

CS 5984 Final Exam – Virtual Environments – Spring 2002

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 3. 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 outside Dr. Bowman's office in the box marked for that purpose. This take-home exam is open-book, open-notes, but you may not consult with others. 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 *props*, in the context of VE user interfaces? Name two advantages of using props. Name one application we studied this semester that used props effectively, and discuss why props were useful in that application.
2. Name and explain at least three ways that usability evaluation in VEs is different than usability evaluation of typical computer user interfaces.
3. Define *proprioception*. Besides the techniques in Mine's (1997) paper, name two other interaction techniques for VEs that take advantage of the human proprioceptive sense.
4. Name three possible *objective measures* for the sense of presence in a VE. For each measure, state why that measure should be associated with presence (a subjective phenomenon). In your opinion, which of the three measures is the most indicative of presence, and why?
5. Explain the concept of *dead reckoning*, as it is used in distributed 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?
6. Many VEs strive for realism, but this goal is in conflict with the requirement that VEs be rendered in real time. Describe at least two techniques or tricks that VE developers use to achieve detailed, realistic scenes while still maintaining a real-time frame rate. (The techniques must be usable on a typical desktop PC – don't describe techniques that require a supercomputer or parallel cluster!)
7. What are some of the sources of *latency* (or lag) in VEs (consider both local and networked VEs)? What effects does this latency have on the user of a VE system?
8. Why are VE-specific software systems (e.g. DIVERSE, WorldToolKit) needed? In other words, why don't VE developers simply use existing graphics packages (e.g. OpenGL, DirectX) when building their applications?

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

9. Write your opinion on the state of applications for VEs. What are the most important reasons why there are few “production” VE applications? Are we on the verge of a large increase in the number of these applications, or will this number stay about the same or increase only gradually? Will VEs ever become general-purpose (used by large numbers of people for common, daily tasks), or are they better suited for specific domains?
10. Most of the interaction techniques for object manipulation in VEs were designed (implicitly or explicitly) for HMD-based systems. Consider the following four interaction techniques – Simple Virtual Hand, Go-Go, HOMER, and World in Miniature. For each of the techniques, discuss how that technique would be implemented in a CAVE-based system. Could the technique be used without any changes, or would the technique need to be modified in order to be usable in the CAVE? Can you make any generalizations about migrating interaction techniques between HMDs and CAVEs?
11. In class, we discussed the use of personal digital assistants (PDAs), such as the PalmPilot or PocketPC, as a general-purpose VE input/output device. Consider a virtual geographic information system (GIS) – an immersive application that runs in the CAVE, displays realistic terrain from a physical location somewhere on earth, and allows the user to query the system for additional geographic and spatial information. Discuss how you could use a PDA (equipped with a 6 DOF tracker) as the sole input device for such an application, and how you could use the PDA as a secondary display device. Be as creative as possible in designing your user interface. Be sure to discuss at least travel, wayfinding, object selection, query, and system control in this application.
12. Consider the other classes that you are taking this semester (if you’re not taking any other classes this semester, consider the classes you had in the last semester you were taking classes). Within the context of one of these classes, describe a way that immersive VEs could be used to teach a particular concept or set of concepts. Describe your educational application in some detail – what it would display, how the user would be able to interact with the application, etc. State your educational objectives, the tasks that students would perform in the system, and how you would use the system in a classroom environment. Finally, make an argument justifying the additional cost and complexity of using a VE for teaching this subject matter – why would a VE be more effective than other methods of teaching the same material?