CSE 333 - Monsoon 2023

Assignment 2: Modelling, Viewing and Projection

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1 QUESTION 1

a

- To move the camera along axes, we directly used position, glm::vec4 and set up x,y, and z using them only.
- On pressing keys, the position of the object is moving in camera space by a constant value(1.0f).
- setupViewTransformation() is called to get the position in camera view by glm::lookAt().
- Left and right arrows move the camera along -X and +X of the camera axes by 1.0f.
- Down and up arrows move the camera along the -Y and +Y of the camera axes by 1.0f.
- Shift + down/up arrows move the camera along the -Z and +Z of the camera by 1.0f.
- The look-at point is kept to be the world space origin (0,0,0) and the camera up- vector to the world vector (0, 1, 0). axes.

b

Using the a) functionalities only camera is moved to specific positions and generated one-point perspective, two-point perspective, and two three-point perspective views (bird's eye view and rat's eye view). The screenshots are attached.

Fig. 1. One Point Perspective

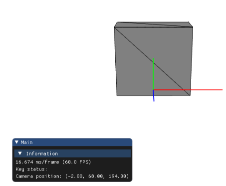

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Fig. 2. Two Point Perspective

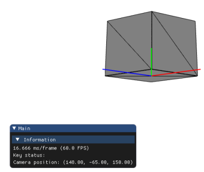


Fig. 3. Bird Eye Perspective

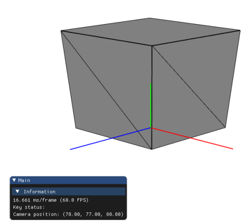
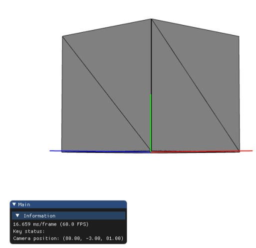


Fig. 4. Rat Eye Perspective



2 QUESTION 2

a

- ImGui::IsKeyPressed() function is used to detect keyboard keys.
- 'A' key is mapped for perspective projections whereas 'Z' key is mapped for orthographic projections.
- A global projection variable is defined which will help in setupProjectionTransformation(shaderProgram) to generate the correct type of projection
- If projection variable == 'O' then orthographic projections are generated otherwise perspective projections are generated.
- Using glm::ortho() and glm::perspective() functions, orthographic and perspective projections are generated respectively.

Fig. 5. Orthographic Projection

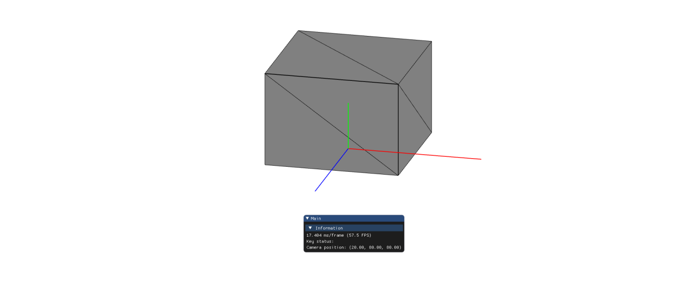
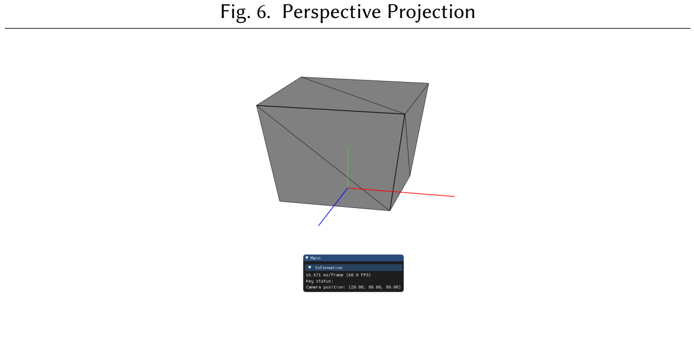


Fig. 6. Perspective Projection



b Top view, front elevation, and side elevation are generated accurately with a modifier key(cntrl key)

- Key mappings:
  - Top View: Cntrl + Up
  - Front Elevation: Cntrl+ Down
  - Side Elevation: Cntrl + Right Arrow

Fig. 7. Top View

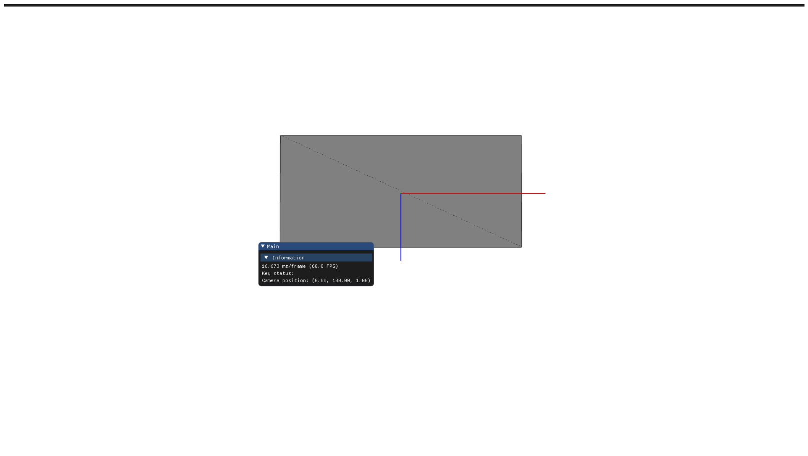


Fig. 8. Front Elevation

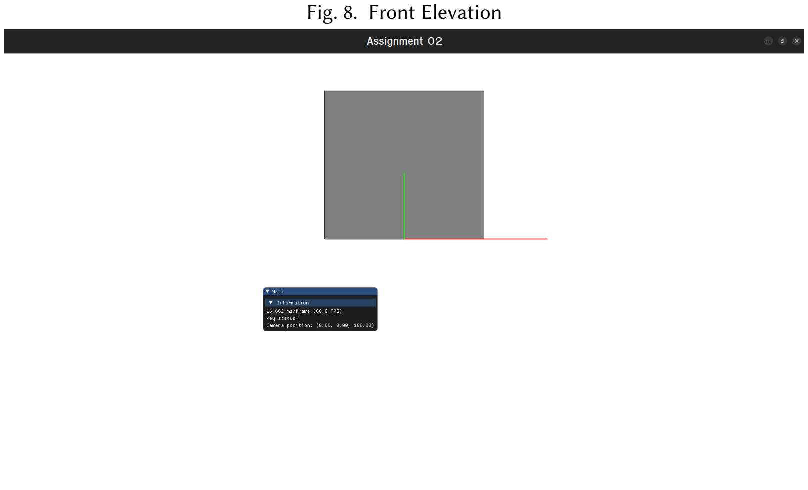
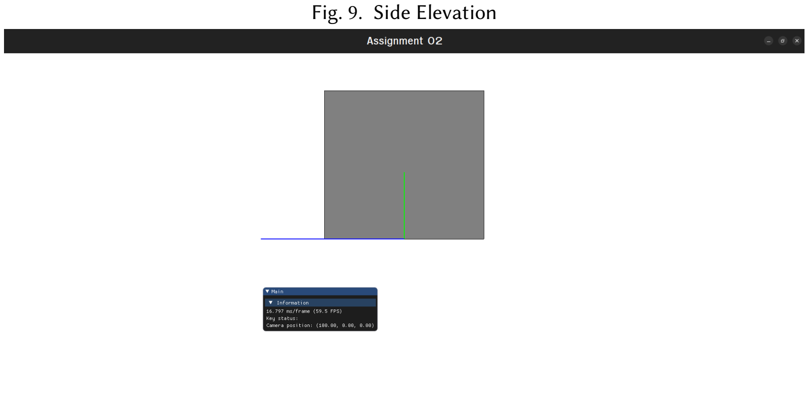


Fig. 9. Side Elevation



3 QUESTION 3

a Finding the inverse of the rigid body transformation.

- Given a rigid body transformation matrix:

$$T = \begin{bmatrix} R & t \\ 000 & 1 \end{bmatrix}$$

where R is a 3x3 rotation matrix and t is a 3-vector, we need to find T^{-1}
- Since $T.T^{-1} = I$, where I is the identity matrix, we can use this property to find T^{-1}.
- Let's assume that the inverse of T is:

$$T^{-1} = \begin{bmatrix} A & b \\ 000 & 1 \end{bmatrix}$$

- By multiplying T and T^{-1}, we get:

$$TT^{-1} = \begin{bmatrix} R & t \\ 000 & 1 \end{bmatrix} \begin{bmatrix} A & b \\ 000 & 1 \end{bmatrix} = \begin{bmatrix} R.A & R.b + t \\ 000 & 1 \end{bmatrix}$$

- Since $T.T^{-1} = I$, R.A must be the identity matrix and R.b + t must be the zero vector.
  - From $R.A = I$, we get , $A = R^{-1} = R^T$ (Since rotation matrix is an orthogonal matrix, the inverse of a rotation matrix is its transpose).
  - From $R.b + t = 0$, we get, $b = -R^{-1}t = -R^T t$.
- Therefore from above, we get the inverse of the transformation matrix :

$$T^{-1} = \begin{bmatrix} R^T & -R^T t \\ 000 & 1 \end{bmatrix}$$