

Title of Proposal: Evaluation of a Multi-User Collaborative Audio Workstation and Experimentation Environment

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Is this proposal related to a sponsored project? Yes

If yes, please indicate:

Existing Award: (Fund # A12016), NSF,

Immersive Architectural Daylighting Design Experience

All investigators, including faculty supervisors, on this project must complete the self-study course on protection of human research subjects.

Certification: I/We have completed the course:

Tyler Sammann (CS Masters student) 8/22/12

Barbara M Cutler 7/2/08, refresher 11/2/11

Objective: To evaluate the effectiveness of our table top Spatially Augmented Reality (SAR) system for multi-user interaction and data visualization. Specifically we will study the effectiveness of the visualization and interaction design for a simple 2-player board game with projector augmentation and computer-based evaluation of the game rules and game play.

Methods: The participants will be asked to play two to four rounds of a simple 2-player board game with small cardboard and plastic pieces on a table augmented with visualization by projectors and answer a short post-play questionnaire. Both players will simultaneously be participants in the study. We will use a video camera with audio to record the game play and save digital files of the game state during play. During the exercise, participants will be asked to speak aloud to each other and to the researcher about their observations of the system and the overall interaction. After the game play is completed, each participant will be asked to fill out a paper and pencil questionnaire about the SAR system, the game interaction design and visualization, and its usefulness in providing feedback and implementation of the game rules and game play. The system introduction will take approximately 10 minutes, game play will last approximately 30 minutes (5-10 minutes per round), and the written questionnaire will take about 20 minutes to complete. The entire study (system and game introduction, game play, and questionnaire) will last approximately 1 hour. We will ensure each participant is completed with the entire study in a maximum of 1.5 hours.

Our primary data collection device is the post-study paper questionnaire. If the participants allow, we will also video tape the session. The video tape is not necessary for completion of our study. Participants that allow us to video tape may be used as samples in our paper, and will allow us to do further analysis related to the timing of game actions, etc. The data collected from video taping and audio taping will be fully anonymized before publication. Faces and bodies will not be visible in the imagery. And we will not publish the audio files, only possible extracted quotations.

The participant will be told that they are under no obligation to participate in the study, and that they may withdraw from the study at any point, without giving a reason.

Participants for this study will be compensated for their time in the form of a gift certificate at the rate of \$10 per hour. This compensation is not contingent upon the subject completing the entire study and will be prorated if the subject withdraws. The participant's performance in the game (winning, losing, playing well or poorly) will not affect compensation.

Effects on Subjects: See benefits and risks.

Benefits to Participants: The participants will gain first-hand experience with a new technology, Spatially Augmented Reality (SAR), and an application of SAR to visualization and multiple player interaction for

game play. The results of the study will lead to the use, development, and improvement of spatially augmented reality tools for entertainment and education.

Documentation of Risks: The spatially augmented reality system is identical to that from our earlier user study #894 Evaluation of the Virtual Heliodon for Architectural Daylighting Design. The risks are the same for these two studies. We will follow the same safety precautions and participant instructions as in that study.

The participants will be standing around a small table, manipulating small cardboard objects on the table and observing imagery projections on the table surface. The table is surrounded by a heavy duty aluminum truss frame with 6 projectors mounted on the frame.

There is a risk of permanent eye damage if participants stand close to (30 centimeters or less) and within the beam of the projectors and look directly into the lens for more than 2 seconds. The study does not require participants to position themselves or direct their gaze in such a way that this damage would occur.

Measures to Minimize Risk: The study will be conducted in a quiet mixed-use lab/office space in the Materials Research Center.

See attached “Overview of the Table Top Spatially Augmented Reality System” for a description of the physical system. As a physical environment, the system does pose some minor physical risks, but we have taken all steps to minimize these risks, described below. One or more researchers will be present at all times and will stop the study immediately if the equipment or safety mechanisms are not fully functional or if the participant is experiencing any difficulties.

- All joints, bolts, nuts, and screws of the frame and peripherals (projectors & camera) will be checked for tightness prior to the user study. Before each participant begins the user study, the investigators will ensure that the frame and equipment is secure and stable, and that the area within and around the frame is clear.
- The participants will be given an overview of the system and all components of the system will be described to them. They will have an opportunity to ask questions about the system before the study begins, and the participants may ask questions during the study as well.
- The participants will be instructed not to look directly into the projectors. The nature of the setup and the exercises the participant is asked to do makes it very unlikely that the user would accidentally look directly at the projector bulb. The natural gaze while using the table-top SAR system is directed downwards, towards the table, and all projectors are mounted above head height. Furthermore, the placement of the table in the center of the space at the convergence of the beams of the light, effectively blocks a user from positioning him/her self within the beam. Before the experiment begins, we will caution the participants against looking directly at the bulbs and explain how to stand and move within the frame to avoid accidentally doing so. During the experiment if the participant appears to be at risk for looking directly into the bulb we will stop the experiment.
- We will provide and offer simple opaque visors to the participants, similar to a baseball cap, for use during the study. The visor will further protect the participant from accidental exposure to the projector light from above. However, we will not require that the participant wear the visor during the study. Whether the participant is wearing the visor or not, we will be watching the participant carefully and stop the experiment if the participant is not using the system as intended and is in any risk of positioning themselves for risk of eye damage.

We note that during intended use of the system, the user’s head should not be in or near the beam of light from any projector. The user naturally positions himself between the beams of the projectors. During normal use of the system, if the user does move to step into the beam, the beam will fall on the person’s hand or arm, or possibly their back. Standing close to the table will ensure that the user’s head is never in the beam. If the user does step into the beam, this is immediately apparent because it casts shadows on the table (the user’s gaze is towards the table) and the user naturally moves out of the beam again. If the user ever moves towards placing their head within the beam, we will stop the experiment.

The entire study will last approximately 1 hour. The participants will be encouraged to work at their own pace and take breaks as needed to stretch or sit down (chairs will be available in the room) and will be told they may stop the study at any time without giving a reason. The study will consist of 2-4 rounds of game play. Each game consists of a period of roughly 5-10 minutes standing at the table-top SAR system followed by a break where the user may sit at a desk in the room to answer written or verbal questions and receive instructions for the next exercise. If a participant has not completed all game exercises within 1 hour, we will stop the game portion of the session and have the user complete the post-game questionnaire. Similarly, we will ensure that the participant completes the entire process within 1.5 hours.

Likelihood of Harm: Very minimal.

Alternate Method Not Using Human Subjects: None

Qualifications of Researcher: Barbara Cutler has a PhD in Computer Science from Massachusetts Institute of Technology. Joshua Nasman is a 4th year PhD student in Computer Science at Rensselaer Polytechnic Institute studying computer graphics and parallel computing.

Recruiting of Subjects: We will ask for student volunteers, 18 years or older, from the Games and Simulation Arts and Sciences courses and major in the School of Humanities, Arts, and Social Sciences. We will obtain permission of the course instructors to advertise for the participation of their students, but participation in the study will be voluntary and will not impact their course grade. The faculty advisor for the study (Barbara Cutler) will not recruit students in her courses to participate. The names of the students who did or did not participate in the study will be confidential and will not be released to their instructors.

We are specifically interested in studying people with interest in the field of Games and Simulations Arts and Sciences (GSAS) and will advertise the study to GSAS majors. Most or all students in this major have extensive prior experience using computer software, computer games, and graphical user interfaces. Most or all students in this major are also very familiar with board games and many are familiar with specific “miniature war games”, similar to the game used in our study. This experience is not required for participation in the user study, but the subject’s interest and prior experience with these interfaces and games is noted, and thus makes participation in this study simple and fun for the participant.

Confidentiality: Participants will be identified by a randomly assigned ID number that is used only for this study. All recordings and design files will be labeled with this ID (and not the participant’s name). All information and data relating to the user study will be protected to secure confidentiality. All electronic files will be stored on password protected computers in locked offices, which can be accessed only by the investigators of the user study. All paper forms (e.g., the exit questionnaire) will similarly be labeled with the ID and not name. The paper forms will be stored in Barbara Cutler’s locked office. The correspondence between ID number and participant name will be recorded by Barbara Cutler and stored on a password protected computer, accessible only by her. This correspondence will be destroyed once analysis of the data is complete, within 1 year after participation in the study. The video/audio recording will be destroyed within 1 year after participation in the study.

1 Overview of the Table Top Spatially Augmented Reality System

The participants position a set of small boxes, ramps, and partition walls made of lightweight white foam-core (foam+cardboard) and red or green plastic army units within the workspace to construct the 3D geometry of the game environment and control game play. Images of the environment are captured by a camera mounted above the scene and are processed using computer vision to detect the current game state and create a 3D digital model. The ARmy computer application calculates the legal movement range of each unit and also calculates the line of sight and distance between opposing units to determine if combat will occur between opposing units and if an advantage is afforded to one unit over the other because of elevation differences. The projectors are used to directly augment the physical objects:

The computer also enforces the rules of the game (play is paused until illegal movements are corrected).