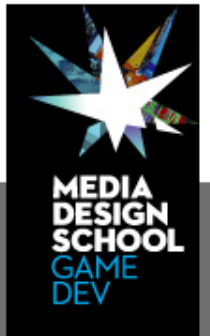
Framebuffers/ Renderbuffers and Porting WebGL/ OpenGLES

Advanced Graphics Programming

GD2P04



Framebuffers

- Up to this point, all of our discussion regarding buffers has focused on the buffers provided by the windowing system as requested by user.
- glutInitDisplayMode(
- GLUT_DEPTH | // depth buffer
- GLUT_DOUBLE | // double buffer
- GLUT_RGBA); // color buffer

Framebuffers

- Color buffer for writing color values,
- Depth buffer to write depth information and
- Stencil buffer that allows us to discard certain fragments based on some condition.
- The combination of these buffers is called a ***framebuffer***

Framebuffers

- Using framebuffer objects, you can create our own framebuffers.
- Use their attached renderbuffers to minimize data copies and optimize performance
- Framebuffer objects are quite useful for performing ***off-screen-rendering***, updating texture maps

Framebuffers

- Framebuffer that is provided by the windowing system is the only framebuffer that is available to the display system of your graphics server---that is, it is the only one you can see on your screen.
- By comparison, the framebuffers that your application creates cannot be displayed on your monitor; they support only off-screen rendering.

Allocating and Binding FBO

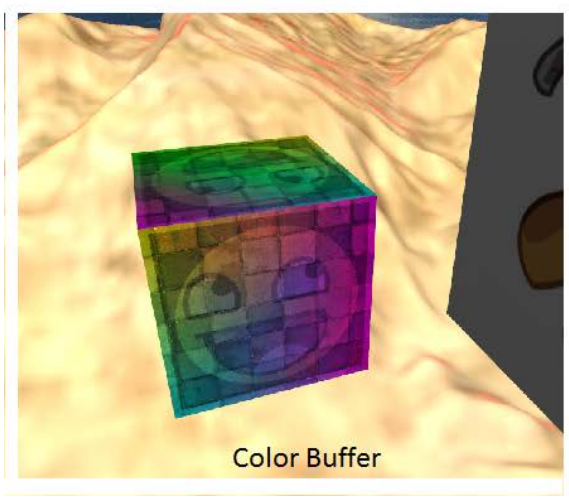
- Generating framebuffers
  - glGenFramebuffers(GLsizei n, GLuint *ids);
- Binding FBO
  - glBindFramebuffer(GLenum target, GLuint framebuffer);
- Target
  - Specifies a framebuffer for either reading or writing.
  - GL_DRAW_FRAMEBUFFER, specifies the destination framebuffer for rendering.
  - GL_READ_FRAMEBUFFER, specifies the source of read operations.
  - GL_FRAMEBUFFER for target sets **both** the read and write framebuffer bindings to framebuffer

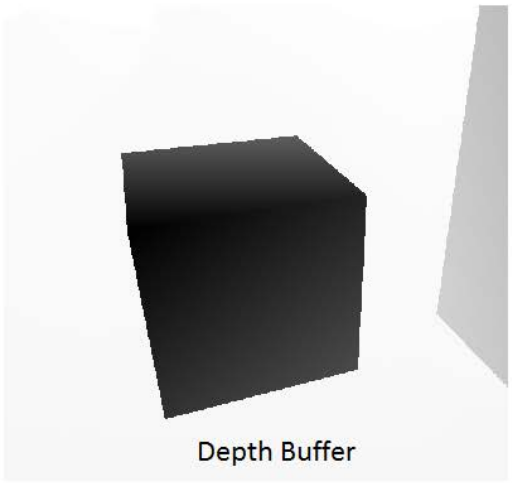
Texture as a target attachment

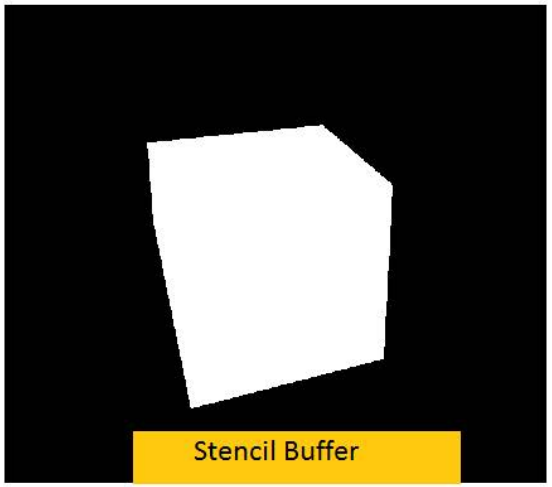
- Whatever is rendered to the framebuffer can be used as a texture.
- To see general output or used later in the pipeline.

```
glFramebufferTexture2D(GLenum target, //type of target
        GLenum attachment, //color, or depth or stencil
        GLenum textarget, // type of texture 1D, 2D or 3D
        GLuint texture, // texture ID
        GLint level); //mipmap level
```

Color, Depth or Stencil Attachment







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Creating, binding and Attaching

```
GLuint framebuffer;
glGenFramebuffers(1, &frameBuffer);
glBindFramebuffer(GL_FRAMEBUFFER, frameBuffer);

//Attach texture to framebuffer object
glFramebufferTexture2D(GL_FRAMEBUFFER, //target buffer
GL_COLOR_ATTACHMENT0,//attachment, could be
                     //GL_DEPTH_ATTACHMENT or
                     //GL_STENCIL_ATTACHMENT
GL_TEXTURE_2D, //texture target type
renderTexture,//texture
0); // level
```

Depth Attachment

- To attach a depth attachment we specify the attachment type as GL_DEPTH_ATTACHMENT.

- The texture's format and internal format type should be GL_DEPTH_COMPONENT to reflect the depth buffer's storage format.

Creating Texture

```
Gluint renderTexture;
glGenTextures(1, &renderTexture);
glBindTexture(GL_TEXTURE_2D, renderTexture);

glTexImage2D(GL_TEXTURE_2D,
0, GL_RGB,
1280,720
0, //border
GL_RGB, //format
GL_UNSIGNED_BYTE, //data type , NULL);
```

- For this texture, we're only allocating memory and not actually filling it

Render Buffers

- Renderbuffers are effectively memory managed by OpenGL that contains formatted image data.
- The data that a renderbuffer holds takes meaning once it is attached to a framebuffer object.
- It stores its data in OpenGL's native rendering format making it optimized for off-screen rendering to a framebuffer.
- Renderbuffer objects are generally write-only, thus you cannot read from them.
- Since depth tests cannot be perfomed on a texture we need the render buffer to do depth and stencil valu for testing.

Render Buffers

- Before you can attach a renderbuffer to a framebuffer and render into it, you need to allocate storage and specify its image format.
- This is done by calling ***glRenderbufferStorage()***
- Then attach the renderbuffer to the framebuffer which is done by calling ***glFramebufferRenderbuffer()***

Creating and Binding RBO

```
GLuint rbo;
glGenRenderbuffers(1, & rbo);
glBindRenderbuffer(GL_RENDERBUFFER, rbo);
glRenderbufferStorage(GL_RENDERBUFFER, // must be
  GL_DEPTH24_STENCIL8, //use as depth - stencil buffer
  1280, 720) //viewport width and height;
glFramebufferRenderbuffer(GL_FRAMEBUFFER, //target
GL_DEPTH_STENCIL_ATTACHMENT, //attachment
GL_RENDERBUFFER, //renderbufferTarget
rbo); // render buffer
```

Framebuffer Testing

- Check if frameBuffer is created and texture and renderbuffer are attached

```
if (glCheckFramebufferStatus(GL_FRAMEBUFFER)
!= GL_FRAMEBUFFER_COMPLETE) {
cout << "ERROR::FRAMEBUFFER:: Framebuffer is
not complete!" << endl;
}
```

Using the framebuffer

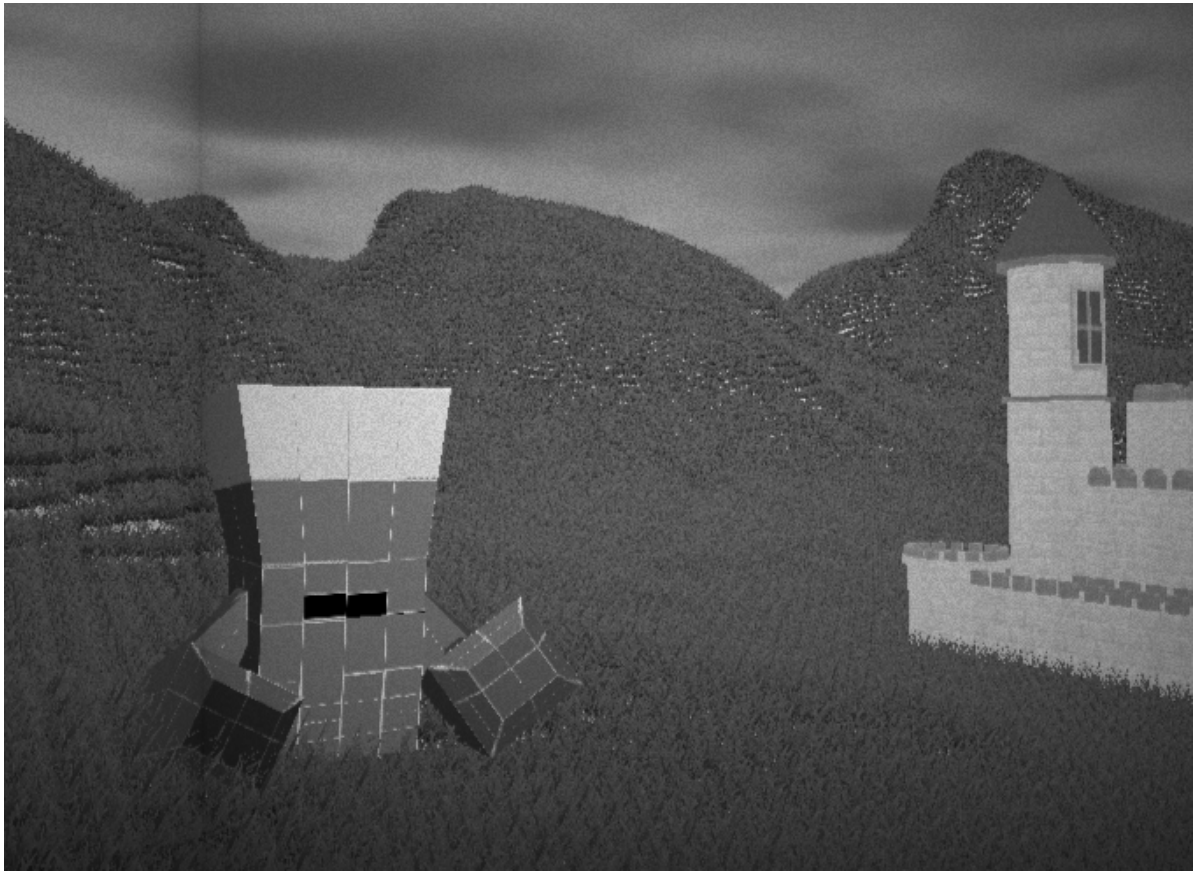
- Bindframebuffer
- Clear color, depth and stencil bit
- Draw the object
  - Draw skybox
  - Draw cube, etc.
- Bind the Texture and use the texture as shader resource and draw it on a quad.

Code

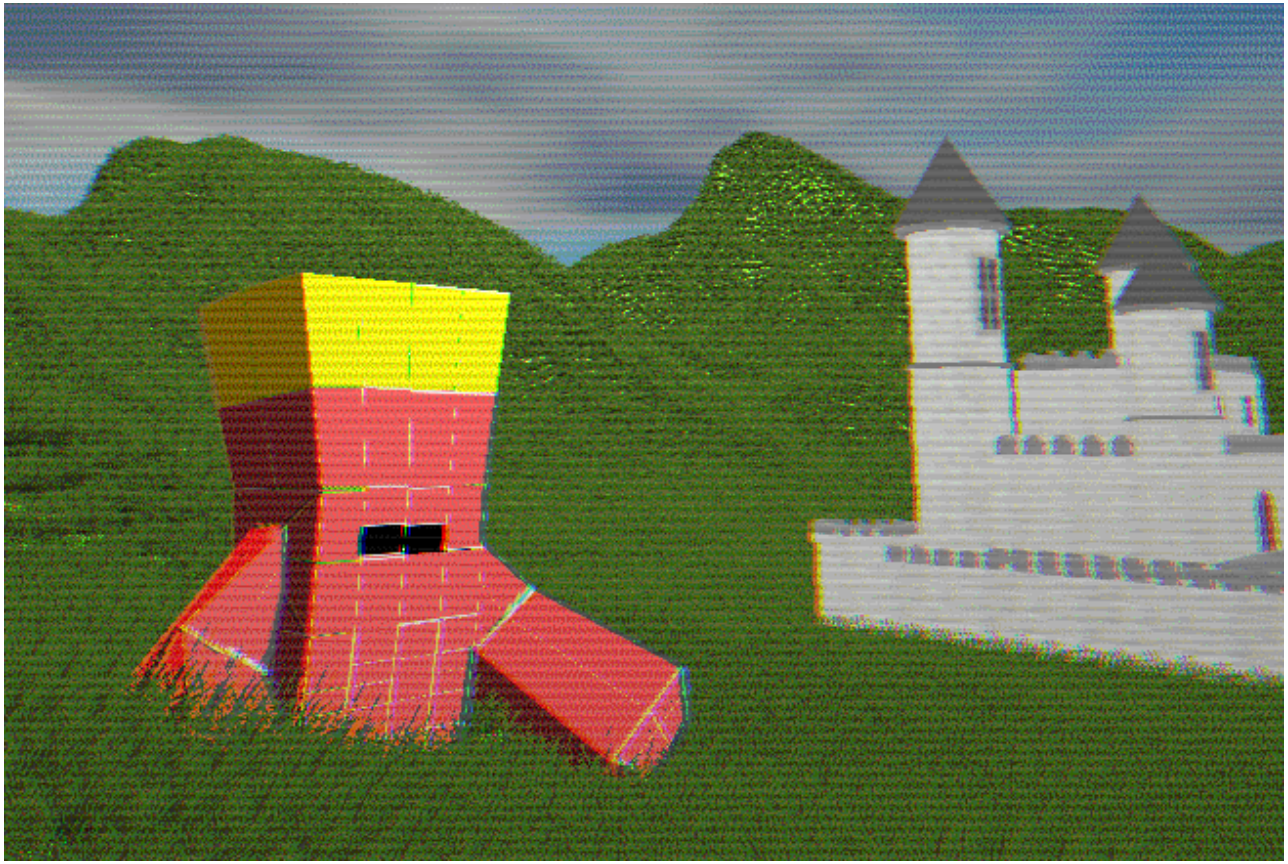
```
glBindFramebuffer(GL_FRAMEBUFFER, frameBuffer);
glClearColor(1.0f, 1.0f, 0.0f, 1.0f);
glClear(GL_COLOR_BUFFER_BIT | GL_DEPTH_BUFFER_BIT | GL_STENCIL_BUFFER_BIT);

Cube->draw();

glUseProgram(program);
glActiveTexture(GL_TEXTURE0);
glUniform1i(glGetUniformLocation(program, "renderTexture"), 0);
glBindTexture(GL_TEXTURE_2D, renderTexture);

glBindVertexArray(quadVAO);
glDrawArrays(GL_TRIANGLES, 0, 6);
glBindVertexArray(0);

glBindFramebuffer(GL_FRAMEBUFFER, 0);
```

Output

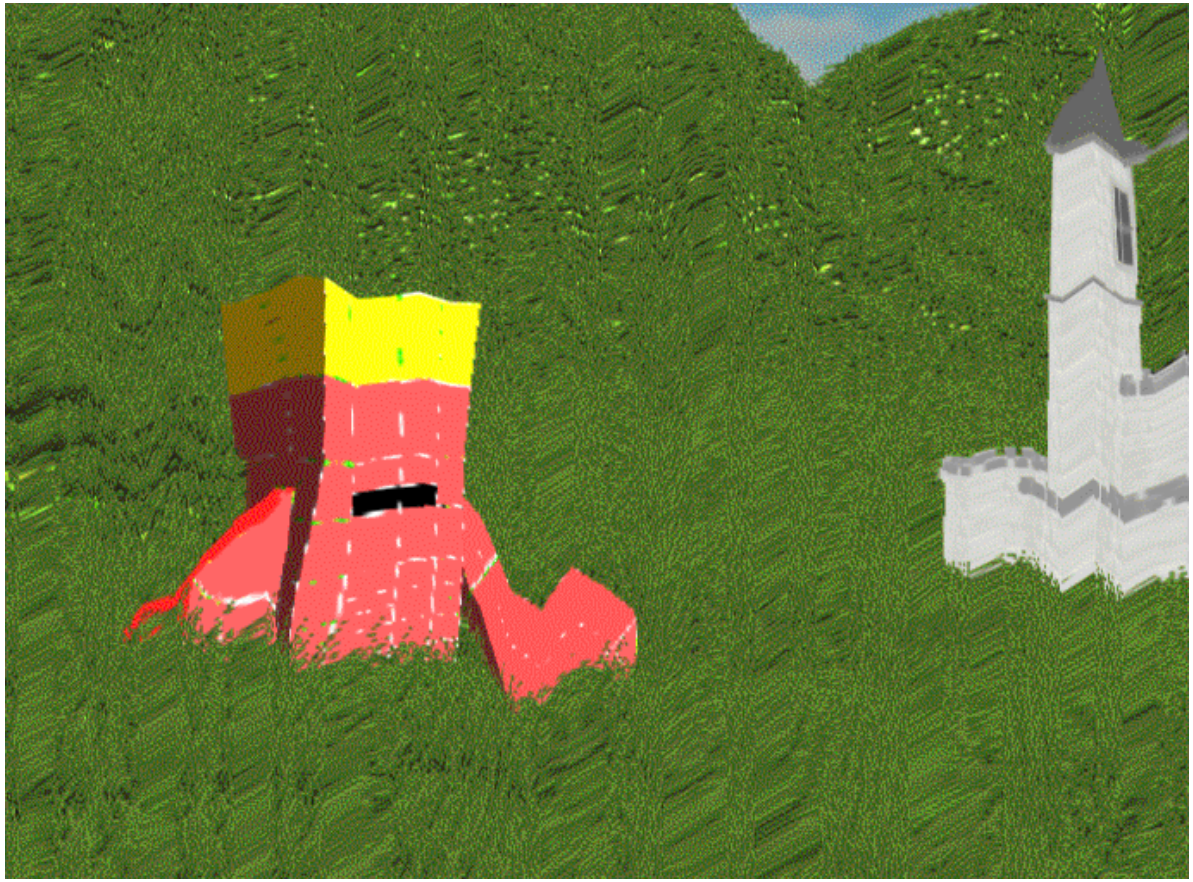
- Old movie scratch and pops



- Chromatical, scanlines, distortion

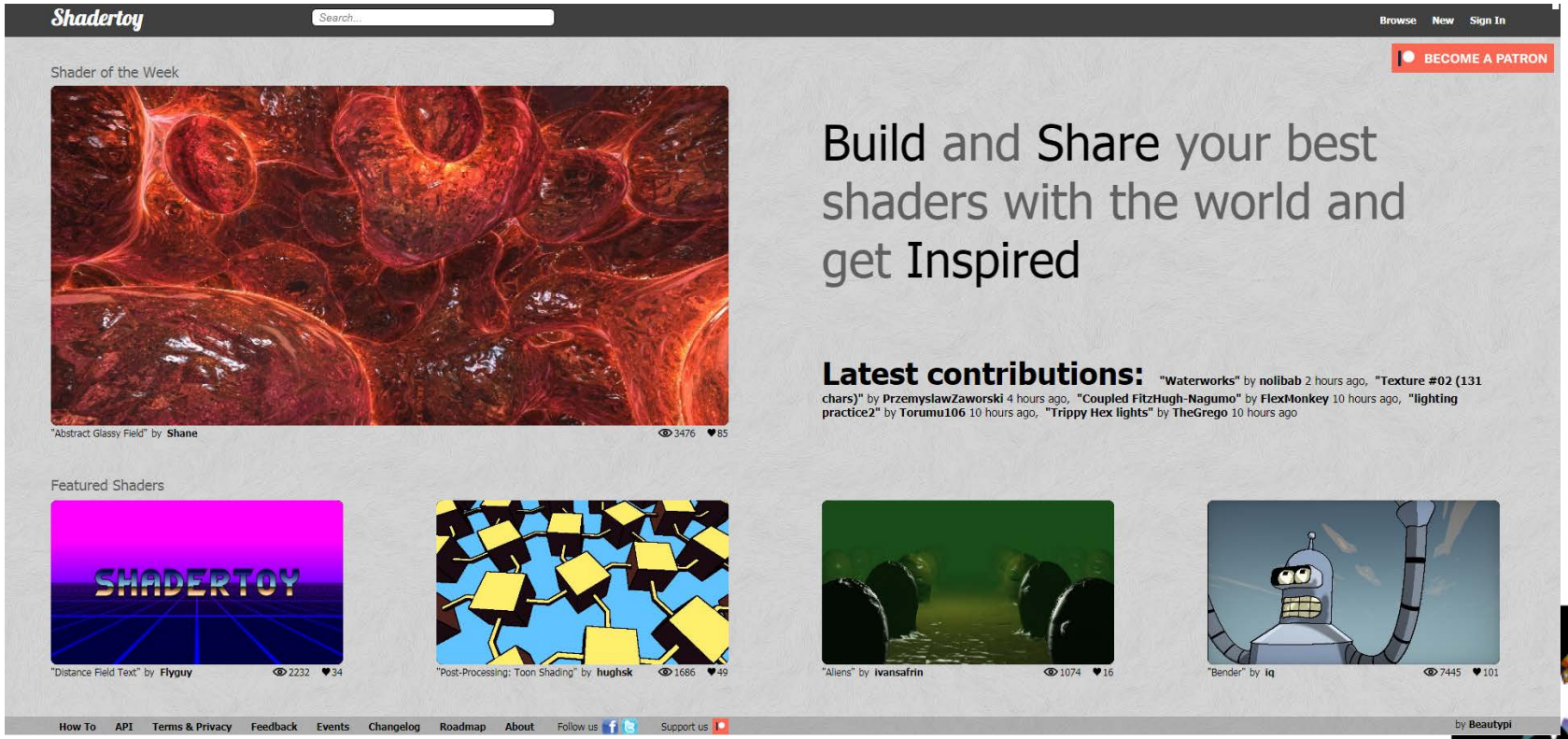


- Raining on your screen



Porting webGL/ openGLES

- https://www.shadertoy.com/



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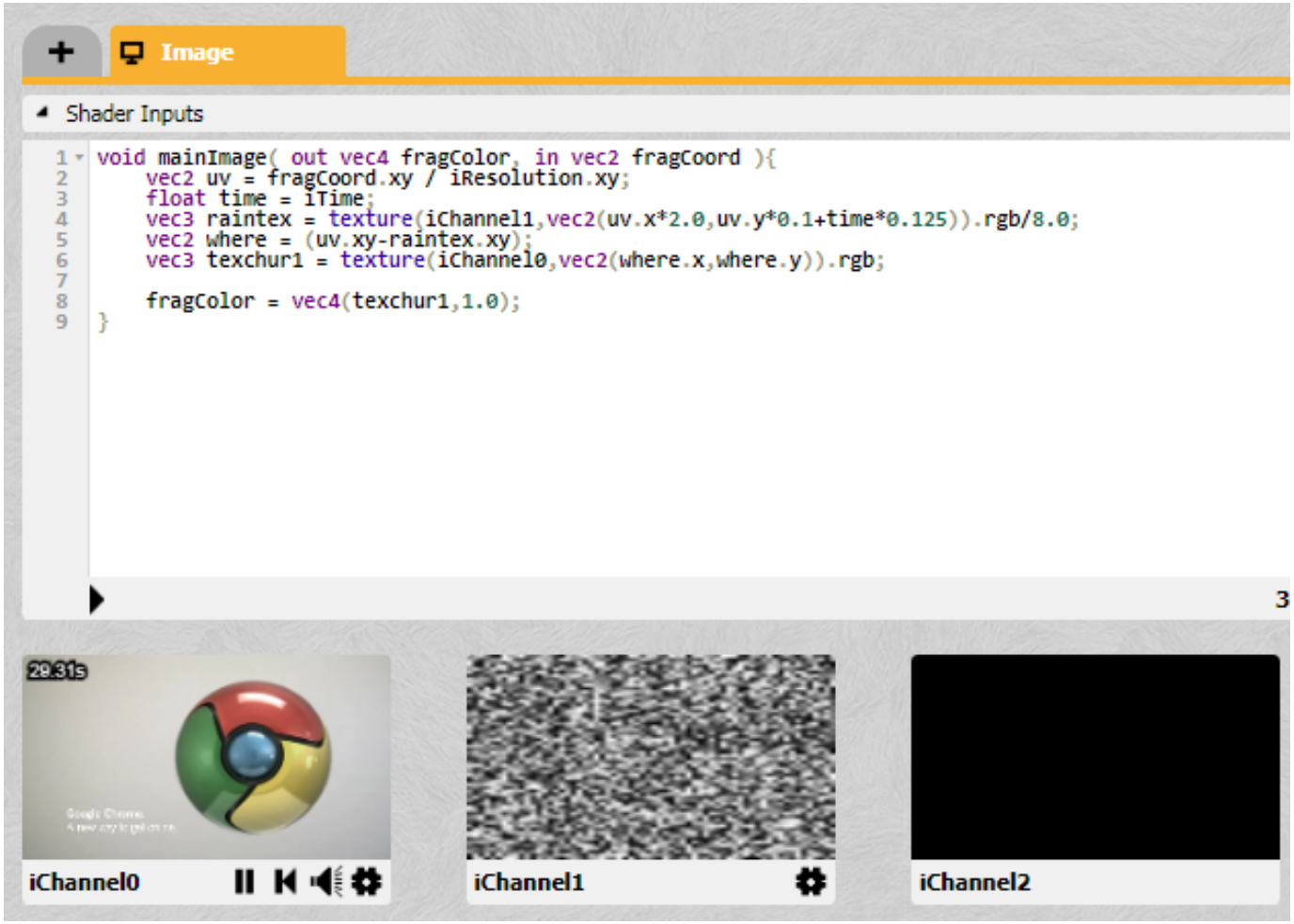
Data type conversions

- fragCoord: vec2 texturecoordinate information
- iResolution: vec2 with width and height of screen
- varying are uniforms
- fragColor: vec4 output color
- iChannel0, iChannel1- textures passed in
- iTime – current time passed in as unform float
- Slight adjustment to values might be required to get similar effect.

Shadertoy code



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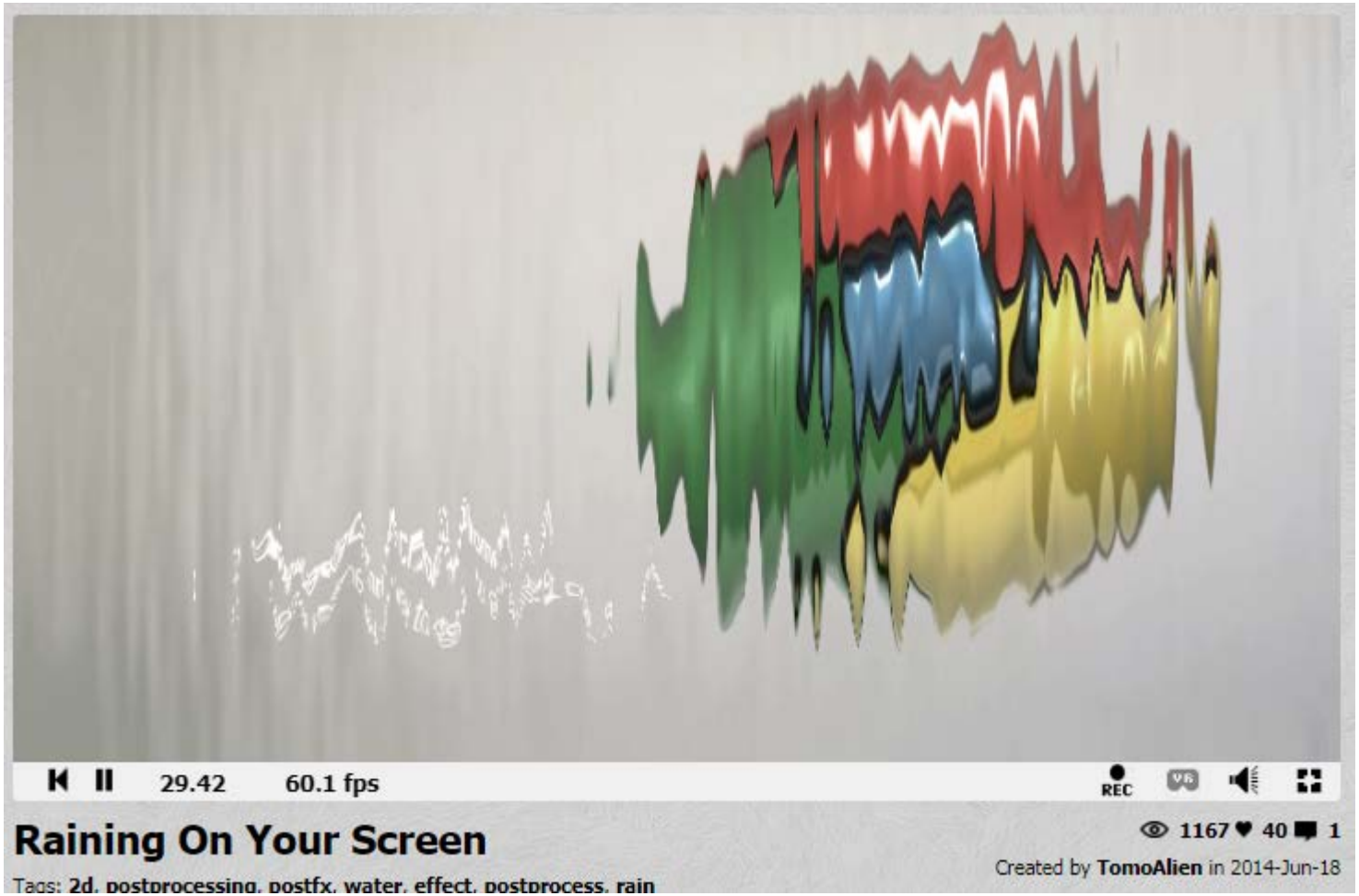
Shadertoy Output



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Excercise

- Create a framebuffer.
- Create a texture attachment.
- Render objects to it.
- Create a quad and apply render texture to it.
- Take a shader effect from Shadertoy and apply to the rendertexture.