DHRUV GARG 16 BCE 1190

HUMAN COMPUTER INTERACTION

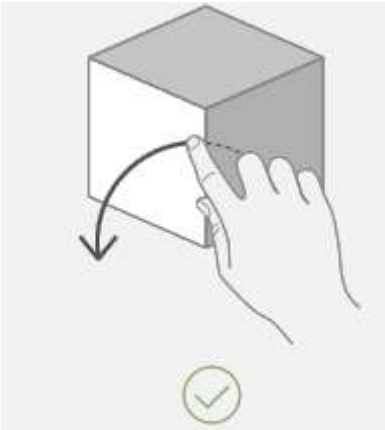
DIGITAL ASSIGNMENT 2

QUESTION: AR, VR and Mixed Reality User Interface - Best Practices, Current trends, Software and tools, Testing Labs and Mobile interface developments

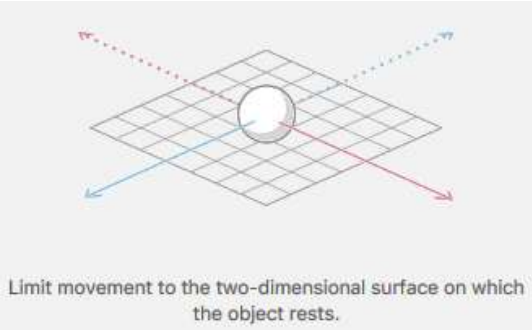
1. AUGMENTED REALITY

BEST PRACTICES (developer.apple.com)

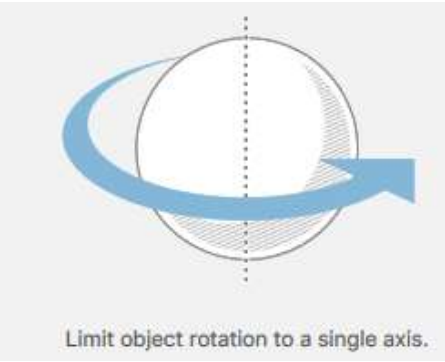
1. **Designing an Engaging Experience**
    a. Use the entire display
    b. Create convincing illusions when placing realistic objects.
    c. Anticipate that people will use your app in environments that aren't optimal for AR.
    d. Be mindful of the user's comfort.
    e. If your app encourages user motion, introduce it gradually.
    f. Be mindful of the user's safety.
    g. Use audio and haptic feedback to enhance the immersive experience.
    h. Wherever possible, provide hints in context.
    i. Consider guiding people toward offscreen virtual objects.
    j. If you must display instructional text, use approachable terminology.



2. **Entering Augmented Reality**
    a. Indicate when initialization and surface detection is in progress and involve the user
3. **Placing Virtual Objects**
    a. Help people understand when to locate a surface and place an object
    b. Respond appropriately when the user places an object.
    c. Avoid trying to precisely align objects with the edges of detected surfaces.



4. **User Interaction with Virtual Objects**
    a. Favor direct manipulation over separate onscreen controls.
    b. Allow people to directly interact with virtual objects using standard, familiar gestures.
    c. In general, keep interactions simple.
    d. Respond to gestures within reasonable proximity of interactive virtual objects.
    e. Be wary of potentially conflicting gestures.
    f. Make sure virtual object movements are smooth.
5. **Reacting to Imagery in the User's Environment**
    a. Design and display reference images to optimize detection.
    b. Use detected imagery only as a frame of reference for displaying virtual content.
    c. Limit the number of reference images in use at one time.
6. **Handling Interruptions**
    a. Avoid unnecessarily interrupting the AR experience.
    b. Use relocalization to recover from other interruptions.
    c. Consider hiding previously placed virtual objects until relocalization completes
    d. Allow users to cancel relocalization.



7. **Handling Problems**
    a. Allow users to reset the experience if it doesn't meet their expectations.
    b. Suggest possible fixes if problems occur.
    c. Offer AR features only on capable devices

CURRENT TRENDS in Augmented Reality

1. **Education**

    New apps are helping to supplement course material in engaging, decidedly more interactive ways. JigSpace, for example, lets kids explore virtual 3D models of objects on a table. By setting up portals around the room, teachers have ready-made learning stations. Kids can leap from the classroom to an underwater world to study whales while filling in workbooks.

2. **Head-Up Displays**

    Head-Up Displays (HUDs) are perhaps the first useful deployment of AR in the marketplace. HUDs now adorn models from BMW, Volvo, Chevy, Lexus, and many others. There's also a thriving aftermarket offering stick-on HUDs that interface with a car's OBD-II port to display vital information like speed and gas mileage without requiring drivers to take their eyes off the road.

3. **Healthcare**

    Healthcare is a prime candidate for AR adoption precisely because its a field that requires individuals to make important decisions on the fly with available information. Just as surgeons have adopted robots to enhance the uncanny dexterity of humans, the industry is looking at novel uses of heads up displays and wearables to enhance the decision-making capabilities of people that are often under stress and under the gun.

4. **Mobile sales**

    As AR penetration grows, it'll kick off a new arms race among suppliers to create better-equipped phones and inject new life into an industry that's starting to plateau.

5. **Enterprise training**

    Honeywell recently announced a mixed-reality simulation tool to train its industrial employees. "Many studies on millennials show that they are looking for more experiential learning," according to Honeywell's blog. The company's Skills Insight Competency trains and tests operator competency in a real plant, guiding trainees' decision-making and capturing performance data via HoloLens headsets.

6. **Grocery shopping**

    A company called Dent Reality has been working on an app that allows customers to see real-time information about products in grocery stores. It uses computer vision and in-store tracking to help customers find food that fits their dietary needs.

7. **Interior design**

    Now you can use IKEA Place, a pioneering AR app from the flatpack king that allows users to virtually place furniture in any space (even on the street). You can now walk through your living room and see definitively that no, that sofa would look terrible there!

8. **Location-based advertising**

    In April Facebook began letting developers build AR apps that contain location-triggered elements. There are lots of potential applications, but you can be sure the first and most prolific will involve marketing to users in the real world.

9. **Museums**

   Looking for any way to attract visitors, museums have been early adopters of the AR experience, which really is just a high tech twist on the good ol' fashioned audio tour.

10. **The AR mirror**

    Allow shoppers to try on clothing virtually before they buy it. The technology will soon solve a vexing problem with online shopping: How to ensure a good fit when you only have model photos to go on.

11. **Home buying**

    Sotheby's International Reality recently launched its Curate app. Much like IKEA's furniture app, Curate lets prospective buyers virtually place the furniture of their choice in commercial or residential spaces they may be looking to buy or lease.

SOFTWARE, TOOLS AND TESTING LABS

Open source:

a) **ApertusVR** is an embeddable, open-source (MIT), framework-independent, platform-independent, network-topology-independent, distributed AR / VR / MR engine
b) **Argon**, augmented reality browser by Georgia Tech's GVU Center
c) **ArUco**, a minimal library for augmented reality applications based on OpenCV
d) **ATOMIC Authoring Tool**, a multi-platform authoring for creating AR applications on Microsoft Windows, Linux and Mac OS X operating systems
e) **GeoAR**, open source (Apache 2.0 License) browser for Android

Proprietary:

I. AR Development toolkits
   a. **ARCore**, a Google SDK, currently designed exclusively for Android 7.0+ app creation.
   b. **ARKit**, an Apple SDK, currently designed exclusively for iOS 11+ app creation
   c. **MAXST AR SDK** is an AR SDK for mobile and PC platforms.
   d. **Catchoom CraftAR AR SDK** is an iOS and Android SDK that renders Augmented Reality experiences with plugins for Cordova and Unity

II. AR content management systems
   a. **Augment**, a web based platform for managing 3D models and creating augmented reality experiences.
   b. **Webcam Social Shopper**, software for integrating apparel visualization on e-commerce sites.
   c. **Hoppala Augmentation**, a web-based content platform for creating geolocation-based mobile augmented reality.

MOBILE INTERFACE DEVELOPMENTS

2. VIRTUAL REALITY

BEST PRACTICES – For VR applications (developer.oculus.com)

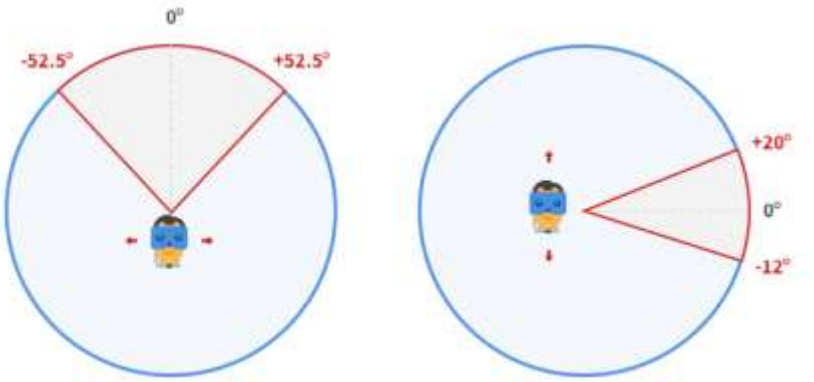
1. Stereoscopic UI Rendering

In VR, everything must be rendered from two points of view -- one for each eye. When designing and implementing VRGUIs, frequent consideration of this fact can help bring problems to light before they are encountered in implementation. It can also aid in understanding the fundamental constraints acting on VRGUIs.

2. The Infinity Problem

Projecting the HUD requires the user to focus on infinity when viewing the HUD. This effectively places the HUD behind everything else that is rendered, as far as the user's brain is concerned. This can confuse the visual system, which perceives the HUD to be further away than all other objects, despite remaining visible in front of them. This generally causes discomfort and may contribute to eyestrain.

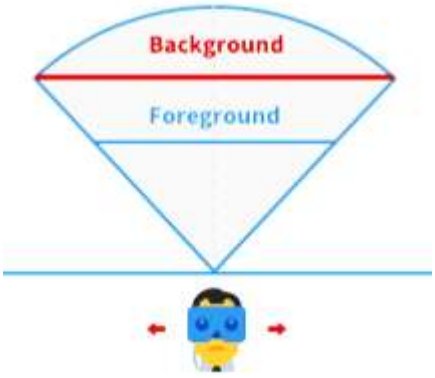
Orthographic projection should be used on individual surfaces that are then rendered in world space and displayed at a reasonable distance from the viewer. The ideal distance varies, but is usually between 1 to 3 meters. Using this method, a normal 2D GUI can be rendered and placed in the world and the user's gaze direction used as a pointing device for GUI interaction.



3. Depth In-Depth

In many 3D applications, it is difficult, even impossible, to guarantee that there will always be enough space in front of the user's view to place a GUI without it being coincident with, or occluded by, another rendered surface. There are some practical solutions to this:

a. Render the VRGUI surfaces in two passes, once with depth pass and once with depth fail, using a special shader.
b. Project the VRGUI surfaces onto geometry that is closer than the ideal distance.
c. Move the user to another scene when the VRGUI interface comes up.
d. Stop rendering the world stereoscopically, i.e., render both eye views with the same view transform
e. Treat VRGUIs as actual in-world objects.



4. Gazing Into Virtual Reality

Like many things in VR, the use of gaze to place a cursor has a few new properties to consider. First, when using the gaze direction to select items, it is important to have a gaze cursor that indicates where gaze has to be directed to select an item. The cursor should, like all other VR surfaces, be rendered stereoscopically.

There are several approaches to handling this issue:

a. Close the interface if it goes outside of some field of view from the user's perspective.
b. Automatically drag the interface with the view as the user turns, either keeping the gaze cursor inside of the interface controls, or keeping it at the edge of the screen where it is still visible to the user.
c. Place an icon somewhere on the periphery of the screen that indicates the user is in menu mode and then allow this icon to always track with the view.

BEST PRACTICES – For VR Gaming (unity3d.com)

1. **UI Resolution and Appearance**
   As the resolution on DK2 is 1920 x 1080 (960 x 1080 per eye), and the Gear VR is 2560 x 1440 (1280 x 1440 per eye), this can lead to some noticeable pixelation on anything that occupies a few pixels in width or height.
   Of particular note are UI elements; bear in mind how large these will appear on-screen. One approach is to use larger or bold fonts, and designing UI without thin lines that can become pixelated when viewed in VR.

2. **Types of UI**
   a. Non-diegetic
      In non-VR projects, UI is frequently overlaid on top of the screen to show things like health, score, and so on as what we often refer to as a HUD (Heads Up Display). This is known as non-diegetic UI - it doesn't exist within the world, but makes sense for the player in the context of viewing the game.

   b. Spatial UI
      Instead, we generally need to position our UI within the environment itself using World Space Canvas render mode. This will allow our eyes to focus on the UI. This is known as Spatial UI.
      Placement of the UI within the world also needs some consideration. Too close to the user can cause eye strain, and too far away can feel like focussing on the horizon - this might work in an outdoor environment, but not in a small room. You'll also need to scale the size of the UI accordingly, and perhaps dynamically depending on your needs. If possible, it's best to position your UI at a comfortable reading distance, and scale it accordingly.

   c. Diegetic UI
      An alternative to Spatial UI is to have elements in the environment itself display information to the user. This could be a working clock on the wall, a TV, computer display, mobile phone, or a holographic display on a futuristic gun. This is known as Diegetic UI.

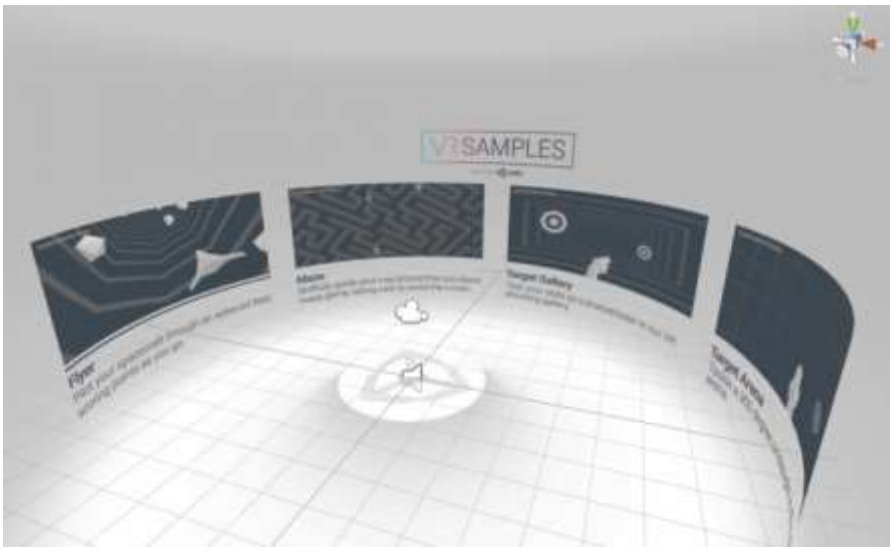


Figure: *Menu option for VR*

CURRENT TRENDS In Virtual Reality

1. **Expect to see more 360° VR videos**
   The Omnivirt study also found that besides the fact that brands using 360° videos were spread across all verticals, content quality is improving every year.
   Major brands that have used VR and 360° videos include NASA, Microsoft, IBM, Honda and Ford. In fact, Youtube's channel dedicated to 360° videos now has almost 3 million subscribers.

2. **We will see more VR adoption in advertising**
   Last year Google announced its experiment with virtual reality ads that react to users' eyes, Infiniti formed an alliance with OmniVirt to let people virtually test drive the Q60 using 360° VR video.

3. **A rise in VR developers**
   There is no stopping this beast, however, so you can expect an increase in demand for developers with VR skills.

4. **A more immersive experience**
   Perhaps more important is the fact that VR will get even realer — in other words, we can look forward to development that will lead to a more immersive experience.

5. **Increased availability, and reduced cost, of VR products**

SOFTWARE, TOOLS AND TESTING LABS

Desktop Tools

- **a.** Unity 3D
- **b.** SketchUp - By Google
- **c.** Blender
- **d.** Unreal Engine (UE4)
- **e.** 3DS Max & Maya

WebVR Tools

- **f.** Three.js
- **g.** A-Frame
- **h.** React VR
- **i.** Vizor.io
- **j.** JanusVR
- **k.** JanusWeb

MOBILE INTERFACE DEVELOPMENTS

3. MIXED REALITY

BEST PRACTICES – (docs.microsoft.com)

1. **The user is the camera**
   Always think about design for your user's point of view as they move about their real and virtual worlds.

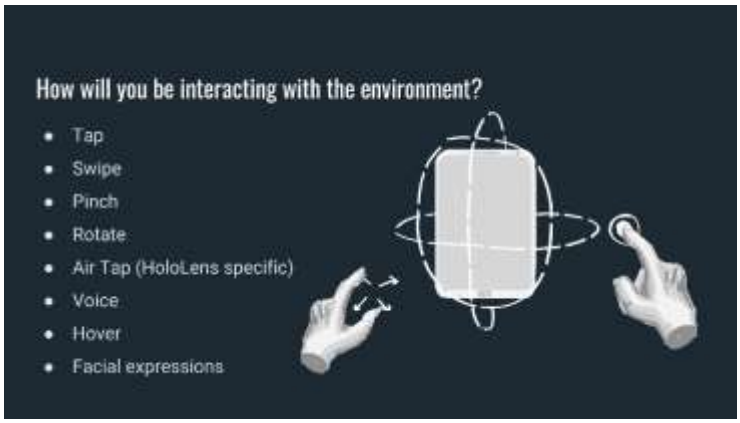
   a. Some questions to ask
      i. Is the user sitting, reclining, standing, or walking while using your experience?
      ii. How does your content adjust to different positions?
      iii. Can the user adjust it?
      iv. Will the user be comfortable using your app?

   b. Best practices
      i. The user is the camera and they control the movement. Let them drive.
      ii. If you need to virtually transport the user, be sensitive to issues around vestibular discomfort.
      iii. Use shorter animations
      iv. Animate from down/left/right or fade in instead of Z
      v. Slow down timing
      vi. Allow user to see the world in the background

   c. What to avoid
      i. Don't shake the camera or purposely lock it to 3DOF (only orientation, no translation), it can make users feel uncomfortable.
      ii. No abrupt movement. If you need to bring content to or from the user, move it slowly and smoothly toward them for maximum comfort. Users will react to large menus coming at them.
      iii. Don't accelerate or turn the user's camera. Users are sensitive to acceleration (both angular and translational).

2. **Leverage the user's perspective**
   a. The user may need to be guided to help locate important events or objects beyond their immediate view.
   b. You can use arrows, light trails, character head movement, thought bubbles, pointers, spatial sound, and voice prompts to help guide the user to important content in your app.
   c. It is recommended to not lock content to the screen for the user's comfort. If you need to keep content in view, place it in the world and make the content "tag-along" like the Start menu. Content that gets pulled along with the user's perspective will feel more natural in the environment.

3. **User comfort**
   a. To ensure maximum comfort on head-mounted displays, it's important for designers and developers to create and present content in a way that mimics how humans interpret 3D shapes and the relative position of objects in the natural world.
   b. From a physical perspective, it is also important to design content that does not require fatiguing motions of the neck or arms.



CURRENT TRENDS in Mixed Reality

These are the three major trends that are notified **by Microsoft** on Mixed reality

1. **Augmented Reality + Virtual Reality**
   These technologies do not need to be mutually exclusive because they can be complementary since one size fits all is rarely the case. This also means scenarios will bridge across form factors, igniting experiences and collaboration on platforms vs hardware alone. Some things we may expect to see:
   a. Practitioners reviewing scans in-person using AR while connecting a remote colleague to collaborate from their office using VR
   b. Bringing hospitalized patients with limited mobility together with their loved ones who may be remotely interacting in their physical space at home

2. **Mixed Reality + Artificial Intelligence**
   Mixed Reality and Artificial Intelligence are driving fundamental shifts that are redefining the future of computing.
   a. Vision – We may see assisted identification, understanding and labelling of the things we are working on (in plain view) – organs, tools, people – assisting us at navigating our work
   b. Speech – We may see this enable those with hearing impairment to more easily engage with the world around them, converting spoken audio to text in real time
   c. Language – We may use natural language processing to enable real-time audio translations between patients and caregivers who speak in different native tongue

3. **Immersive Communication**
   Immersive communication will let us have real-time and photo realistic holograms of the people we are speaking with. Immersive communication will enhance our ability to achieve digital presence. Communication becomes more natural when we are speaking to a photo realistic hologram of someone in real time.

4. **Mixed Reality + Internet of Things (IoT)**
   Combining IoT data with the visualization capabilities of mixed reality will continue to evolve the way we interpret, track and interact with data from near and far.

SOFTWARE, TOOLS AND TESTING LABS

I. Windows Mixed Reality Developer Kit
II. Other Microsoft tools
   a. HoloLens emulator
   b. Visual Studio
   c. Vuforia
III. Unity3D

MOBILE INTERFACE DEVELOPMENTS