Augmented reality is a trendy subject, existing both in modern science fiction as well as early prototypes built by researchers and hardware-makers. Virtual objects can be imposed in the physical world through a viewing screen (usually a head-worn device) but there hasn't been a standard way to directly interact with these virtual objects with our hand; rather, most current interaction techniques use some sort of separate controller. In this assignment, you will be creative but rigorous in coming up with your own study protocol that explores direct hand manipulation with the virtual world. What is it like to interact with things that appear but don't exist? How can we be comfortable manipulating 3D virtual objects like we do with 2D objects (touching them on a screen)? This is something that's hard for a person who hasn't used the system to opine, so we will use a method called *Experience Prototyping*.

In the first week, you will prepare your study protocol for the augmented reality system "Portalble" developed by the Brown HCI research group. The Portalble system turns a mobile phone into a portal that shows virtual objects in the 3D space captured by the back-facing camera. There are two design-related applications that are enabled: arranging furniture (interior design) and 3D brushes (painting); only one handed manipulation will be considered for simplicity (otherwise the assignment becomes a bit too unwieldy, no pun intended). Then you will recruit two non-student participants to perform the study, and come up with design implications that will help designers and developers actually implement the manipulation techniques (feel free to see papers from class an examples).

1   Research Questions

You will have one primary research questions to address in your study, as well as one other one that you will come up with. The primary question is: what ways of manipulating (grasp, move, push, paint) virtual objects makes sense to people? This sounds simple at first, but there are many factors to consider. Consider what type of visual/audio feedback might be appropriate when a virtual object is touched/grasped/moved/inactive/etc. What even defines "picking up" an object or "activating" an object? Should the hand touch the object from two sides or more to pick it up like physical objects? Are fingers considered touching an object if it is inside it, or near the surface and how near? Should the system compensate for natural human behavior like wobbling when they are trying to manipulate an object? How should virtual objects interact with physical objects in terms of weight, collision, or movement? How can objects be created (painted) from scratch by hand—what is a comfortable way to do this? How can a hand perform painting tasks as well as pointing/panning without confusing the two? How should painted objects be occluded, moved, or erased?

You do not have to find specifically answers to all of the above, but you should be trying to figure out a "language" for manipulating (grasp, move, push, paint) objects that can be described in enough detail for an unimaginative but competent programmer to build. Basically, plan from the beginning a study procedure that allows you to get answers to the research question—

the Design readings should be helpful here. Finally, come up with one other smaller research question you can include in the protocol. Something about collaborating with others, or how people might want to comfortably virtual people, or something else of your choosing. Prepare a protocol that asks thoughtful probing questions to participants as they are performing tasks that you instruct them to do.

2   Preparing Your Study Protocol

A study protocol should provide all the tools for another experimenter to run the study and achieve similar outcomes. It should give instructions for the experimenter to set up the study, include the informed consent form and any questionnaires to be given to the participants, describe the tasks that the participants should do (including what their goal should be), explain what the experimenter should observe, and so forth. How should the experiment be captured (as written notes, audio, or video)? Basically, this should be something that can be handed off to another person to run the study without you being there, while producing similar outcomes (what we have called **realibility**). You will compensate your participants with $5 for about half an hour of their time.

Before writing the study protocol, you will have to decide what the aims of the study are—what questions should it explore or answer? Consider how you will preserve **construct validity**. A core principle of experience prototyping is to put the participant in the right mindset, so that they basically forget about that they are using a prototype and instead are imagining the experience you want them to. The prototype (Portalble) is just a prop to get them to get a sense of the experience. The Design readings should be helpful for understanding experience prototyping. As you are writing the study protocol, try to imagine how the participant will respond to the various instructions or questions you give them throughout the study.

This is a assignment that will lead to better outcomes if you iterate a few times on the study protocol!

Logistics: On March 22, we will do a check in where you should have completed your study protocol draft (protocol swap activity). After this date, you should try to recruit participants before Spring Break to do the study after Spring Break. You will be able to schedule time in a room and have access to the Portalble prototype for your study using [TBD: Jing's spreadsheet schedule]. After Spring Break, you will be running your study and then writing the "design implications". By April 10 before class, hand in your protocol files, notes/recordings during the study, and the design implications. Your grade will be based on the comprehensiveness of the study protocol for an experimenter to reproduce the study (7 points), the ability of your study to address the main research question (7 points), and the utility and appropriateness of your design implications (4 points) for a total of 18 points.

Will you be the one to design the future of mixed reality? Or will your best line be "I almost thought of that."