Assignment 5

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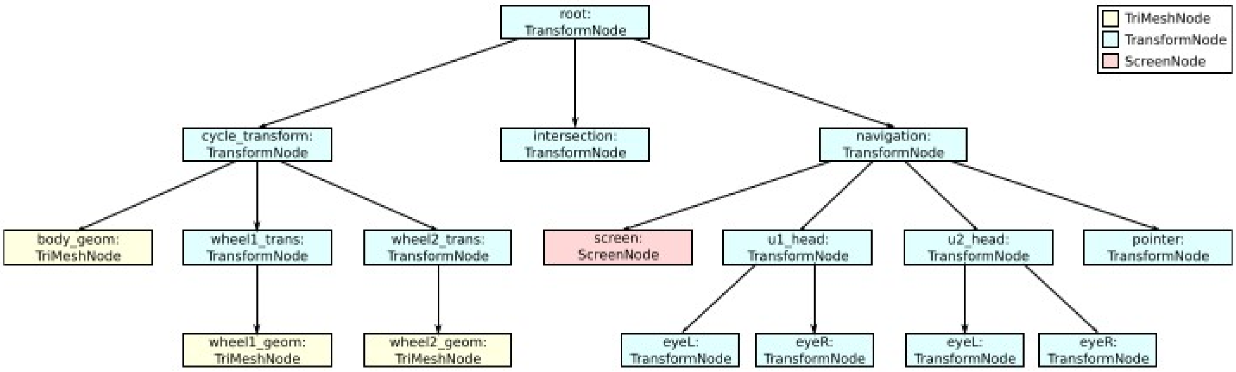
5.1



- You are given an arbitrary rotation matrix R and a rotation center defined by the intersection node. Apply the rotation correctly to the navigation node.

  navigation.T = R * inv(intersection.T) * navigation.T

- The pointer node defines the transformation of a tracked input device controlling a straight-line pick ray. The intersection node represents the intersection of the pick ray with the scene in world coordinates. Transform the intersection node into a coordinate system, in which the -z-translation component represents the distance of the pointer to the intersection.

  T = intersection.T * inv(navigation.T) * inv(pointer.T)

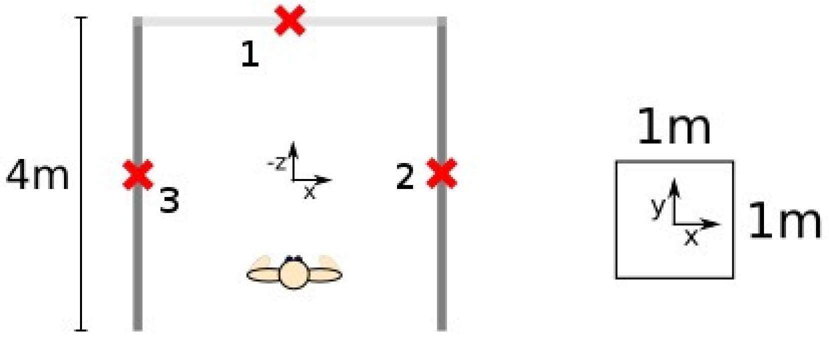
- You are given pointer.T in the last frame and the current frame, denoted by pointer_lf and pointer_cf, respectively. What is the delta matrix for which pointer_lf · delta = pointer_cf holds?

  pointer_lf.T * delta = pointer_cf.T
  delta = inv(pointer_lf.T) * pointer_cf.T

- Perform a Model-View-Transformation of wheel1_geom.

  inv(screen.T) * inv(navigation.T) * cycle_transform.T * wheel1_trans.T * wheel1_geom.T

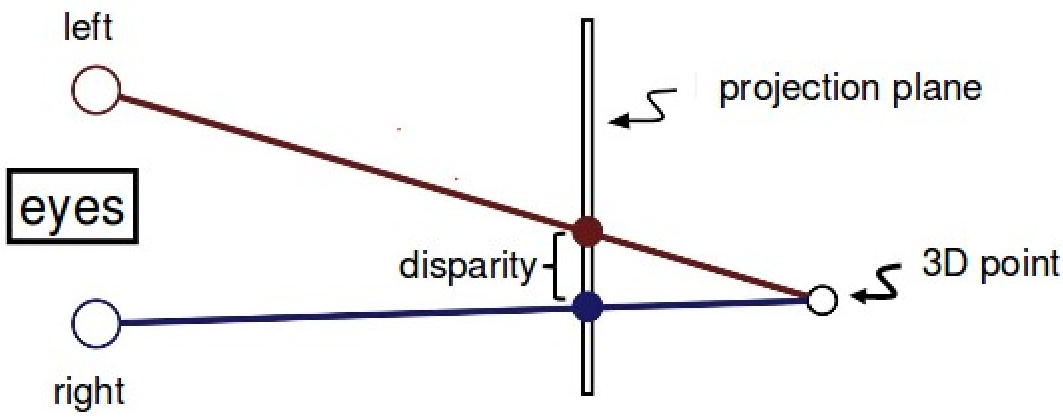
5.2.



screen_1.T = translate(0, 0, -2) * scale(4,2,1) * screen_org.T
screen_2.T = translate(0,0, 2) * rot(90, axis=(0,1,0)) * scale(4,2,1) * screen_org.T
screen_3.T = translate(0,0, 2) * rot(-90, axis=(0,1,0)) * scale(4,2,1) * screen_org.T

5.3

The average eye distance of a male adult is $6.5cm$ and hence set as a default in many setups for this gender. Given a projection screen with $4m$ x $2m$ in size and a resolution of 2560x1440, what is the maximum positive disparity a 3D point in the virtual environment can have on the screen? Provide this value in meters **and** pixels. As a result, how many depth levels behind the screen plane can be represented by this setup?



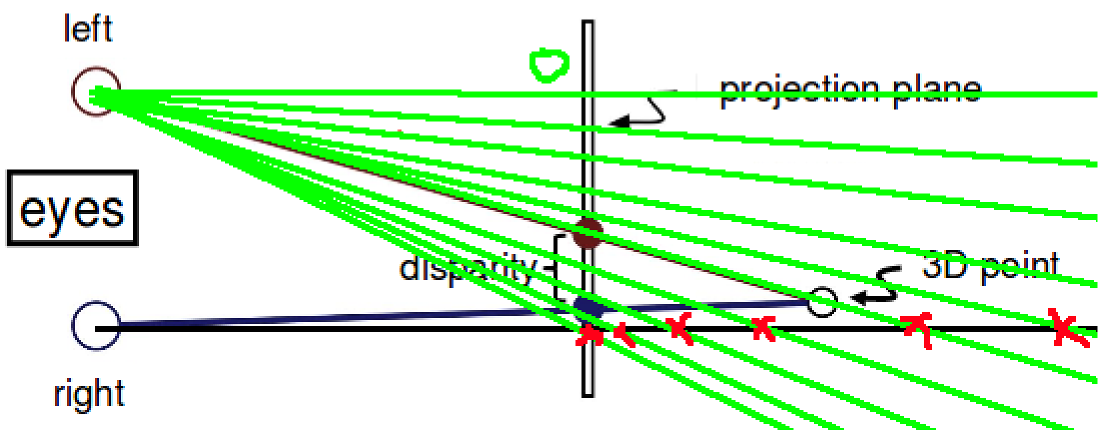
- when the 3d point approach infinity, the disparity values approach its maximum value, which is equal to the eye distance.

  => the maximum positive disparity in this case is 6.5 * 1e-2 meter.

- number of pixels per meter = 2560/4 = 640

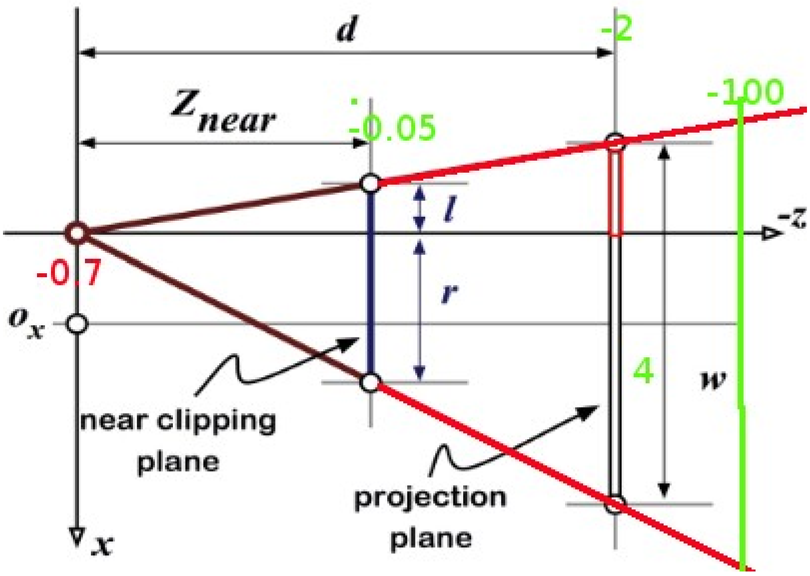
  => the maximum positive disparity = 6.5*1e-2 * 640 = 41.6 pixels

- the maximum number of depth levels in this set up: 41, which is the number of red points on the below picture. In other words, we shoot 41 green rays from the left eyes and then the red points are found as the intersection points between these green rays and the projection direction of the right eye.



5.4

In projection-based Virtual Reality setups, the user's head is tracked to allow for rendering the correct perspective onto the scene in each frame. This results in an off-axis frustum that needs to be parametrized correctly. As an example, an eye is located $2.0m$ in front of a projection screen with $4m$ x $2m$ in size. The eye is located $0.7m$ to the left of the projection plane's center, and the vertical height of the eye is $1.75m$. The clipping planes are set to $0.05m$ (near) and $100m$ (far). Illustrate the necessary formulas and compute the left and right boundaries of the viewing window.



$$\frac{l}{\boxed{o_x - \frac{w}{2}}} = \frac{z_{near}}{d}$$

$$l = \frac{\left(o_x - \frac{w}{2}\right) z_{near}}{d}$$

$$r = \frac{\left(o_x + \frac{w}{2}\right) z_{near}}{d}$$

l = ((-0.7 - 4/2) * 0.05) / 2 = -0.0675
r = ((-0.7 + 4/2) * 0.05) / 2 = 0.0325