CS 5984 Final Exam – Virtual Environments – Spring 2003

Instructions: Read questions carefully before answering. Write all your answers using complete sentences. Put your name and student ID number on the exam you turn in. The exam is due by 5:00 PM on May 5. The preferred method of turn-in is by attaching an MS Word or PDF file to an email and sending it to bowman@vt.edu. If you prefer to write your exam by hand, you must turn it in at Dr. Bowman's office (Torgersen 3030A; slide the stapled exam under the door).

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 aid 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. What are the major barriers to the use of immersive VEs in higher education (university classes)? Give at least three barriers. How can each of the barriers be overcome?
2. Some VE applications wish to provide a realistic technique for travel in the virtual world. Discuss the advantages and disadvantages of using a locomotion device (such as the omni-directional treadmill) or a walking-in-place technique for this purpose. Consider at least implementation, usability, and effectiveness issues.
3. Define the "accommodation-convergence mismatch". Why do most common VE displays have this characteristic? What properties would a visual display need in order to solve this problem?
4. Name and describe two techniques for embedding menus within an immersive VE. What are the major issues that must be addressed when designing such a technique?
5. Define "culling" as it relates to 3D computer graphics. Why is culling so important for VEs? Describe at least two different types of culling that can be done in VEs.
6. Describe the basic "dead reckoning" algorithm. Why is this algorithm useful for improving the performance of distributed VEs? What are the limitations of the algorithm?
7. What is the basic theory explaining the prevalence of "simulator sickness" in immersive VEs? What characteristics of VEs might lead to feelings of discomfort in users? Which of these characteristics can be solved (e.g. with better technology) and which cannot?

8. Compare and contrast the approaches to building a VE software toolkit taken by the developers of Alice and DIVERSE. What audience, target platform, and development style does each toolkit focus on? Describe at least two ways you could combine these approaches.

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 3D manipulation techniques (e.g. Go-Go, HOMER, Image-plane techniques) allow users to manipulate objects remotely (at a distance). This provides power and flexibility, but can also make it difficult for users to place objects precisely, because the object is so far away. Discuss strategies that have been or could be used to help users be more precise in remote object manipulation tasks. Based on your discussion, design and describe an extension to the HOMER technique that would provide greater precision of object placement, without limiting the expressiveness of the technique.
10. The most successful commercial *immersive* VE applications have been in the fields of entertainment (e.g. DisneyQuest), military training, and psychiatric treatment (e.g. phobia therapy). First, analyze all three of these areas and discuss why immersive VEs are a) possible, b) usable, and c) beneficial in each area. Second, predict what the next big application of immersive VEs will be, and provide arguments and rationale to justify your choice. What will have to change (e.g. improved technology, further research) to make your prediction a reality?
11. One approach used in the evaluation of all types of interactive systems is *heuristic evaluation* – an inspection approach used by experts to catch large usability problems at an early stage of design. One common set of heuristics is the one proposed by Nielsen. His set of 10 heuristics can be found at:

    http://www.useit.com/papers/heuristic/heuristic_list.html

    Create a small set (10 or fewer) of heuristics specifically for 3D interfaces in immersive VEs. You may use Nielsen's list as a starting point, or start from scratch. For each heuristic you propose, a) state the heuristic, b) state what it means, c) explain why the heuristic is important in designing 3D interfaces, d) give an example of how the heuristic might be applied.
12. You have been given a contract to design and implement an immersive VE system to be placed in a science museum. The system will display many different types of scientific content, so the system must be fairly general. At least 7 visitors must be able to experience the VE at a time, and the experience must last no longer than 10 minutes from beginning to end. Your job is to determine what output and input devices will be used in the installation. You may choose from existing commercial devices, or design a custom solution. In making your choices, you should consider cost, space restrictions, ruggedness, interface learnability, user comfort, the ability for groups to collaborate, and the ways that visitors can interact with the content, in addition to the constraints mentioned above. Justify your choices.