of the “grand challenge” questions we saw at the end of the semester was this:

What VE travel techniques will allow users to navigate effectively through multiple scales?

Suppose that you were going to do an MS thesis on this topic. Write a brief summary of your proposed thesis work. Include at least the following: a) motivation, b) related work, c) problem statement, d) hypotheses, and e) description of approach. Be sure to identify the scope of your work – what specific parts of this broad question are you going to address?

12. Suppose that you are designing the user interface for an augmented reality (AR) interactive space planner for the Department of Computer Science. This application will allow the user to physically walk around within the physical “shell” of the building; view both the physical building and the virtual interior design; add, resize, move, and remove walls; add, move, or remove furniture; and add annotations to each room. Describe the user interface you would recommend for this system, including input and output devices, and interaction techniques for (at least) selection, manipulation, and system control. You may choose existing devices or techniques, or design your own. Use sketches if necessary to describe your 3D UI. Justify your choices based on the characteristics of the application.