

CAVERN TOOLKIT

HALVES

Spelunx

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Instructor

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Spelunx Team

GOAL

A toolkit that makes the CAVERN easy to use, so that CAVERN developers with varying skill sets can develop impactful experiences for it.



2/17 CAVERN Jam Playtest




Location | CAVERN #3404
Time | Kickoff 2/17 M 2:30pm
Showcase 2/18 T 4:00pm
Boba Provided!
Only if you fill out surveys :D

CAVERN JAM

Make a short experience using a single interaction with the CAVERN using Spelunx's CAVERN toolkit and help us playtest our toolkit!

“

I would never have been able
to build a CAVERN project
without the toolkit

”

from CAVERN Jam Feedback



Findings

Average Development Time: < 4 hours

Average Setup Time: < 20 minutes

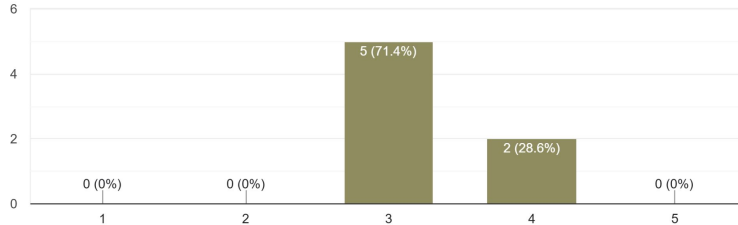
“This experience was quite easy to get started with”
- Jam Participant

“This was so fun for me! Do this again!”
- Jam Participant

Confidence Level for Developing on the CAVERN

On a scale from 1-5, technical-wise, how nervous (1) /confident (5) are you about developing on CAVERN?

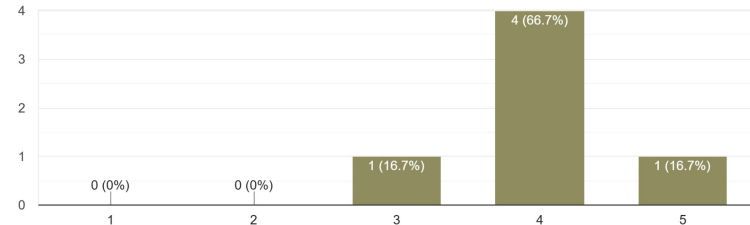
7 responses



Before Jam: **3.28** out of 5

On a scale from 1-5, how nervous(1)/confident(5) are you in building another cavern project in the future?

6 responses

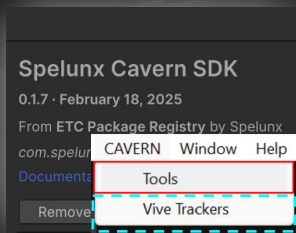


After Jam: **4** out of 5

Playful Space



CAVERN Toolkit Package



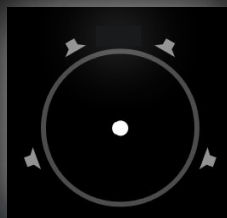
Interface



Render Solution



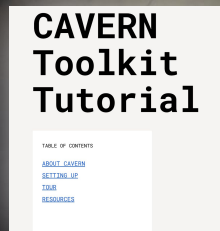
Physical Controller
Inputs



Audio



Sample Scene



Documentation

How We Got Here

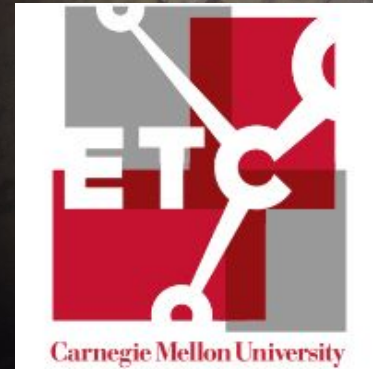


Target Users

People who have access to CAVERN and want to build experiences on it



High School Class at South
Fayette High School



BVW Students, Project
Teams, and Faculty

Working with South Fayette

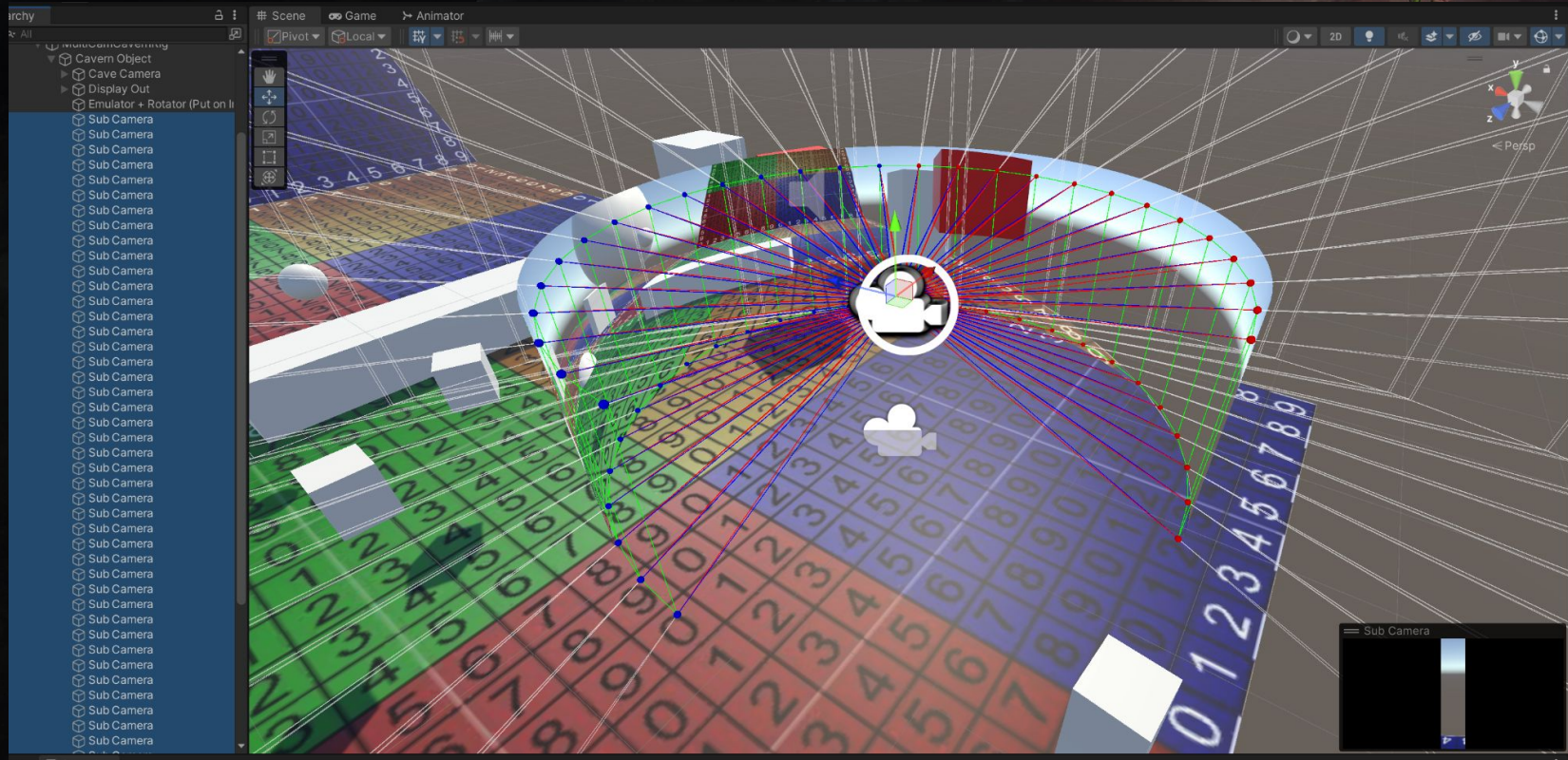
- Using CAVERN Toolkit v1.0
- Joint effort: Roadmap and Curriculum
- 2/28 showcase to teachers
- 3/25 Digital Promise Conference



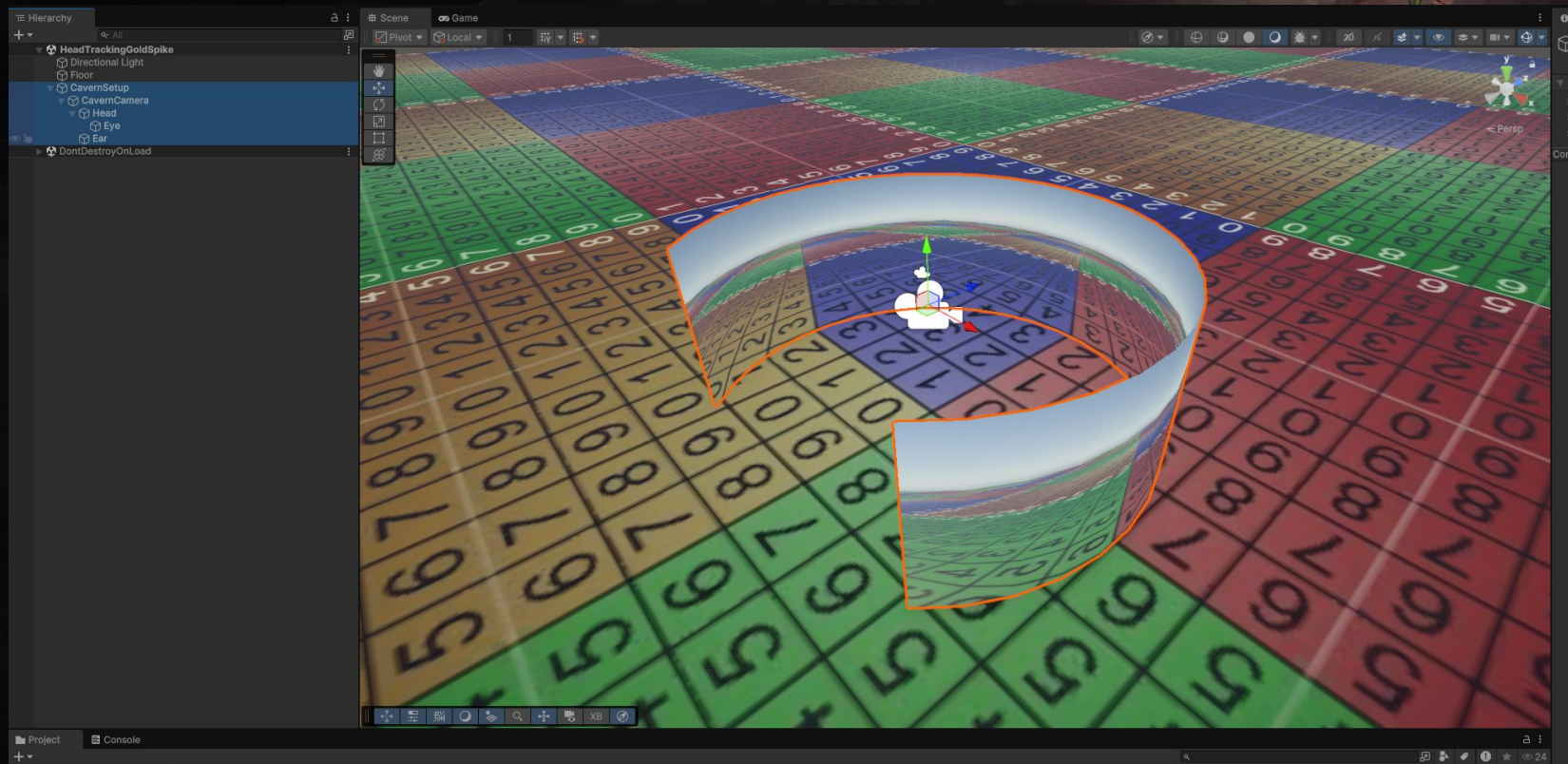
Our Breakthroughs



Camera (Old)



Camera (New)



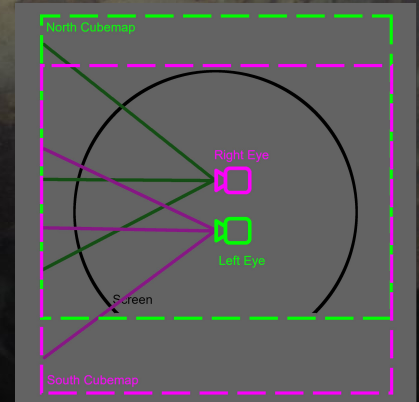
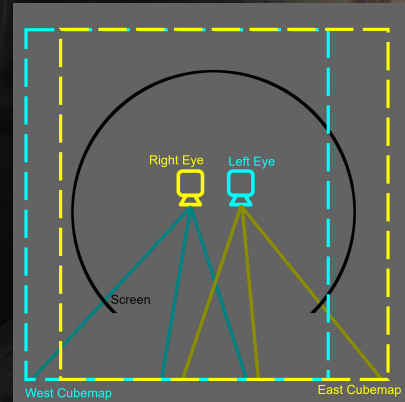
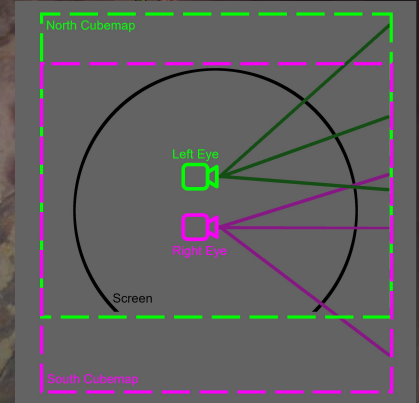
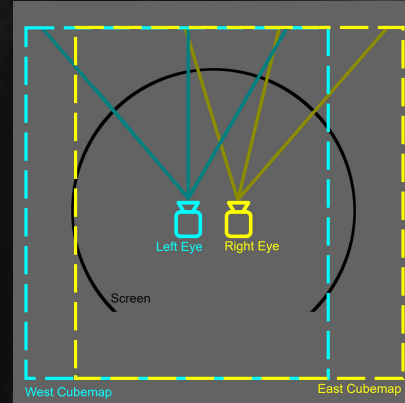
Camera - Cubemap Sampling



Camera – Stereoscopic Rendering



These images were rushed and badly drawn. Look at my technical document instead. ----->



Camera – Off-Axis Rendering



Camera - Hycave Comparison



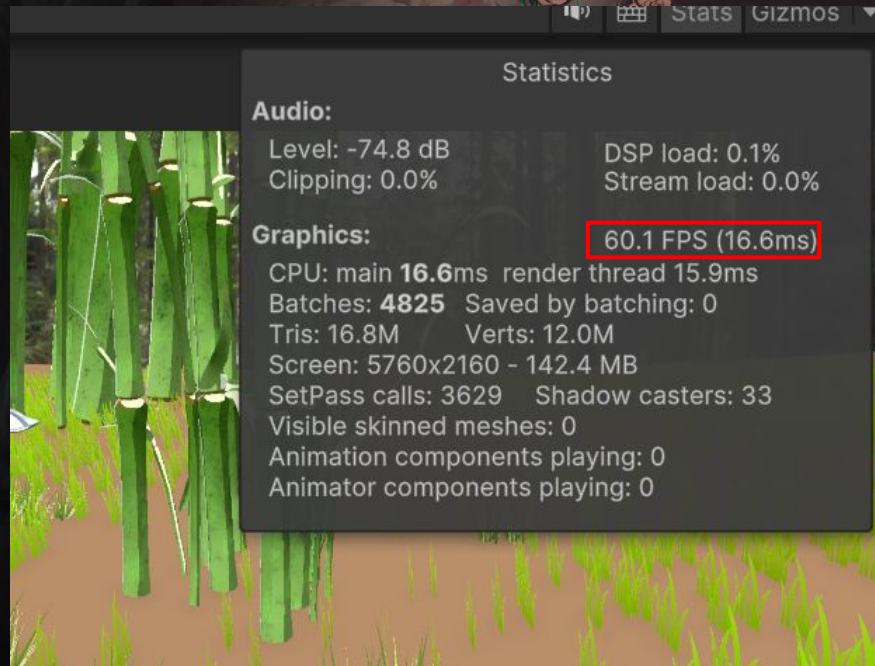
The screenshot shows a performance statistics overlay for the 'Old Camera'. The background is a 3D scene with green reeds and a grassy field. The overlay is a dark grey box with white text. The 'Statistics' section is at the top. Below it, 'Audio' stats are shown: Level: -74.8 dB, Clipping: 0.0%, DSP load: 0.1%, and Stream load: 0.0%. The 'Graphics' section follows, with '22.8 FPS (43.8ms)' highlighted in a red box. Other graphics stats include CPU: main 43.8ms, render thread 41.1ms, Batches: 6231, Saved by batching: 0, Tris: 26.0M, Verts: 18.6M, Screen: 5760x2160 - 142.4 MB, SetPass calls: 4189, Shadow casters: 177, Visible skinned meshes: 0, Animation components playing: 0, and Animator components playing: 0.

Statistics

Audio:
Level: -74.8 dB DSP load: 0.1%
Clipping: 0.0% Stream load: 0.0%

Graphics: **22.8 FPS (43.8ms)**
CPU: main 43.8ms render thread 41.1ms
Batches: 6231 Saved by batching: 0
Tris: 26.0M Verts: 18.6M
Screen: 5760x2160 - 142.4 MB
SetPass calls: 4189 Shadow casters: 177
Visible skinned meshes: 0
Animation components playing: 0
Animator components playing: 0

Old Camera: ~22 Frames Per Second



The screenshot shows a performance statistics overlay for the 'New Camera'. The background is the same 3D scene as the left image. The overlay is a dark grey box with white text. The 'Statistics' section is at the top. Below it, 'Audio' stats are shown: Level: -74.8 dB, Clipping: 0.0%, DSP load: 0.1%, and Stream load: 0.0%. The 'Graphics' section follows, with '60.1 FPS (16.6ms)' highlighted in a red box. Other graphics stats include CPU: main 16.6ms, render thread 15.9ms, Batches: 4825, Saved by batching: 0, Tris: 16.8M, Verts: 12.0M, Screen: 5760x2160 - 142.4 MB, SetPass calls: 3629, Shadow casters: 33, Visible skinned meshes: 0, Animation components playing: 0, and Animator components playing: 0.

Statistics

Audio:
Level: -74.8 dB DSP load: 0.1%
Clipping: 0.0% Stream load: 0.0%

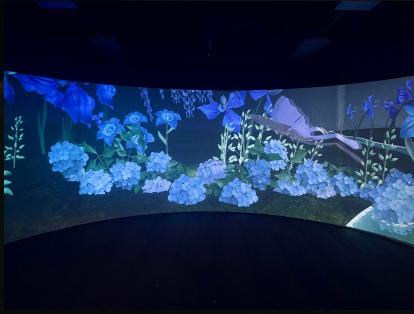
Graphics: **60.1 FPS (16.6ms)**
CPU: main 16.6ms render thread 15.9ms
Batches: 4825 Saved by batching: 0
Tris: 16.8M Verts: 12.0M
Screen: 5760x2160 - 142.4 MB
SetPass calls: 3629 Shadow casters: 33
Visible skinned meshes: 0
Animation components playing: 0
Animator components playing: 0

New Camera: ~60 Frames Per Second





We make Sample Scene to



Arouse Sense of Immersion

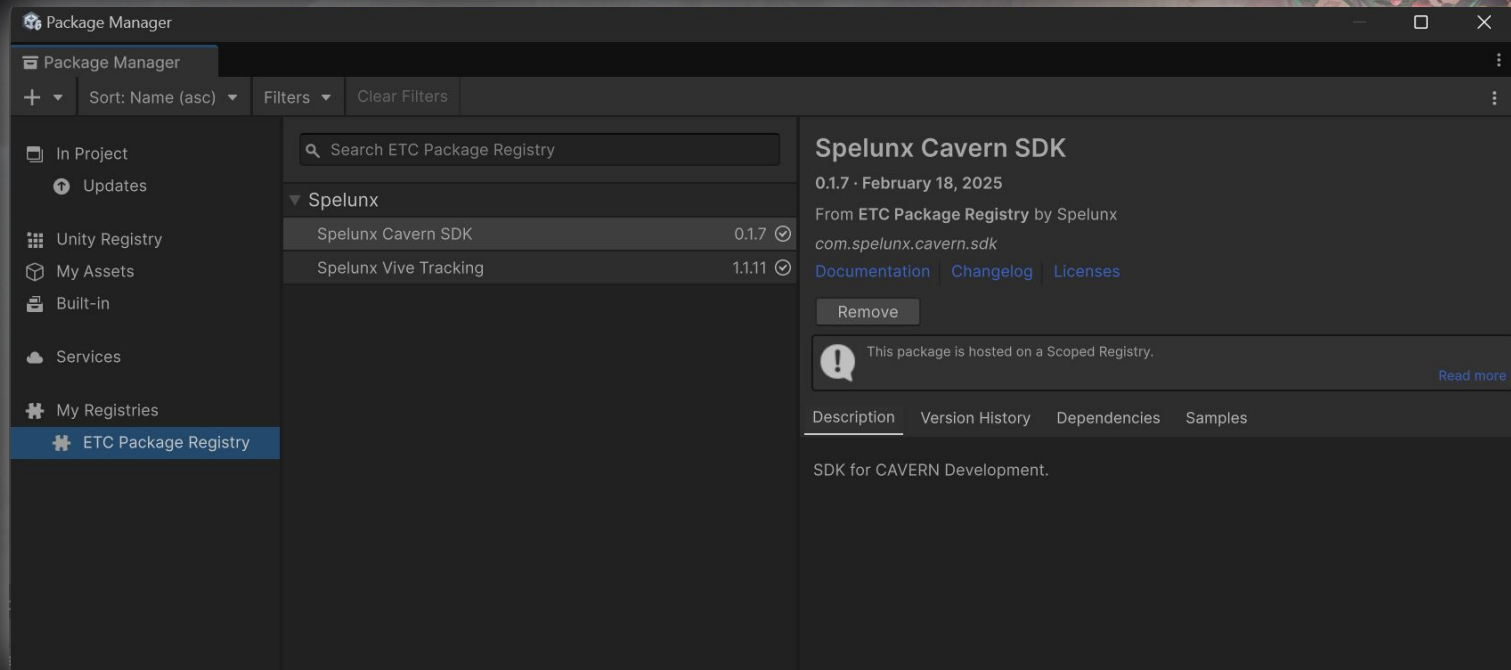


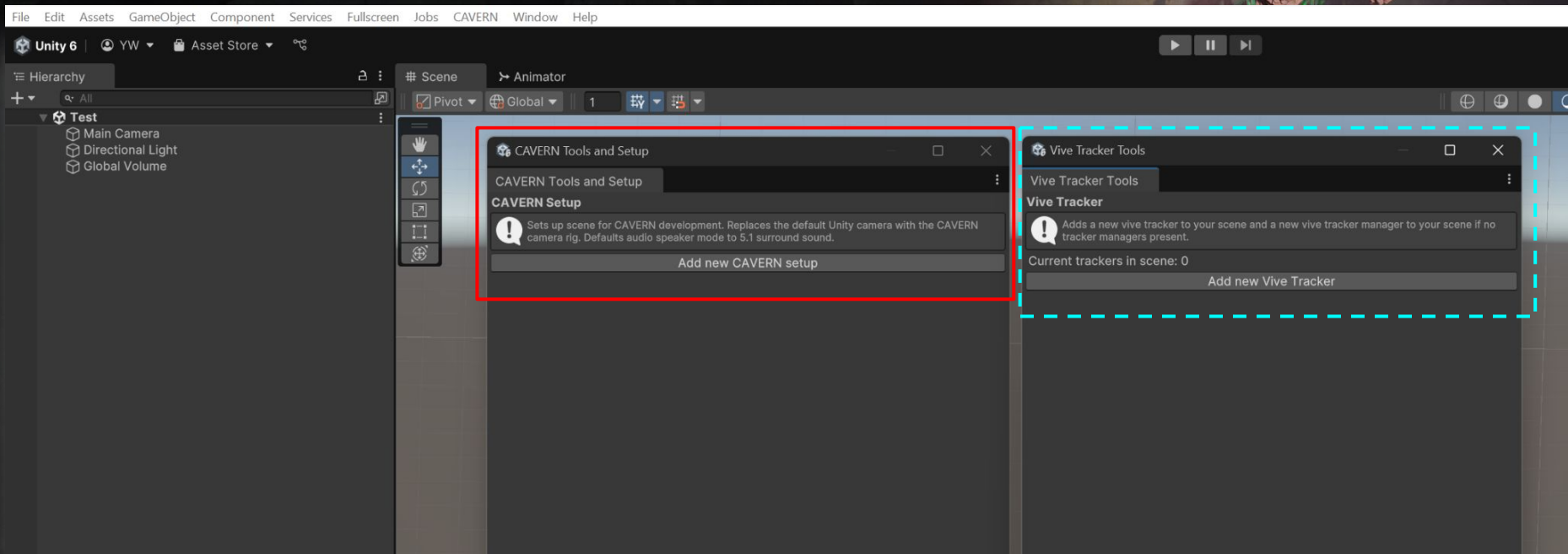
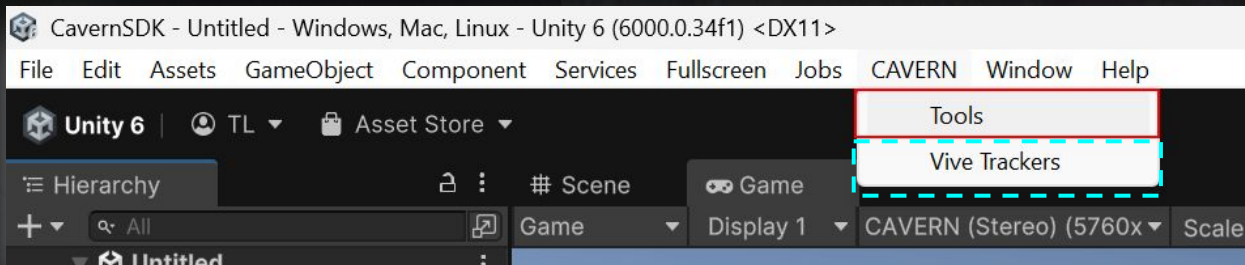
Demo Interactions



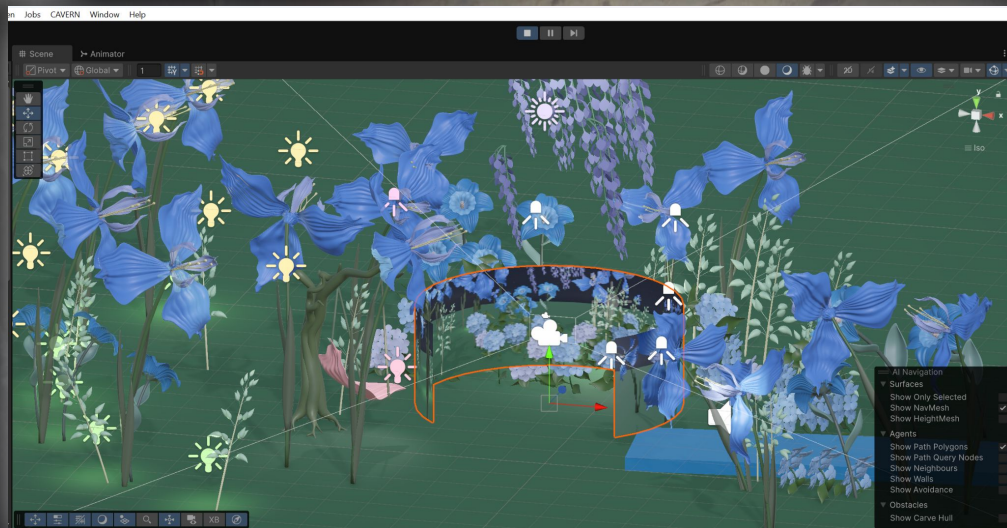
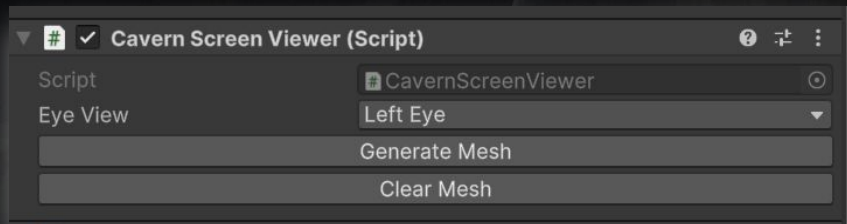
Prove Performance

Toolkit/Package Management





CAVERN Preview



Input - Vive Trackers

Gives **position** and 6 degrees of freedom **rotation**

Designed for use with VR headsets



Input - Vive Trackers

5 potential methods

1. OpenXR + OpenVR + SteamVR
2. OpenXR + OpenVR + vive tracker package
3. OpenXR + Vive Tracker Profile
4. OpenXR + OpenVR + VIU
5. Libsurvive + ???



Input - Vive Trackers

4 potential methods

- ~~1. OpenXR + OpenVR + SteamVR (bulky, outdated)~~
2. OpenXR + OpenVR + vive tracker package
3. OpenXR + Vive Tracker Profile
4. OpenXR + OpenVR + VIU
5. Libsurvive + ???



Input - Vive Trackers

3 potential methods

- ~~1. OpenXR + OpenVR + SteamVR (bulky, outdated)~~
- ~~2. OpenXR + OpenVR + vive tracker package (crashes Unity)~~
3. OpenXR + Vive Tracker Profile
4. OpenXR + OpenVR + VIU
5. Libsurvive + ???



Input - Vive Trackers

2 potential methods

- ~~1. OpenXR + OpenVR + SteamVR (bulky, outdated)~~
- ~~2. OpenXR + OpenVR + vive tracker package (crashes Unity)~~
- ~~3. OpenXR + Vive Tracker Profile (doesn't work without headset)~~
4. OpenXR + OpenVR + VIU
5. Libsurvive + ???



Input - Vive Trackers

2 potential methods

- ~~1. OpenXR + OpenVR + SteamVR (bulky, outdated)~~
- ~~2. OpenXR + OpenVR + vive tracker package (crashes Unity)~~
- ~~3. OpenXR + Vive Tracker Profile (doesn't work without headset)~~
4. **OpenXR + OpenVR + VIU + SteamVR** (works, bulky)
5. Libsurvive + ???



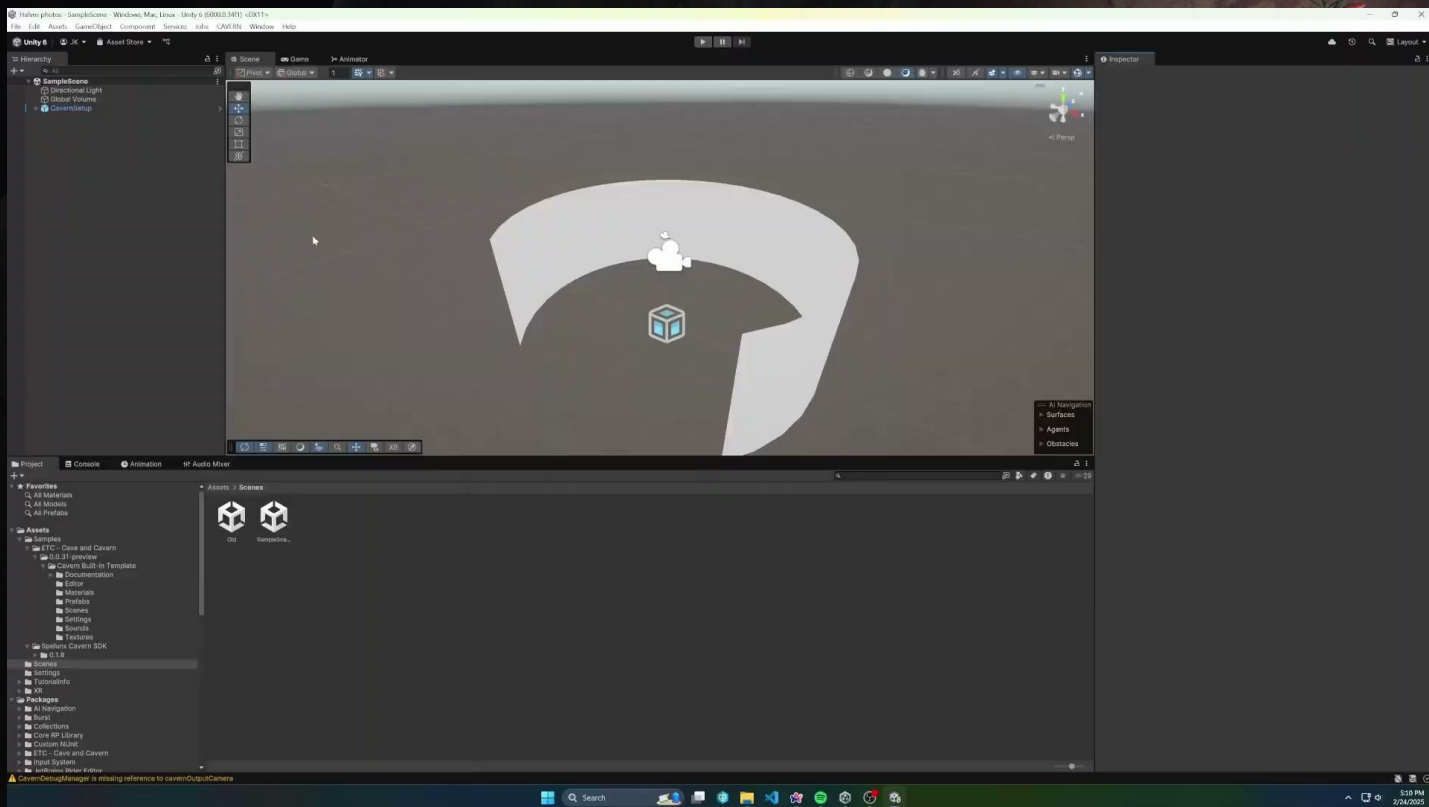
Input - Vive Trackers

1 working method

- ~~1. OpenXR + OpenVR + SteamVR (bulky, outdated)~~
- 2. OpenXR + OpenVR + vive tracker package**
- ~~3. OpenXR + Vive Tracker Profile (doesn't work without headset)~~
- ~~4. OpenXR + OpenVR + VIU + SteamVR (bulky, too many packages)~~
- ~~5. Libsurvive + ??? (requires redoing CAVERN setup)~~



Input - Vive Trackers



Documentation - User Guides

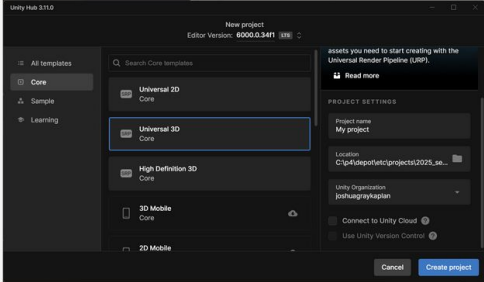
SPELUNXDOCUMENTATIONSETTING UP

SETTING UP

→ UNITY SETUP

The CAVERN package is designed for Unity 6, so that is the version that needs to be installed. Any version of Unity 6 should work but we would recommend the latest LTS version, which is 6000.0.37f1.

Create a new Unity 6 project using "Universal 3D"



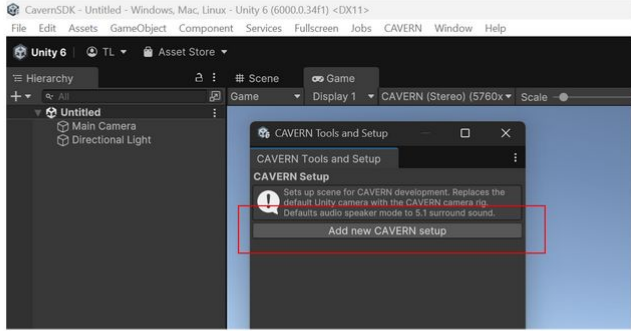
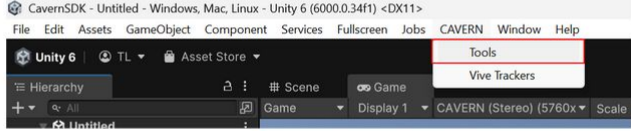
→ INSTALLING THE SPELUNX CAVERN PACKAGE

- Go to **Edit > Project Settings > Package Manager**



Cavern Unity Setup User Guide

- Add a **CavernSetup** to your scene. The **CavernSetup** prefab can be added to the scene via the **Tools** menu in the toolbar.



Documentation - API Documentation

Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

FullscreenEditor

Spelunx

CavernRenderer

CavernScreenViewer

A preview screen to simulate the Cavern screen in the editor's Scene window

CavernScreenViewerInspector

MathsUtil

Utility class for maths functions

MoveWith

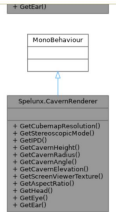
Window

EvasiveMotion

MotionMirrorer

Spelunx Cavern SDK

Collaboration diagram for Spelunx CavernRenderer:



Public Types

```
enum StereoscopicMode { Mono, Stereo }
enum CubemapResolution { Low = 1024, Mid = 2048, High = 4096, VeryHigh = 8192 }
```

Public Member Functions

```
CubemapResolution GetCubemapResolution ()
StereoscopicMode GetStereoscopicMode ()

float GetFOV ()
float GetCavernHeight ()
float GetCavernRadius ()
float GetCavernAngle ()
float GetCavernElevation ()

RenderTexture GetScreenViewerTexture ()
float GetAspectRatio ()

GameObject GetHead ()
GameObject GetEye ()
GameObject GetEar ()
```

Detailed Description

Definition at line 7 of file CavernRenderer.cs.

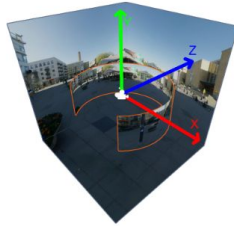
Member Enumeration Documentation

CubemapResolution

Documentation - Technical Documentation

Determining Fragment Position On Screen

To determine the 3D position of a fragment, consider "unrolling" our 3D screen into a flat 2D plane. In our fragment shader, we have our UV coordinates. We can also pass the physical height, radius and end-to-end angle of the screen into our shader as a uniform.



Screen Dimensions in 3D



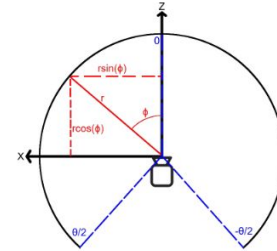
Screen "Unrolled" into a 2D plane.

Assume both the camera and the centre of the screen are at the origin.

Firstly, we shall define a few variables. Let

- h be the physical height of the screen in metres.
- r be the physical radius of the screen in metres.
- θ be the total angle of the screen from one end to the other in radians.

• P be the position of the fragment on the physical screen.



Top View of Screen

Since a u' value of -1 represents an angle of $-\frac{\theta}{2}$, and a u' value of 1 represents an angle of $\frac{\theta}{2}$.

Then,

$$\phi = u' \left(\frac{\theta}{2} \right)$$

and consequently,

$$P_x = r \sin(\phi), P_z = r \cos(\phi)$$

Thus,

$$P = (r \sin \phi, \frac{v' h}{2}, r \cos \phi)$$

Finally, we have our cubemap texture coordinates $\hat{P} = \frac{P}{|P|}$.

Documentation

Known Bugs

- When exiting full screen, after pressing ctrl+P, must press alt+F4. If it doesn't let you ctrl+P full screen again, go to windows->layout->reset all layout
- The Orbec Trackers are sometimes flipped
 - In the ETC cavern, the middle one is flipped upside down
 - In the high school cavern, all of them are flipped upside down
 - This needs to be accounted for by our toolkit
- South Fayette's Cavern has a different size
 - We need to account for that in our tools
- Sometimes unity crashes when exiting play mode and using vive trackers
- Vive tracker rotation isn't aligned with head
- Vive trackers aren't in same position as eyes

Living Best Practices

Design

- 2 ways of treating the CAVERN space
 - Use as a flat screen that's curved
 - Use CAVERN as a 3D space that extends beyond the screen
- Objects with non-detailed texture, larger scale, and colorful appearance look better in CAVERN.
- When you move around the CAVERN without head tracking, the world will appear to shift and sway. Either design experiences where you stand mostly still, or design things where the swaying gives them more life

The background of the image is a dark, textured surface, possibly a cave wall or a rocky landscape, with a small cluster of pink flowers in the upper right corner. The flowers are small and delicate, with green leaves and stems. The overall mood is somber and contemplative.

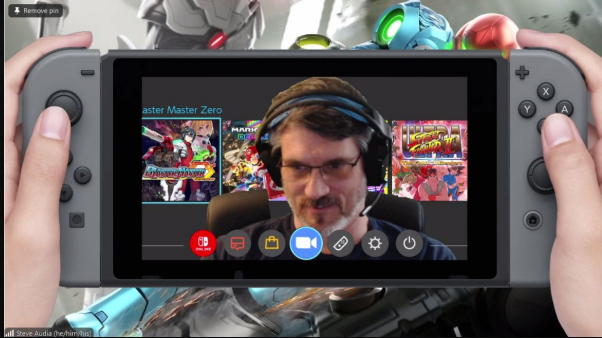
Looking forward

Previous		
Unity 5 BIRP (Build in Render Pipeline)		
No Interface		
Complex undocumented code		
Calibration sample scene		
32 cameras with limited performance		
No default setup support for input devices		
Lack of documentation		

Previous	Current	
Unity 5 BIRP (Build in Render Pipeline)	Unity 6 URP (Universal Render Pipeline)	
No Interface	One click interface window	
Complex undocumented code	Modular & expandable toolkit	
Calibration sample scene	Inspiring sample scene	
32 cameras with limited performance	1 camera, triple the performance	
No default setup support for input devices	Vive tracker setup supported in toolkit	
Lack of documentation	Well-organized & living documentation	

Previous	Current	Next
Unity 5 BIRP (Build in Render Pipeline)	Unity 6 URP (Universal Render Pipeline)	Technical art features in URP
No Interface	One click interface window	Systematic UI
Complex undocumented code	Modular & expandable toolkit	Polish modular toolkit
Calibration sample scene	Inspiring sample scene	Interactions in sample scene
32 cameras with limited performance	1 camera, triple the performance	2D rendering for GUI & video
No default setup support for input devices	Vive tracker setup supported in toolkit	Add 2nd input device: ORBECC Femto Bolt
Lack of documentation	Well-organized & living documentation	Continue testing & documentation...

Acknowledgements

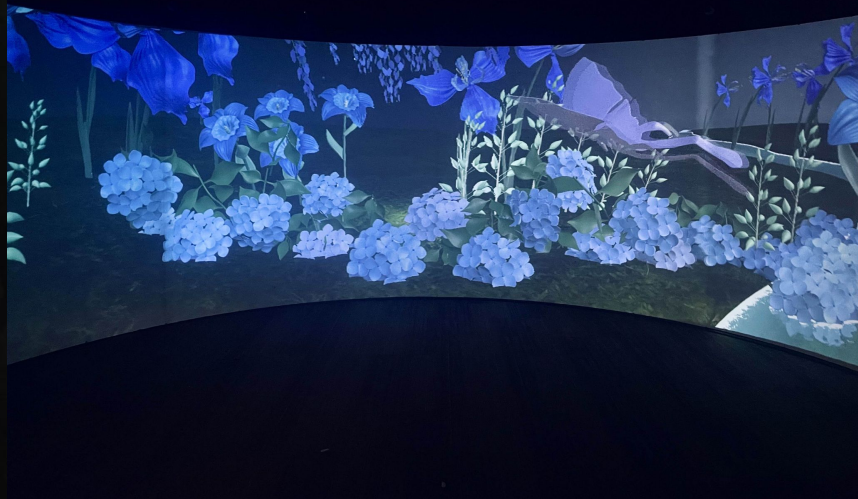


ask-ezra

Come see it in person!

Tomorrow (2/27) at **1pm** in the **CAVERN**

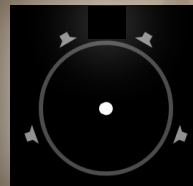
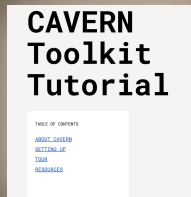
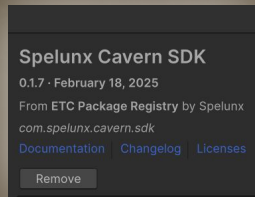
Our Sample Scene



CAVERN Jam Projects



CAVERN development tools for South Fayette and ETC



Questions?