ShaderGraph in RealityKit

Yasuhito Nagatomo Sep 27, 2023

Content

1. What is ShaderGraph
2. An example of ShaderGraph and Swift code

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ShaderGraph

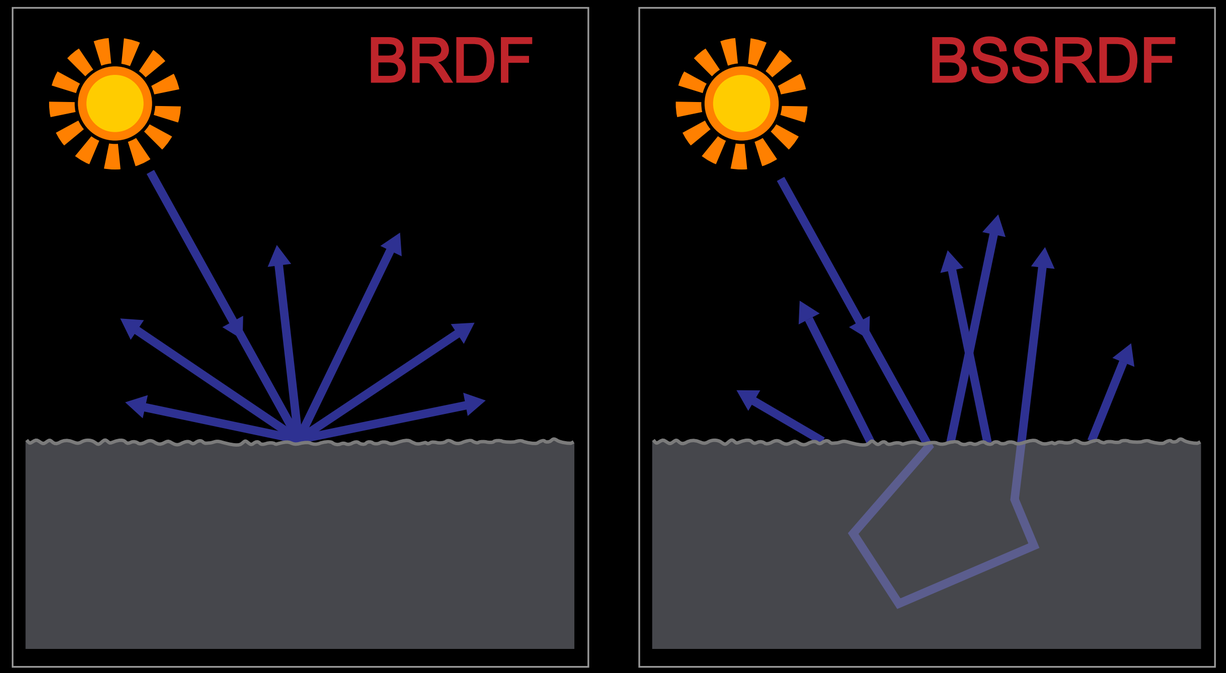
What's Shader

- A program that calculates shading during rendering processing (mainly executed on GPU)
- Performs calculations based on the laws of physics based on the position, shape, and surface material of 3D objects. (**VertexShader**, **SegmentShader**)
  - Calculate diffuse reflection, specular reflection, etc. using parameters such as BaseColor (diffuse reflection color), Roughness (roughness), Specular (specular reflection amount), etc.
- There are also calculations that generate shapes (**GeometryShader**) and subdivide shapes (**Tessellation**).

RealityKit

Game Engines

3D Modeling Tools



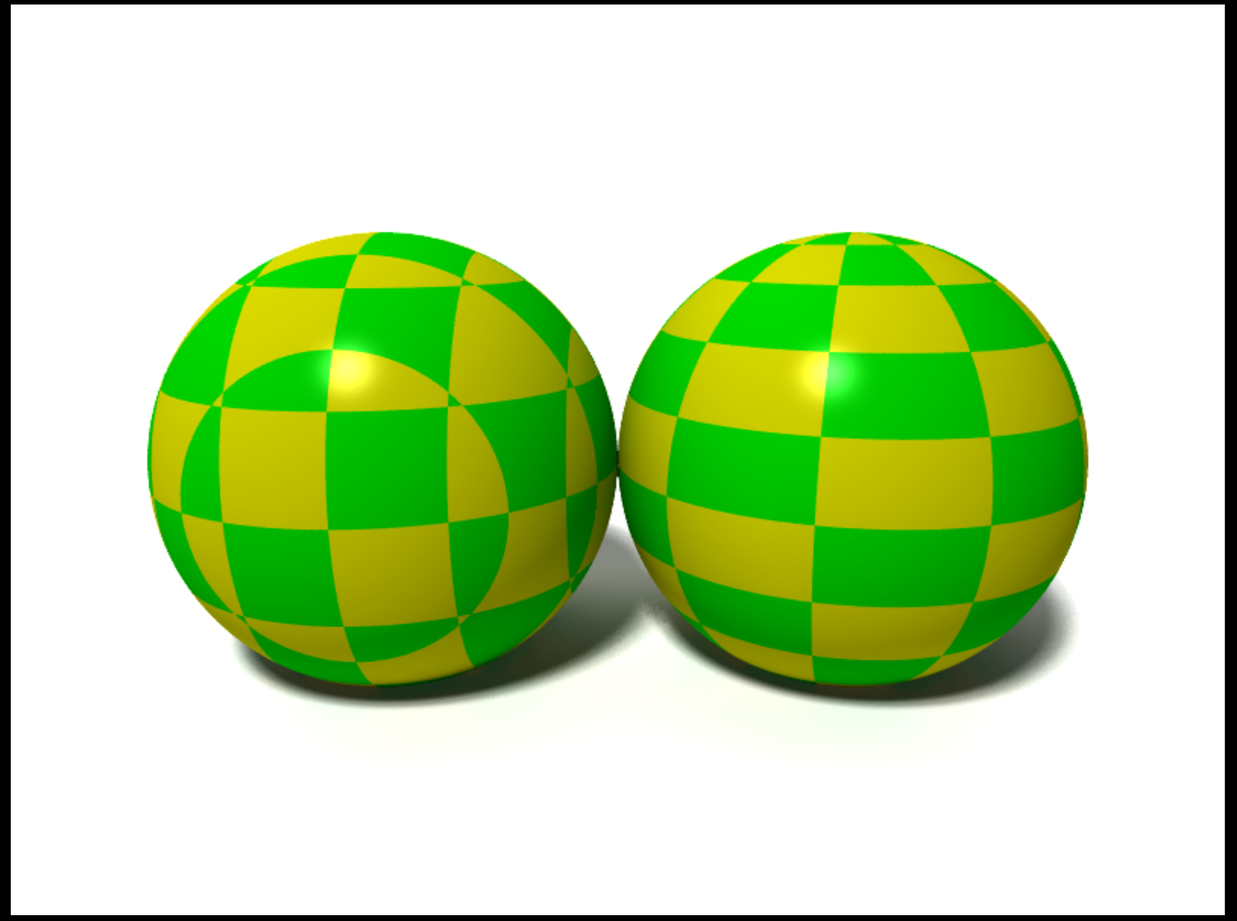
Cite: Jurohi (original); Pbroks13 (redraw) - http://en.wikipedia.org/wiki/Image:BSSDF01_400.png, CC -3.0

BRDF : Bidirectional Reflectance Distribution Function, **BSSRDF** : Bidirectional scattering-surface reflectance distribution function

ShaderGraph

Shaders in RealityKit

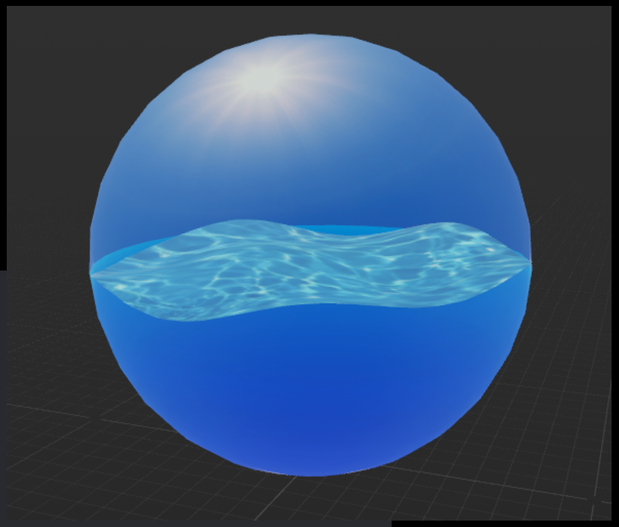
1. Vertex Shader
    - Calculations related to position and shape (mainly coordinate transformation of vertices)
    - In RK it is called **GeometryModifier**
2. Fragment Shader
    - Calculates pixel color based on surface material, taking into account lighting and camera position
    - In RK it is called **SurfaceShader.**



Cite: I, Jleedev, CC - 3.0

ShaderGraph

Shader description method has changed in visionOS



A. RK in iOS

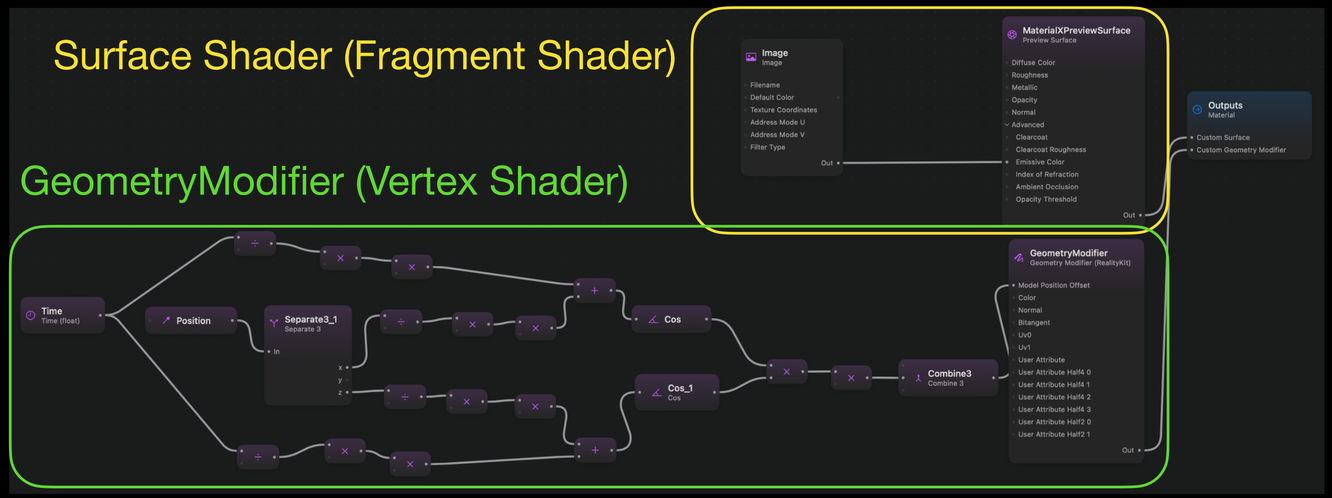
- MSL (Metal Shading Language): C++ 14 +/-

```metal
#include <metal_stdlib>
#include <RealityKit/RealityKit.h>
using namespace metal;

[[visible]]
void waveGeometryModifier(realitykit::geometry_parameters params)
{
    float3 pos = params.geometry().model_position();
    // x axis: wave length = 0.2 [m], cycle = 8.0 [sec]
    // z axis: wave length = 0.3 [m], cycle = 10.0 [sec]
    // wave height = +/- 0.005 [m]
    float3 offset = float3(0.0,
                           cos( 3.14 * 2.0 * pos.x / 0.2 + 3.14 * 2.0 * params.uniforms().time() / 8.0 )
                         * cos( 3.14 * 2.0 * pos.z / 0.3 + 3.14 * 2.0 * params.uniforms().time() / 10.0 ) * 0.005,
                           0.0);
    params.geometry().set_model_position_offset(offset);
}
```

B. RK in visionOS

- MaterialX Standard
- Node Graph (ShaderGraph)
- GUI Node Editor (Reality Composer Pro)

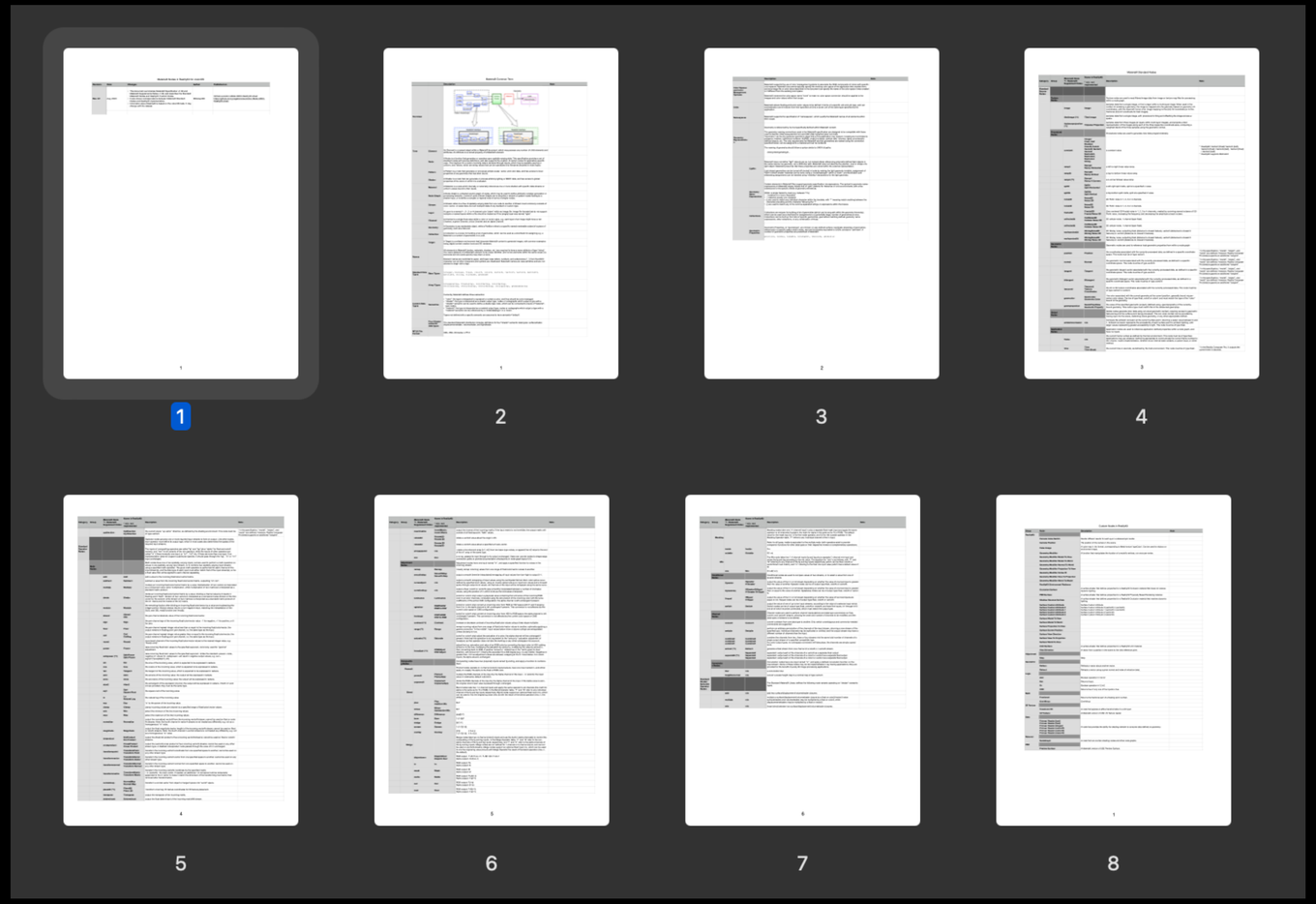


Metal Shading Language Specification V3.1 (Jun, 2023): https://developer.apple.com/metal/Metal-Shading-Language-Specification.pdf

ShaderGraph

Learning ShaderGraph

1. WWDC23
    - Session: Explore materials in Reality Composer Pro (https://developer.apple.com/videos/play/wwdc2023/10202/)
2. Apple Documentations
    - Article: Designing RealityKit content with Reality Composer Pro (https://developer.apple.com/documentation/visionOS/designing-realitykit-content-with-reality-composer-pro)
3. MaterialX
    - MaterialX Spec v1.38 (https://materialx.org/)
4. My Note on GitHub (Overview of RK's Nodes)
    - MaterialX Nodes in RealityKit (https://github.com/ynagatomo/evolution-Metal-ARKit-RealityKit-sheet)
    - MaterialX + RealityKit Extensions: about 140 Nodes

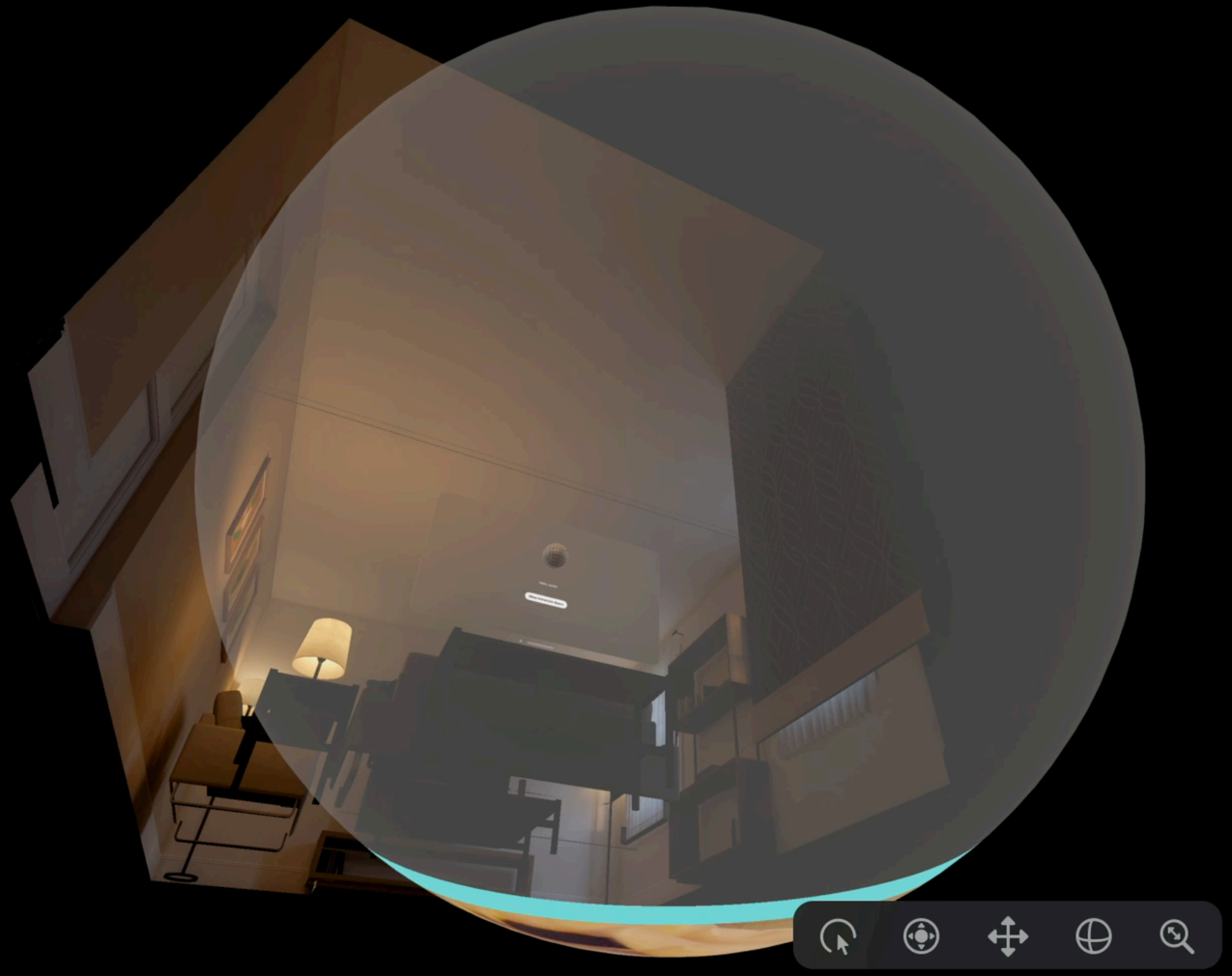


MaterialX Nodes in RealityKit
(https://github.com/ynagatomo/evolution-Metal-ARKit-RealityKit-sheet)

Example

Skybox Animation

- Display a texture image (equirectangular spherical image) inside the sphere
- A spherical image appears from bottom to top and top to bottom as time passes (usually translucent gray color)
- Texture images can be switched using Swift Code

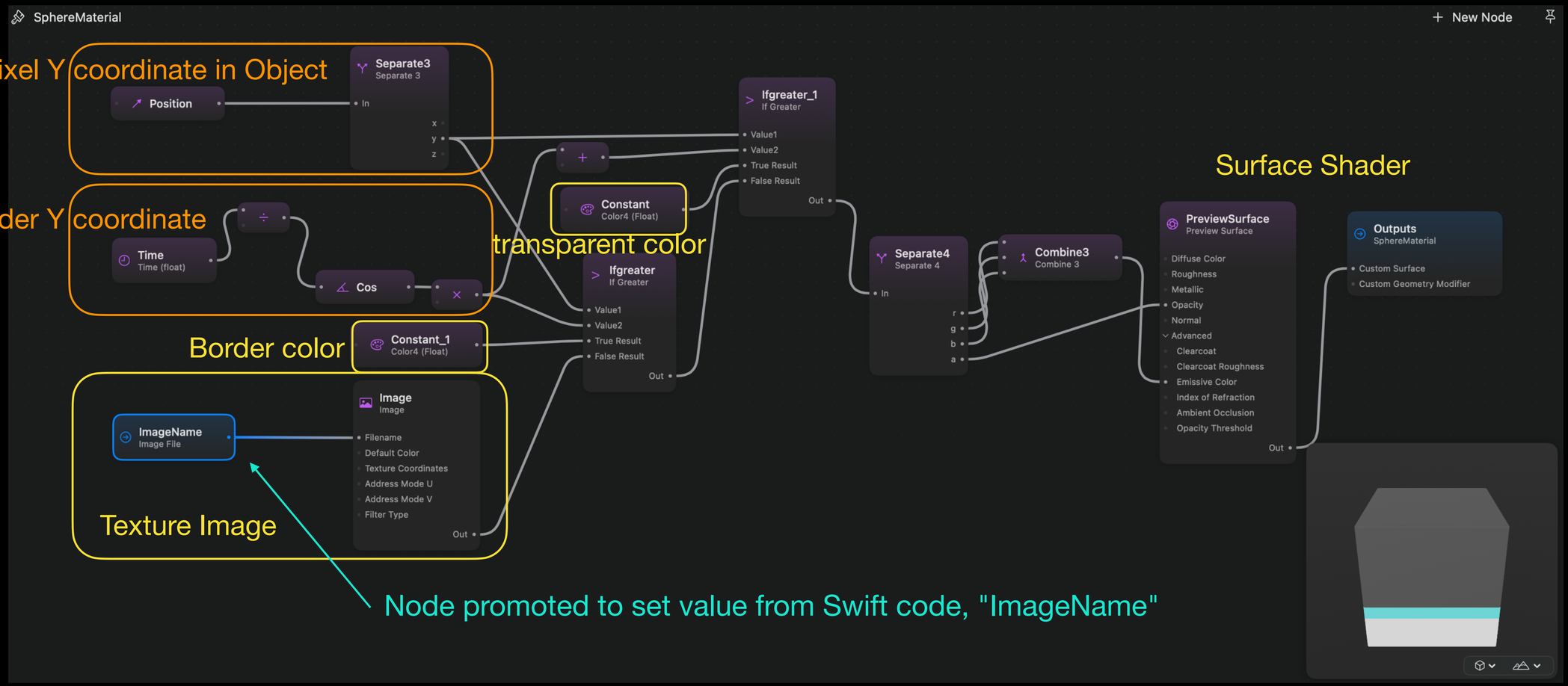


Demo movie

Example

Skybox Animation: ShaderGraph

- ShaderGraph Material can be created using Reality Composer Pro and used as a Material for scene creation. Cannot be used with Particle System at this time
- You can also read and use ShaderGraph Material in Swift code (sample shown in this Example)



Example

Skybox Animation: Swift Code

- You can set the value of the promoted Node using Swift Code.
- The value settings for TextureResouce are not shown in WWDC/Article/Sample, so I present them in this Example.

```swift
struct ImmersiveView: View {
    var body: some View {
        RealityView { content in
            if let scene = try? await Entity(named: "Immersive", in: realityKitContentBundle) {
                if let sphere = scene.findEntity(named: "Sphere_Right") as? ModelEntity {
                    if var sphereMaterial = sphere.model?.materials.first as? ShaderGraphMaterial {
                        if let textureResource = try? await TextureResource(named: "town360") {
                            try? sphereMaterial.setParameter(name: "ImageName", value: .textureResource(textureResource))
                            // Attach the material to a sphere.
                            let entity = Entity()
                            entity.components.set(ModelComponent(
                                mesh: .generateSphere(radius: 2),
                                materials: [sphereMaterial]
                            ))
                            // Ensure the texture image points inward at the viewer.
                            entity.scale *= .init(x: -1, y: 1, z: 1)
                            entity.transform.translation = SIMD3<Float>(0, 1, 0)
                            content.add(entity)
```

1) Get ShaderGraph Material

2) Create Image-Texture

3) Set the Image-Texture into "ImageName" node

4) Create a sphere object

5) Adjust the material to be on the inside surface

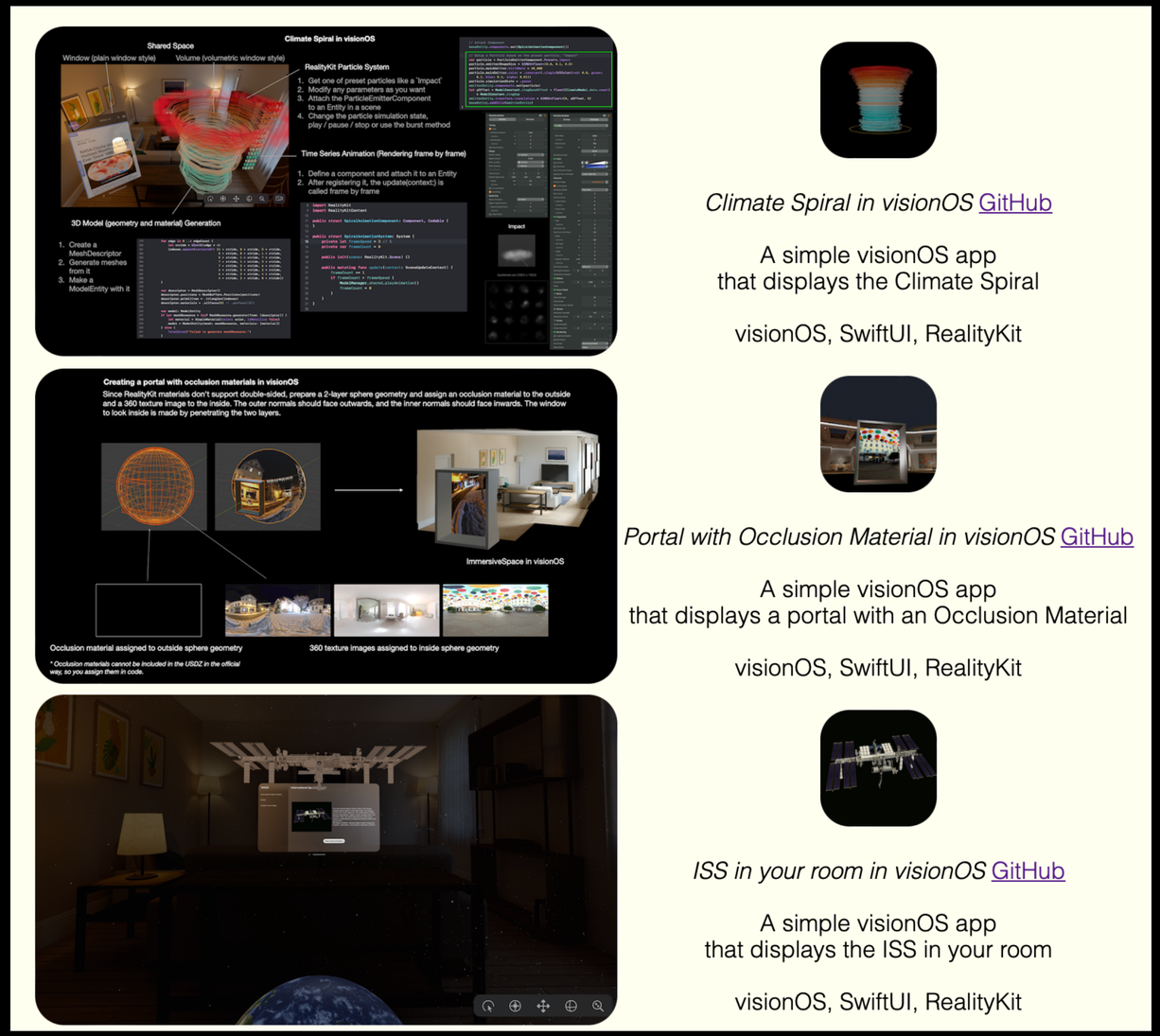
6) Add it to content

Recap

ShaderGraph in RealityKit

- ShaderGraph is a new way to represent Shaders in visionOS
- It can work with Swift Code

- X: @AtarayoSD
- GitHub: ynagatomo (https://github.com/ynagatomo)



Climate Spiral in visionOS GitHub

A simple visionOS app
that displays the Climate Spiral

visionOS, SwiftUI, RealityKit

Portal with Occlusion Material in visionOS GitHub

A simple visionOS app
that displays a portal with an Occlusion Material

visionOS, SwiftUI, RealityKit

ISS in your room in visionOS GitHub

A simple visionOS app
that displays the ISS in your room

visionOS, SwiftUI, RealityKit

Projects for visionOS on GitHub