

What is your professional background and how long have you had experience with augmented reality (AR)?

I am a developer for AR and VR applications. I have experience with different platforms, like the HoloLens, MagicLeap, AR core and AR kit for mobile devices. I have also tried the DAQRI device, which is no longer distributed. I also tested Google Glass. Google Glass is just a head up display with a camera and cannot interact with the environment. I have experience with various VR headsets and attend conferences in the AR/VR field. I would say I have 3 to 4 years of experience in AR.

Do you feel that you have successfully completed all tasks on the test sheet?

Thanks to my experience with the HoloLens, I was able to perform the tasks successfully. I have noticed that the instructions include the gestures for operating the HoloLens (Bloom, AirTap). Someone who uses the HoloLens for the first time does not know what the Bloom gesture is or how AirTap works. Before using the app, it would be great to explain the HoloLens to new users. I suppose that first time users would be overwhelmed without this introduction. New users should also be made aware of the limited FOV and that the field of view is only in the middle of the headsets screen and they cannot expect any projection at the edges of the image.

How would you rate the visual quality of the application? Were all options and information you expected available?

Yes, the actions required by the testing guideline were doable. For some UI elements it was not clear whether they were buttons or just labels. You will probably notice this depending on your experience level.

Should interactive and non-interactive UI elements be visually better distinguishable?

Yes, the headlines of the menus were visually almost the same as the interactive buttons. This could lead to the assumption that they were also selectable. Furthermore, I noticed that the colliders of the 3D models are larger than the actual model. This can lead to an issue if you want to select a visible menu item behind the model, but it is hidden by the box collider of the model and therefore cannot be selected. This is because the collider boxes are adapted to the bounding boxes that allow scaling and rotating the models.

Do you have any suggestions for a better design of the collider boxes?

Capsule collider instead of box collider would be an option. A mesh collider would be ideal, but these require higher computing power. Missing corners to manipulate the holograms could also be an issue with mesh colliders. Here a manipulation with both hands instead of the bounding box would be necessary. This again, is a learning factor and must be supported by the hardware. It might be possible to activate the collider with the bounding box by pressing a button.

Interaction with holograms, which allow scaling and rotating the models by pulling with both hands, was found to be very intuitive by both the focus group and the other test users. What is your impression about interaction with holograms. Would replacing the bounding box with two-handed interactions be more intuitive?

I think the interaction with holograms by manipulating them with 2 hands or fingers comes from interaction with smartphones. So, users interacting with a hologram expect to be able to touch it and pull it apart to resize it. This is intuitive because of the experience with smartphones.

Was the operation of the bounding box working? Was it intuitive and did it give enough feedback on user input?

The bounding box is only intuitive for people with experience, otherwise it can be learned by trial and error. New users should be shown how to control the HoloLens and how to use the application.

Some form of introduction or tutorial for new users would be important?

Yes, otherwise the user can quickly become frustrated.

It is planned to use the application in an educational setting. Are hands on tutorials necessary or could this also be brought closer by for example, an instructional video?

It does not necessarily have to be Hands on with a trainer. It might be possible to create interactive tutorials directly on the HoloLens to teach new users the gestures and how they work. It is important to explain the importance of the hand position, if it gets out of the HoloLens' field of vision, gestures do not work anymore. Details such as too low a hand position or twisting the hand can lead to gestures not being recognized. The menu navigation in the app should also be explained to new users. For example, that the menu can be pinned so that the menu does no longer follow the users gaze.

Did the application provide enough feedback for your inputs?

Yes, you could see which items were selected in the menu. One possibility would be that a model selected for moving it around the users' space, could also give visual feedback and be highlighted after selection. Now, it is visible to the user when the gaze cursor is placed on the object, but an additional highlighting of the object could be helpful.

Do you think new users would recognize the gaze cursor's interactivity label?

I worked on a mobile AR application that deals with strabismus. Here we tested interaction prompts in the form of visual highlights, haptic and audio feedback. Visual prompts were better received than haptic or audible feedback.

Would extended audio feedback, in addition to the clicking noise by pressed buttons be useful?

Too much sound, such as when moving objects, does not make sense. At most maybe, when selecting a 3D object, a short minimal audio feedback to confirm the selection could be helpful. Like the clicks of the buttons.

Would you consider such an application useful in the training of radiographers?

I think it does make sense. However, feedback on positioning would be important, to also draw attention to possible mistakes. I would see it as an additional teaching tool and not as a substitute for on-site teaching. On site teaching offers the advantage, that experienced trainers can pass on their knowledge. As an independent training possibility, such an application is certainly useful.

How was your impression of the application compared to other HoloLens applications?

As an experienced user, there were no complicated procedures to perform. In the first version I did not notice some the content due to objects being outside the FOV. After the update, objects were displayed directly in front of the user.

How do you see the connection between hardware and software limitations of this application on the HoloLens?

An application must always be programmed around the hardware limitations. If I don't have objects in my FOV, the application will not work for me. If the room is darkened, the holograms work better.

Was the hologram transparent enough? Was the brightness adjustment of the HoloLens useful?

If you know that there are hardware buttons, they are enough for brightness control. Every additional menu interaction on the HoloLens is exhausting. Especially keyboard input should be avoided. In general, voice input should be used instead of keyboard inputs.

Will the new interaction possibilities of HoloLens 2 provide more intuitive operation?

Yes, thanks to the more precise hand tracking, and after a short ten-minute test of the HoloLens 2, I believe that the operation is more intuitive. Instead of using gauze and Air Tap, you can interact with objects directly, just like on a smartphone. Another exciting feature is the remote rendering to stream models with higher quality to the HoloLens. Especially the HoloLens 1 is very limited in computing power.

Were the holograms stable enough in the real space? Was the frame rate enough? Was the visual quality of the holograms enough?

Yes, visually the holograms were attractive. The performance was enough, 60 FPS are not necessarily required for this application. I would not have noticed any stutter.

Are there any remarks or comments on topics we have not discussed?

Maybe the use of hand tracking on an Oculus headset could help to check the positioning of the body parts to give the users feedback on the positioning. Since AR devices are rare, a VR version of the application would also make it more accessible to more users.