

Question 1 (1 point)

Runkeeper is a popular mobile app that tracks your running, walking, cycling, and other fitness activities. It presents the data in a typical social mobile app interface, allowing you to view your progress over time and share your accomplishments with friends. During the fitness activity, you can also view several real-time metrics such as distance, pace, and time overlaid on a 2D map view of your current location.

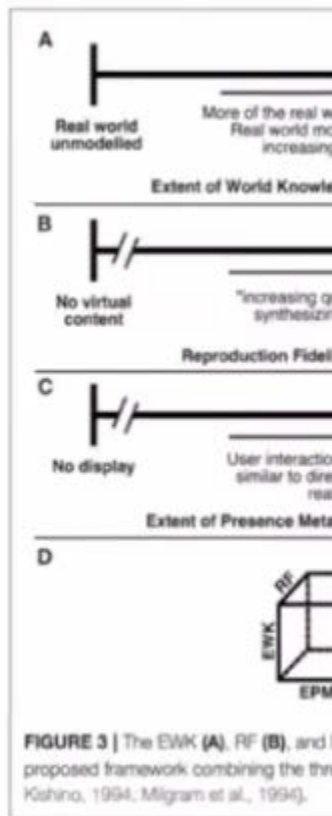
Considering the features described, in which dimension of the original Milgram-Kishino's RV continuum will this application have the highest (rightmost) value?

You can view the YouTube video below to get an idea of the app features.

Runkeeper Features: <https://youtu.be/1b8OkEcsMrw>

(Acronyms are based on papers related to the RV continuum, also shown in class.)

- ☐ RF
- ☐ IM
- ☐ CO
- ☐ EPM
- ☒ EWK



Question 2 (1 point)

Pragmata is an upcoming game set in a dystopian future where you control a space-suited character exploring a desolate cityscape. The stunning graphics clearly aim for realism, capturing intricate textures, lighting, and environmental effects. It targets the latest gaming consoles and high-end PCs and you control the character using typical desktop peripherals and console controllers.

Considering the features described, in which dimension of the original Milgram-Kishino's RV continuum will this application have the highest (rightmost) value?

You can view the YouTube video below to get an idea of the app features.

Pragmata Trailer (WARNING: contains some robotic violence. You can actually answer this question solely from the description above.): <https://youtu.be/8-N5fYjhQO8>

☐ CO

☐ IM


☒ RF

☐ EWK

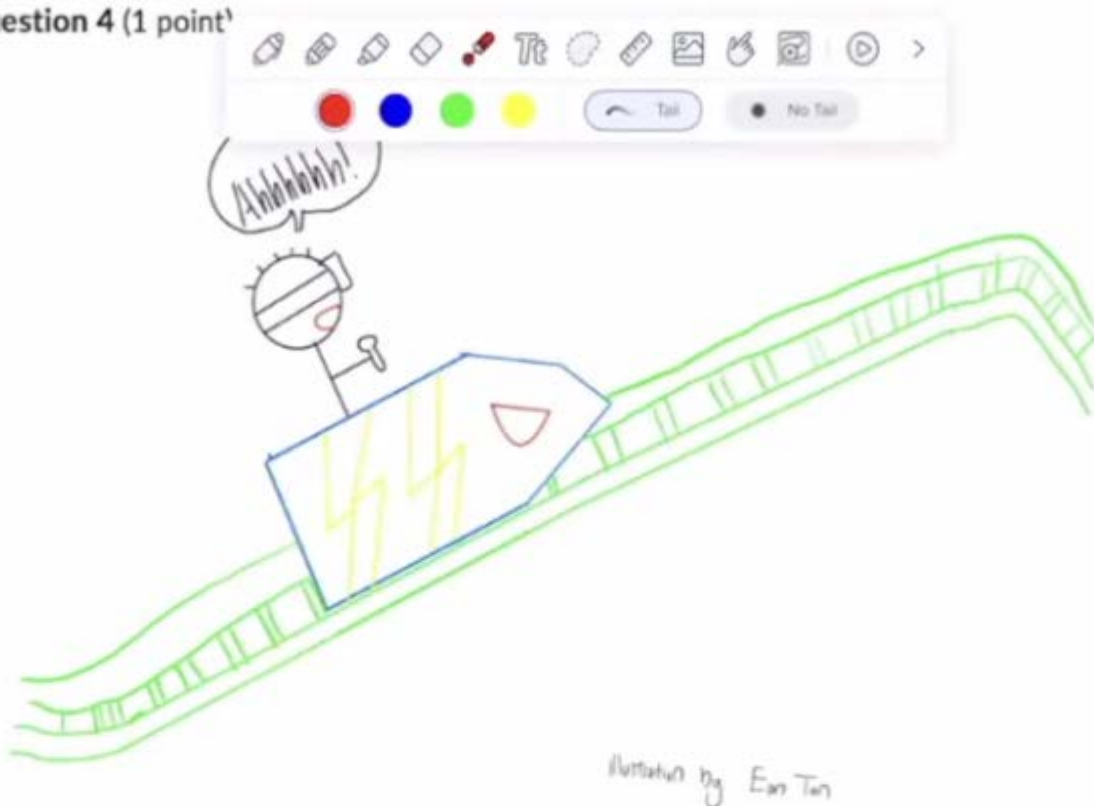
☐ EPM

Question 3 (1 point)

Which of the following is/are characteristic experiential dimensions of presence known in current research literature?

- ☐ Loss of self-consciousness ←
 - ☒ Realness
 - ☐ Sense of Control ←
 - ☐ Effortlessness ←
 - ☐ Warped sense of time ←
 - ☒ Involvement
- 

Question 4 (1 point)



In a VR user study, this was an account from a participant: "My eyes feel very sore after a while during the VR rollercoaster experience."

Which dimension of cybersickness is this?

- ☒ Oculomotor
- ☐ Realness
- ☐ Involvement
- ☐ Nausea
- ☐ Disorientation

Question 5 (1 point)

Your UX team aims to improve feelings of involvement, realness and reduce feelings of disorientation and nausea. They will run user studies before and after some identified features are added to your existing VR application.

What is/are the possible famous validated questionnaires to use in the user studies, pertinent to the aims above, to aid in design decisions for your UX team?

- ☐ Flow State Scale (FSS)
- ☐ Systems Usability Scale (SUS)
- ☐ Igroup Presence Questionnaire (IPQ)
- ☐ Virtual Reality Sickness Questionnaire (VRSQ)
- ☒ Simulator Sickness Questionnaire (SSQ)

Question 6 (1 point)

When designing for immersion in the next version of our VR commuting simulator, I want to improve the experience of flow.

Which of the following is/are suitable approaches that translate this goal into implementation?

- ☐ add AI-driven human characters with realistic behaviors in the simulation
- ☐ implement real-walking locomotion (tracking actual walking in a room-scale setting) instead of the current walking-in-place locomotion
- ☒ implement GUI elements to present clear goals for the user to attain at every point of the commuting experience
- ☒ implement mechanics to structure the commuting experience akin to completing progressively challenging levels in a game setting
- ☐ implement teleportation locomotion instead of the current walking-in-place locomotion
- ☐ increase the visual fidelity of the graphics with custom physically based rendering shaders

Question 7 (1 point)

What sort of affordance will most likely occur when you strap on vive trackers on the hands and feet for an experienced VR user in a VR commuting simulator application with walking as the main interaction?

- ☐ The user will consciously use only the feet in his/her own way to navigate in the virtual environment
- ☒ The user will consciously use both the hands and feet in his/her own way to navigate in the virtual environment
- ☐ The user will reach out for a vive controller to use the thumbstick to navigate in the virtual environment
- ☐ The user will perform a natural walking action with the whole body to navigate in the virtual environment
- ☐ The user will consciously use only the hands in his/her own way to navigate in the virtual environment

Question 8 (1 point)

In designing an HMD, you want to make the generated virtual image look like it's further away.

What dimension(s) can you change to achieve this?

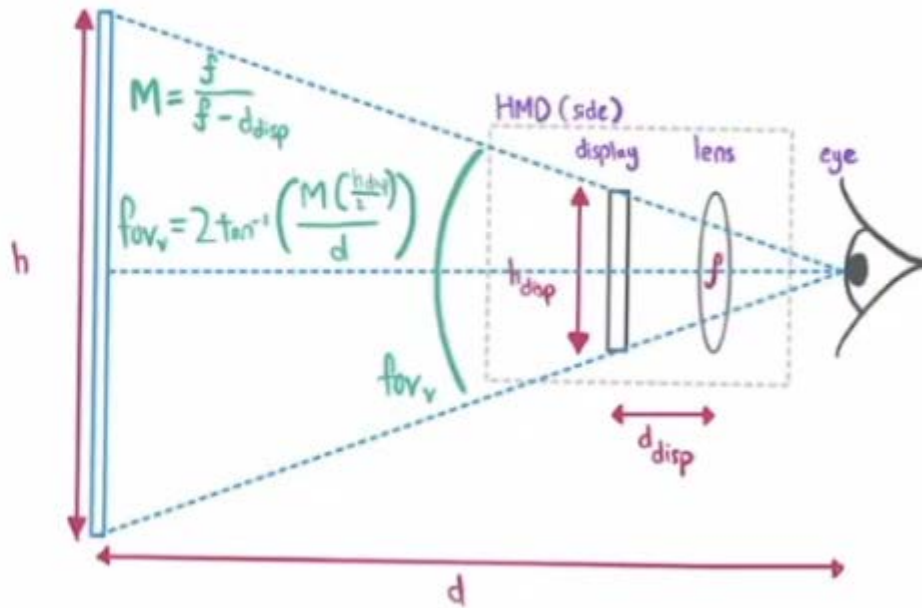
- ☒ Focal length of the lenses
- ☐ IPD between the lenses
- ☐ Height of the physical display
- ☒ Distance between the lenses and the physical display
- ☐ Eye relief
- ☐ Width of the physical display

Question 9 (1 point)

In designing an HMD, you want to expand the vertical FOV.

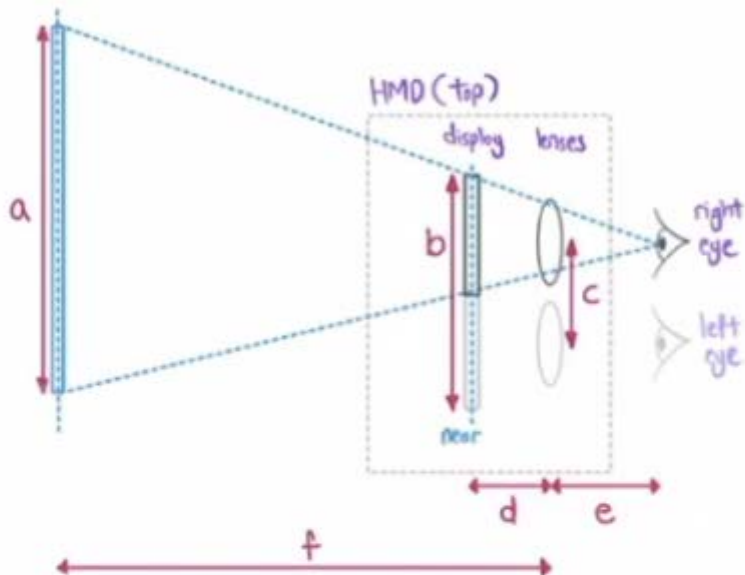
What dimension(s) can you change to achieve this?

- ☐ IPD between the lenses
- ☒ Distance between the lenses and the physical display
- ☒ Eye relief
- ☐ Width of the physical display
- ☒ Focal length of the lenses
- ☒ Height of the physical display



Question 10 (1 point)

In the schematic HMD diagram, where is the IPD?



☐ f

☒ c

☐ d

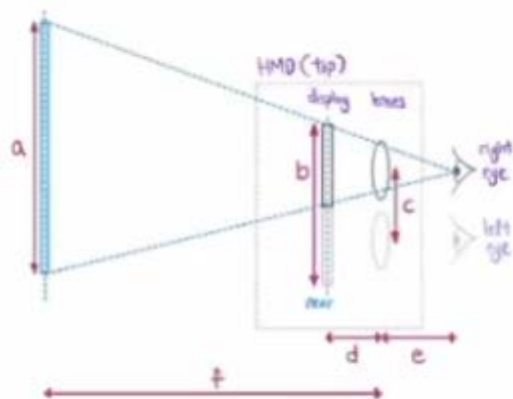
☐ a

☐ b

☐ e

Question 11 (1 point)

In the schematic HMD diagram, which value(s) will be changed if d was changed, in order to still maintain a correctly projected image that fully utilizes the display. Assume that the HMD hardware and the user wearing the HMD cannot be changed.



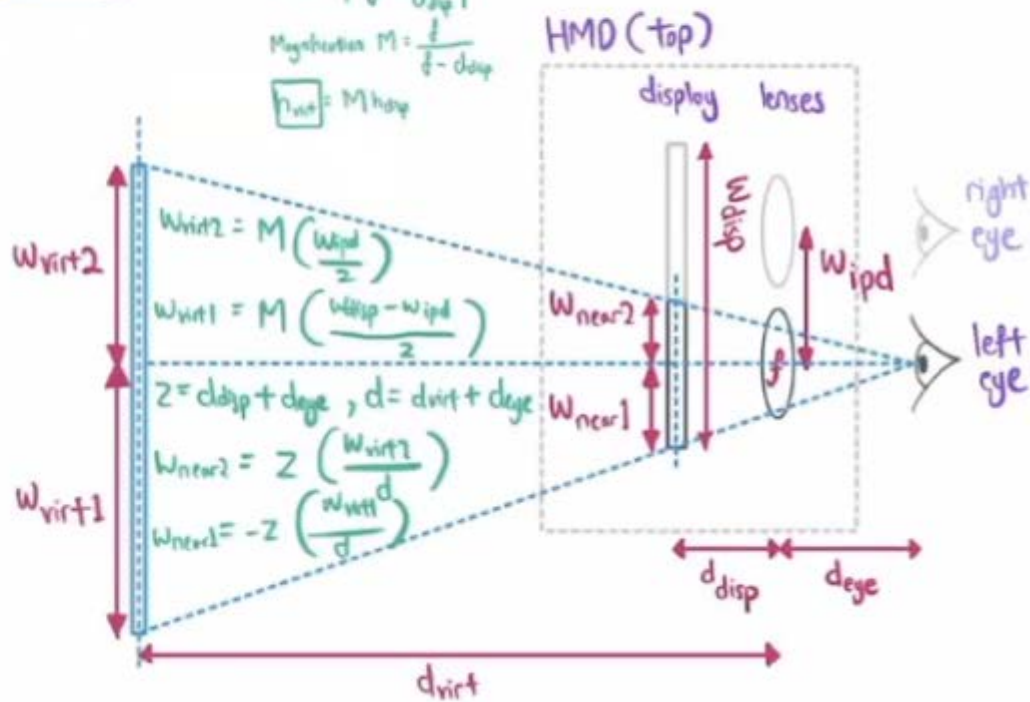
- ☐ c
☒ f
☐ e
☒ a
☐ b

$$\frac{1}{d_{net}} + \frac{1}{d_{obj}} = \frac{1}{f}$$

$$\boxed{\text{det}} = \left| \frac{1}{\frac{1}{d} - \frac{1}{d_{\text{no}}}} \right|$$

Magnification $M = \frac{d}{d - d_{\text{obj}}}$

$$\boxed{n_{\text{net}} = M \ln 2}$$



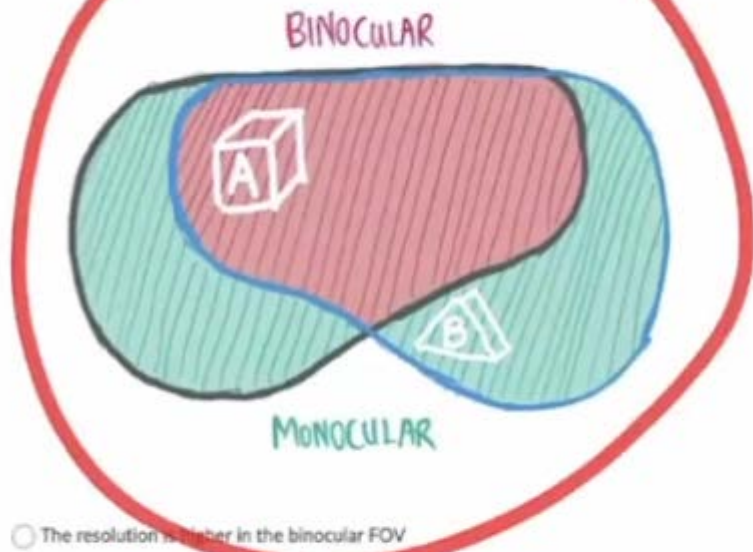
Question 12 (1 point)

What is a valid property of the view frustum generated by typical HMDs?

- ☐ View frustum is both vertically and horizontally symmetric
- ☐ View frustum is vertically asymmetric only
- ☒ View frustum is horizontally asymmetric only
- ☐ View frustum is both vertically and horizontally asymmetric

Question 13 (1 point)

Compared to object B, why is object A easier for the user to reach out and grab with his/her hands?



- ☐ The resolution is higher in the binocular FOV
- ☐ Humans see things more clearly near the top of the FOV
- ☒ Humans have a better sense of depth in the binocular FOV
- ☐ Humans have a better sense of depth using binoculars
- ☐ The binocular FOV is larger

Question 14 (1 point)

What is a result of reducing the eye relief?

- ☐ increased distance between lens to virtual image
- ☐ decreased distance between lens to virtual image
- ☒ increased FOV
- ☐ decreased FOV

Question 15 (1 point)

In your WebXR typescript-based app, you want to enable a new "npm run commit" command to run on the command line in your app directory. When run, this new command will build and commit+push latest changes to GitHub.

Name the file in your project directory you should amend to make this happen.



Question 16 (1 point)

You introduced a new `"/entities"` directory containing new source files for your Babylon.js project. To adhere to good programming practices, which file should you modify to reflect this?



Question 17 (1 point)

What effect does using the same projection matrix for both displays (or display partitions) for both eyes in a VR HMD have?

- ☐ This is ideal for a uniform perception across both eyes to reduce cybersickness symptoms
- ☐ The alignment across both eyes will reduce visual anomalies like ghosting or flickering.
- ☐ Head tracking accuracy may suffer, increasing the likelihood of cybersickness symptoms
- ☒ This results in a lack of depth perception
- ☐ The field of view will be enlarged

Question 18 (1 point)

```
1  createSkyBox(scene: Scene) {  
2      const skybox = MeshBuilder.CreateBox("skybox", { size: 1000.0 }, scene);  
3      const skyboxMaterial = new StandardMaterial("skybox-mat");  
4  
5      skyboxMaterial.backFaceCulling = true;  
6  
7      skyboxMaterial.reflectionTexture = new CubeTexture(  
8          "assets/textures/skybox",  
9          scene  
10     );  
11     skyboxMaterial.reflectionTexture.coordinatesMode = Texture.SKYBOX_MODE;  
12     skyboxMaterial.diffuseColor = new Color3(0, 0, 0);  
13     skyboxMaterial.specularColor = new Color3(0, 0, 0);  
14     skybox.material = skyboxMaterial;  
15 }
```

When running this code, we are unable to see the textures on the skybox, but we know that the textures are correctly loaded.

Which line needs to be fixed (refer to the line numbers on the left gutter of the code snippet) in order to see the textures?



Replace the entire line you identified with the correct code, with only the required changes reflected from the original text. Write this entire line in the next text box.



Question 15

Match the optimal scene construction approach based on the requirements listed in the question.

2

Develop a VR application to offer virtual house tours for potential buyers. The objective is to provide users with a sense of scale similar to viewing a real house. The only interaction involves navigating around the house at predetermined locations. Your company requires quick turnaround times to produce new tours for each house listed on your website.

1

Develop a VR application for training astronauts for space missions on unexplored planets, including simulating zero-gravity locomotion, driving rovers and examining mineral samples. Accurate vehicular operation and plausible hand interactions with the environment are crucial for the training experience.

1. Model-based
2. Image-based

1

Develop a VR application for training medical students on surgical procedures on simulated patients, including tasks such as making incisions, suturing wounds, and manipulating surgical instruments. Realistic hand interactions with equipment and accurate representation of anatomical structures are crucial for the training experience.

Question 20 (1 point)

Choose the correct statements related to implementation tools.

- ☒ Babylon.js can be used to build WebXR applications
- ☒ Babylon.js can be used to build web-based AR applications
- ☐ WebXR is an open-source 3D engine for building web-based XR applications
- ☐ Babylon.js is an open standard for programming web-based XR applications
- ☒ The Unity engine can be used to build WebXR applications
- ☐ WebXR is only meant for building desktop 3D web applications