CS 5754, Virtual Environments – Final Exam Spring 2006

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. Exploratory, informal evaluation and controlled, formal evaluation are two popular methods of designing a user study. Describe at least four differences between these two types of methods in terms of the experiment procedures, metrics, data collection, and results analysis.

2. In terms of 3D depth cues provided, what are the differences between a standard four-wall CAVE, such as the one in Torgersen Hall, and a volumetric display such as the one pictured in Figure 3.19 in the textbook?

3. What does it mean for a VE software system to be device-independent? Why is this an important goal?

4. What is the difference between integral and separable degrees of freedom (DOFs) in input devices? Consider the standard “wand” used in our lab. How many total DOFs does the wand have (name them)? Which are integral and which are separable?

5. Define immersion as we described it in this class. Why is it important for the VE community to empirically verify the benefits of immersion? Why is it not sufficient to simply compare non-immersive systems with immersive systems?

6. How do level of detail (LOD) techniques in computer graphics allow us to “beat” the speed-quality tradeoff? In other words, how do LOD techniques maintain real-time frame rates while also maintaining a high level of apparent quality to the viewer?

7. There are several types of “magic” that can be used in 3D interaction technique design. Give examples from the book or literature of magic interaction techniques that give users a) better motor (physical) abilities, b) better perceptual (sensing) abilities, and c) better cognitive (thinking) abilities.

8. Describe at least four challenges in the design/development of mobile outdoor augmented reality systems.
**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. Too often when designing virtual environments, developers assume that the input devices, interaction techniques, and visual displays are inherently linked. For example, if we are using a CAVE, we may feel that we must use a 3D input device with 3D interaction techniques. Or if we are using a desktop monitor, we may feel that we must use a mouse and keyboard with traditional 2D interaction techniques. But this is not necessarily true, and exploring other combinations may be very useful. In your essay, consider two displays – a desktop three-monitor tiled display and a four-wall CAVE – both of which will display a 3D VE. Develop several ideas in which 3D input devices and/or 3D interaction techniques might be effective on the desktop display, and in which 2D input devices and/or techniques might be effective in the CAVE. Also consider how these devices/techniques might be integrated with existing devices/techniques for the two displays.

10. We have seen that many 3D manipulation techniques are relatively usable, but still not very effective for real-world tasks. One idea for improving 3D manipulation techniques is to add haptic feedback. Suppose that you were designing a CAVE-based interface for Virtual-SAP (our structural engineering design application we’ve seen many times this semester). Describe how you would add haptics to the HOMER technique for manipulation of structural elements in this application. Discuss at least what hardware you would use, how this would be integrated into the CAVE, and how/when you would provide haptic feedback. Consider not only physically-realistic haptics, but also “magic” haptics. How would your technique(s) increase the usability or performance of the HOMER technique?

11. Currently, most 3D user interfaces are developed using toolkits or software systems that focus mainly on real-time 3D computer graphics and devices. In your opinion, what would an ideal software system for 3D UI development look like? (Think about questions like “What features need to be provided to support the process of developing 3D UIs?” and “How can a software system match the way that 3D UI developers think about their designs?”). What are the challenges in implementing the ideal software system you have described?

12. Choose one (1) of the 20 questions in chapter 13 of the textbook. Suppose that you were going to do an MS thesis addressing (part of) this question. Write a short “thesis proposal” that includes the following elements:
   a. introduction/motivation (what is the general problem and why is it important),
   b. literature survey (show what’s been done and what needs to be done),
   c. specific set of research questions you will address,
   d. list of hypotheses for your research questions, and
   e. general description of your approach (what you will do to start addressing your research questions).