Lecture slides (CT4201/EC4215 – Computer Graphics)

OpenGL: Interaction

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Computer Graphics
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User Interaction in Virtual World

- Camera transformation
  - A user changes his/her eye position, direction, …
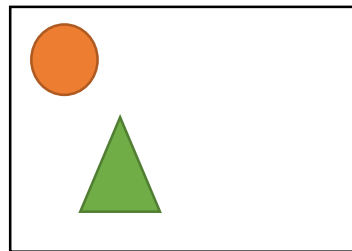

- Object transformation
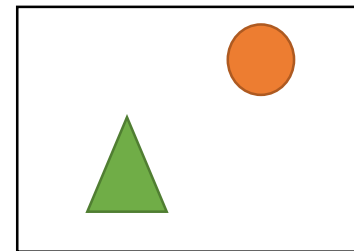 - A user can move an object

Target Scenario

- Problem: a user may want to select an object in 3D world, and transform the chosen object by keyboard or mouse inputs
  - Click a mouse button at a pixel and drag a selected object

- Tasks
  - Catch the mouse event
  - Identify which objects are selected
  - Apply a transformation to the objects by the user input
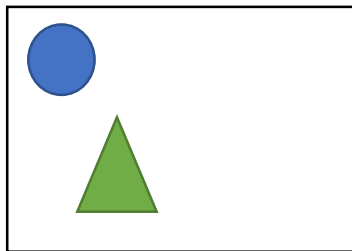
input

User selects an object

Transform the object

Picking and Selection

- Ways to select an object
  - Build a ray (position and direction) and identify the intersection point between the ray and primitives

  - Employ OpenGL selection buffers

  - Utilize OpenGL a double buffer

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A Naïve Idea 1

- Read the pixel color at the clicked position (x,y) from your screen (frame buffer)
    - unsigned char pixel[3];
    - glReadPixels(x, y, 1, 1, GL_RGB, GL_UNSIGNED_BYTE, pixel)

- Compare the color with object colors
    - e.g., if the color is green, then the selected object is the teapot!

- Problems?
    - Each primitive can have different colors because of
        - Lighting, textures…
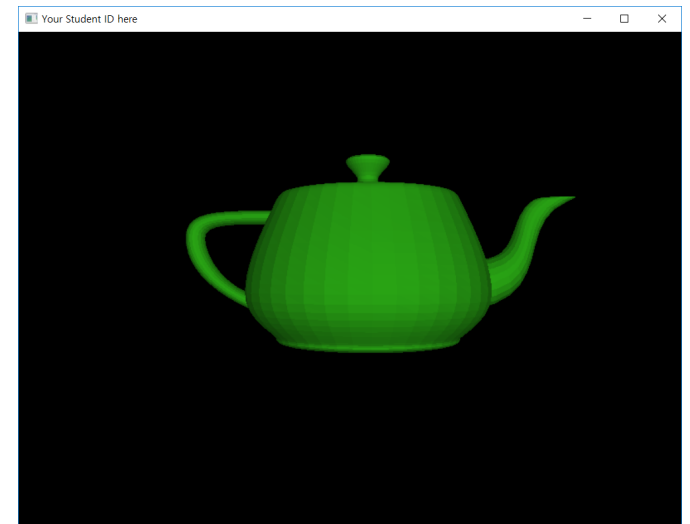
A Naïve Idea 2

- Compare the color with object colors
    - e.g., if the color is green, then the selected object is the teapot!

- Disable the lighting (and texture)
    - glDisable(GL_LIGHTING);

- Assign a specific color (like object ID) to each object
    - glColor4f(0.0, 1.0, 0.0, 1.0);
    - // before drawing your primitives
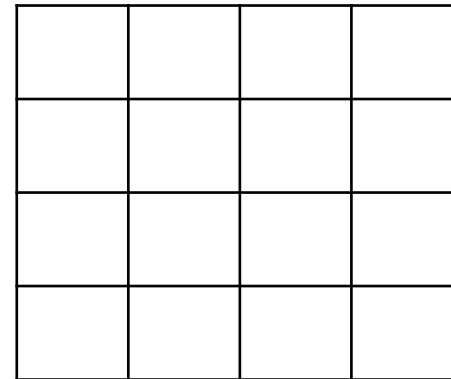
- Problems?
    - This is not a realistic image…
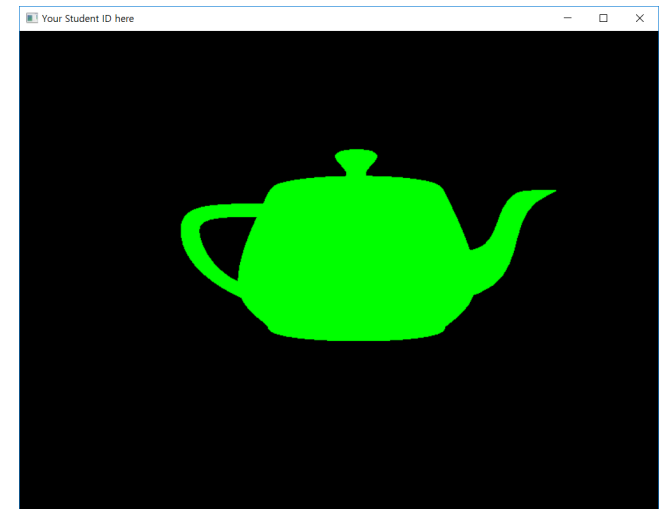
OpenGL: Double Buffer

- Two buffers can be allocated with the following:
    - You can set a mode before creating an window.
    - glfwWindowHint(GLFW_DOUBLEBUFFER,GL_FALSE) // Single buffer mode
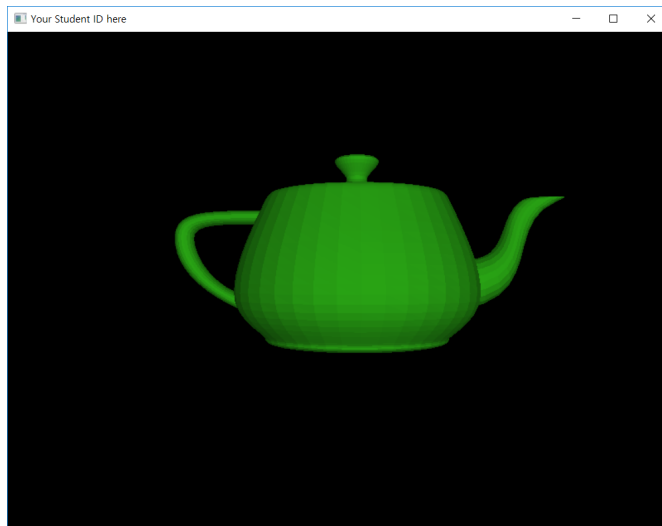   - glfwWindowHint(GLFW_DOUBLEBUFFER,GL_TRUE) // Default option
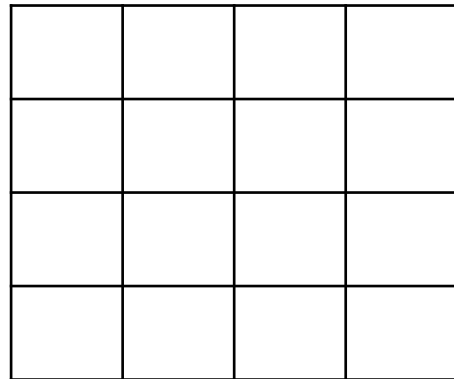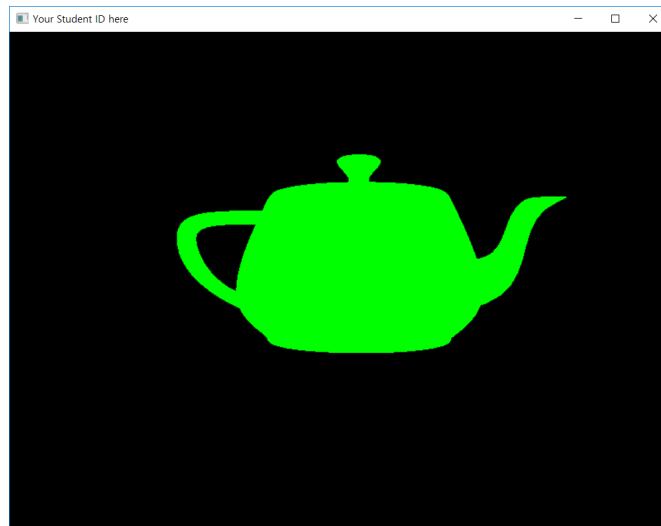
Front buffer

Back buffer

OpenGL: Double Buffer

- Two buffers can be allocated with the following:
  - You can set a mode before creating an window.
  - glfwWindowHint(GLFW_DOUBLEBUFFER,GL_FALSE) // Single buffer mode
  - glfwWindowHint(GLFW_DOUBLEBUFFER,GL_TRUE) // Default option

Front buffer

Back buffer
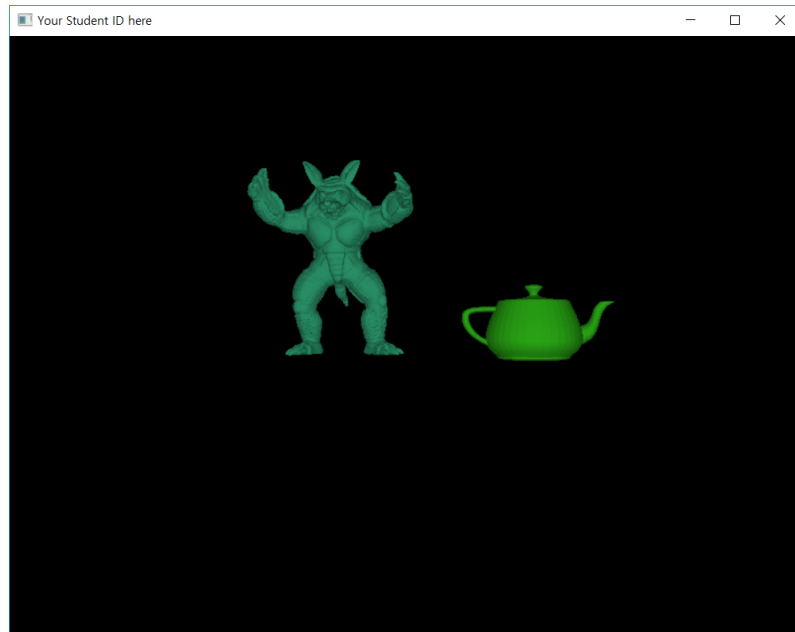
OpenGL: Double Buffer

- Read the pixel color at the clicked position (x,y) from the back buffer
  - ○ glReadBuffer(mode)
    - ▪ mode: GL_FRONT, GL_BACK
  - ○ unsigned char pixel[3];
  - ○ glReadPixels(x, y, 1, 1, GL_RGB, GL_UNSIGNED_BYTE, pixel)

- Check whether the mouse is being pressed:
  - ○ Need to draw the back buffer (without lighting)
    - ▪ glDrawBuffer(mode)
      - ▪ mode: GL_FRONT, GL_BACK

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Example

Front buffer

Back buffer

OpenGL: Double Buffer

- Pros.
  - Easy to implement it
  - Support for robust picking and selection compared to the naïve choices

- Cons.
  - Hard to handle flickering for animations, by swapping the two buffers
    - The original purpose of the double buffer is to prevent flickering.

- Selection buffers:
  - A better solution for the picking and selection
    - e.g., glRenderMode(GL_SELECT)
  - Require more completed implementations (will be not covered in this course)