UE4 TressFX 5.0

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Agenda

- UE4 TressFX 4.1 limitations
- UE4 TressFX 5.0
  - Simulation improvements
  - Rendering improvements
- Integration
- How to Use in UE4
- Future Work

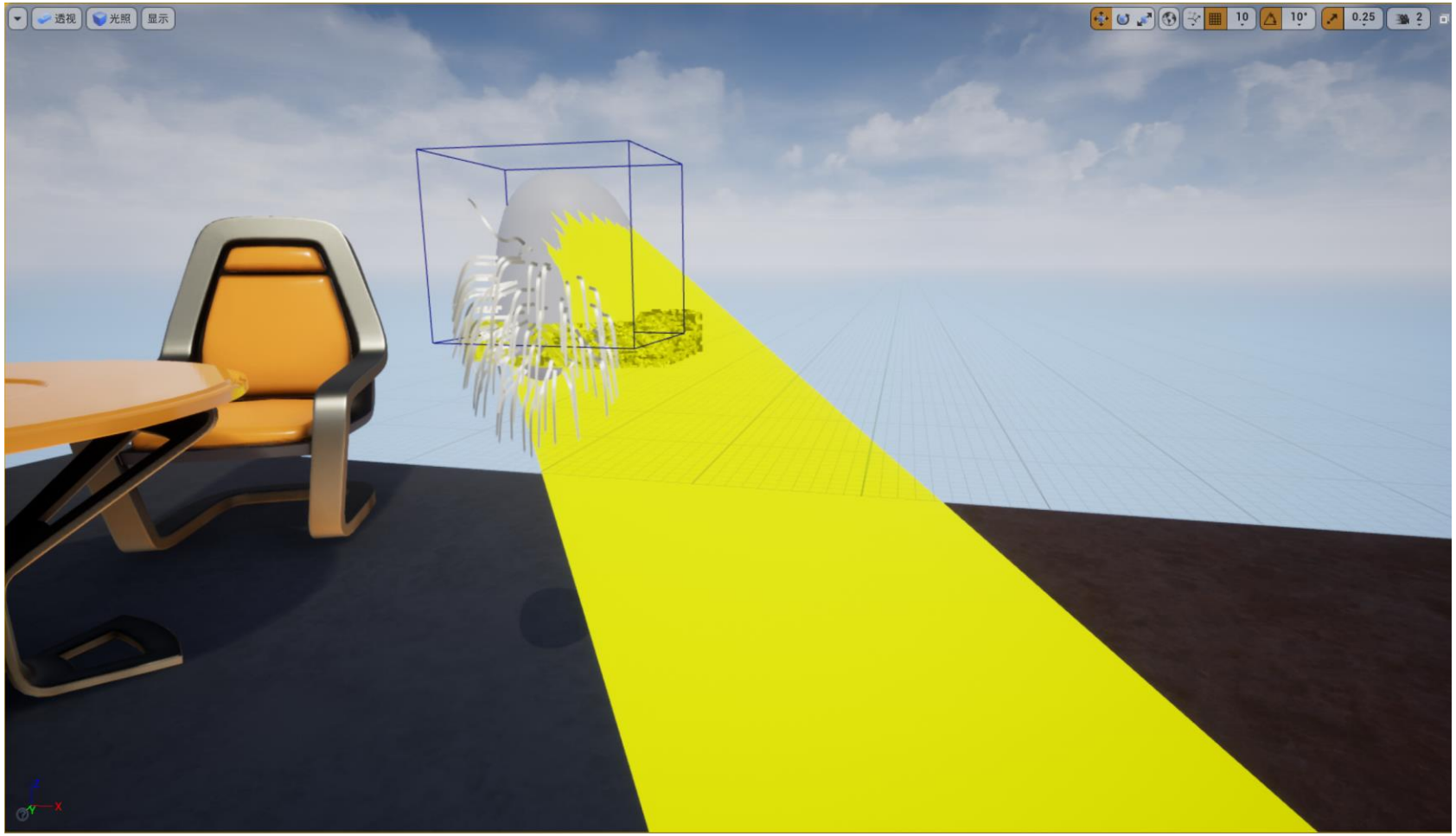
UE4 TRESSFX 4.1 LIMITATIONS

UE4 TressFX 4.1 limitations

- Maya Python Exporter
  - The number of binding bones limits to 4
  - Strands/Collision Mesh skinned twice if not export in the right way from Maya XGen
- Asset Editor & Visualization Tools
  - No support for LevelMap/Asset/Blueprint Editor well and lots of bugs
  - No support for Visualization tools to check whether asset is correct
- Simulation
  - Animation data used for simulation lags a frame behind UE4 Skinned Mesh animation data
  - Simulation Editor wasn't easy to use and no SDF Editor
  - SDF BoundingBox was computed on CPU side
  - SDF limitation which from developer feedback
- Rendering
  - No support for TAA
  - No support for SkyLight
  - No support for Cast/Receive Shadows
  - ResourceManagement was not reasonable enough which is very important to implement Editors

Limitations from developer feedback

- SDF Info is incorrect, yellow area is SDF Voxels



Limitations from developer feedback

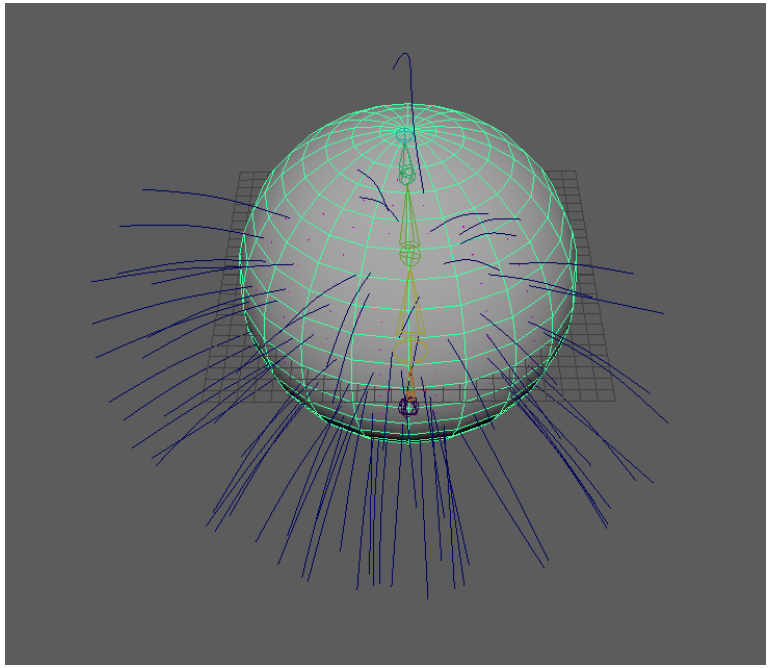
- Animation data used for simulation lags a frame behind UE4 Skinned Mesh animation data

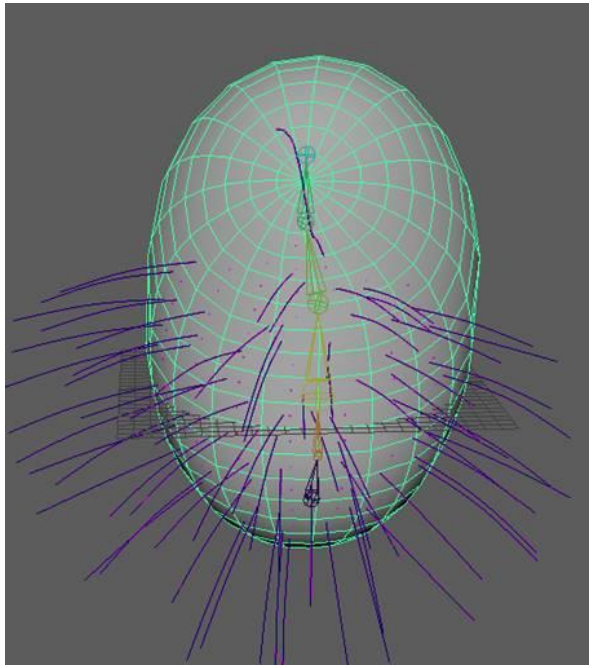
UE4 TRESSFX 5.0

How to implement improvements

- Prepare Simple Maya Asset for test
- Check whether the Asset is correct after it’s imported in UE4
- Validate the Collision Mesh Computation
- Reproduce simulation issue by making a video
- Validate the SDF Computation

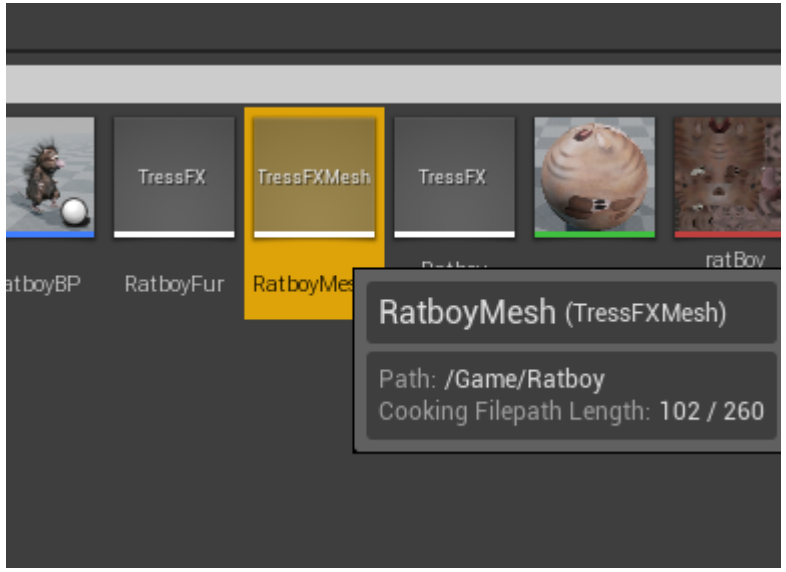
Simple Maya Asset for test

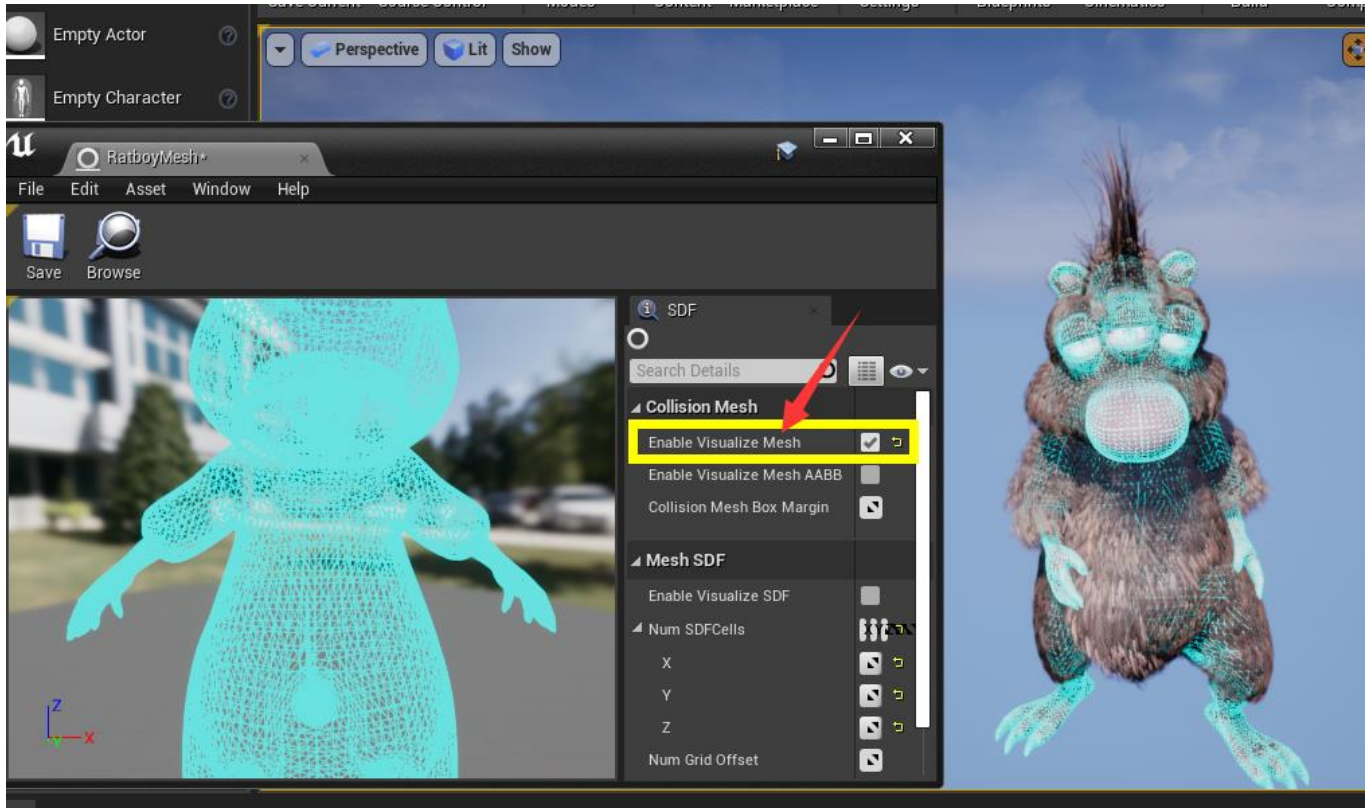




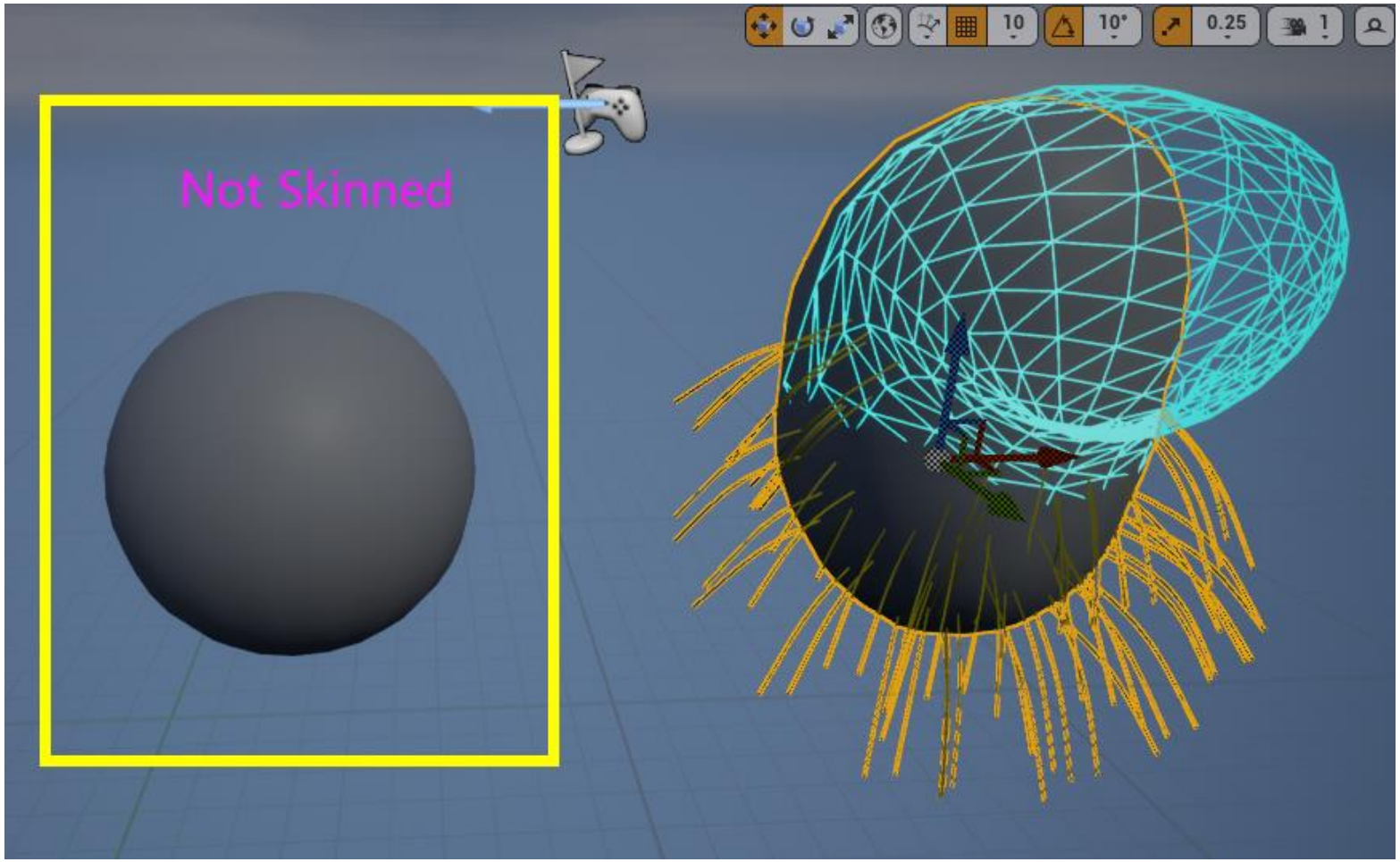
- Two Keyframes
- Check to export from each Keyframe
- Need to Visualize Collision Mesh in UE4

TressFX Collision Mesh





Import in UE4 to Validate the Collision Mesh Computation



- If export from the second Keyframe, it would result in collision mesh and strands skinned twice
- Should export from the right keyframe

Reproduce < Animation data used for simulation lags a frame behind UE4 Skinned Mesh animation data>

- If the animation plays very fast,

it’s not easy to reproduce this issue

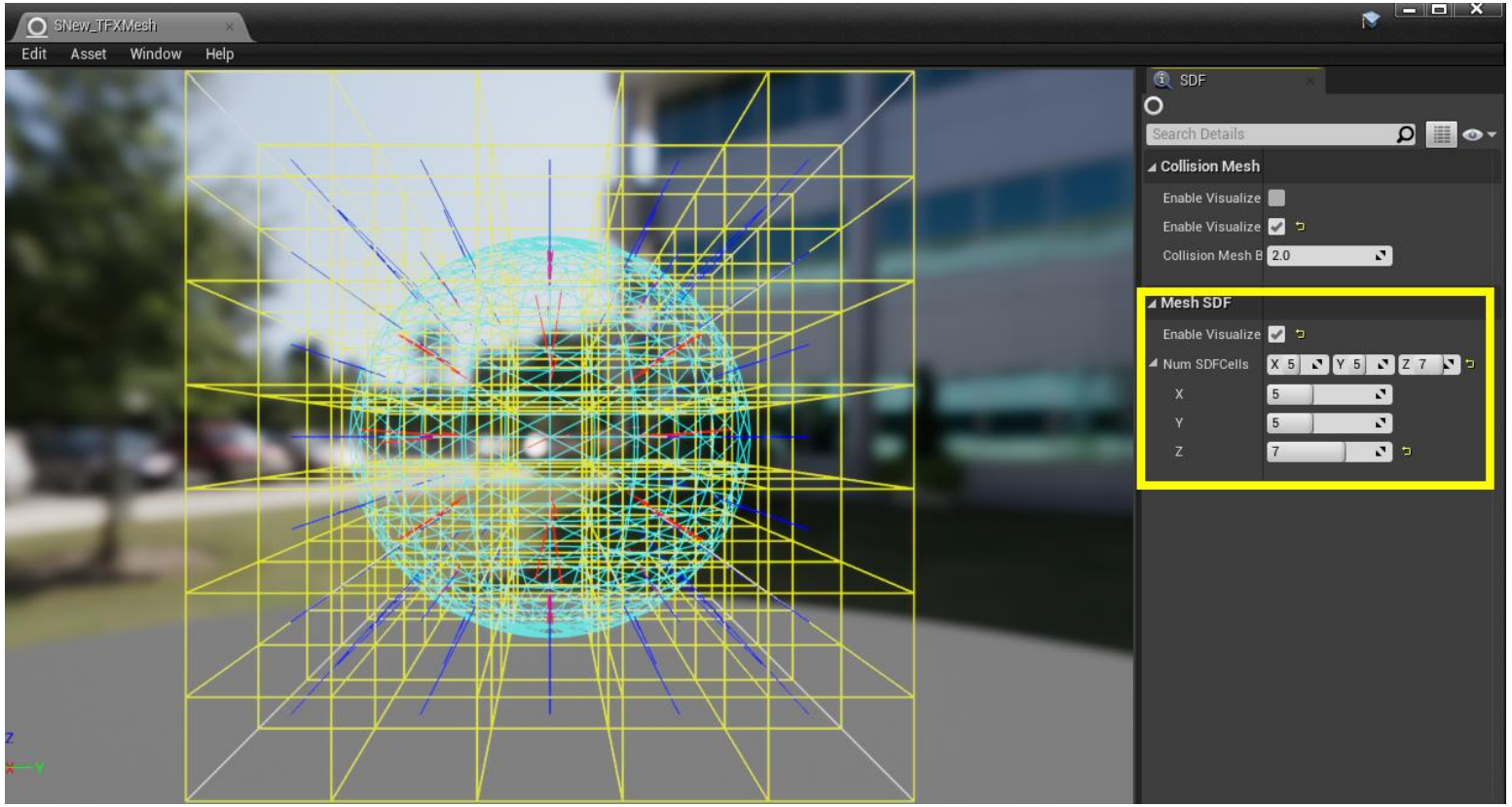
- To check whether it has been fixed,

also need to reproduce it

- Try to make a video by UE4 Sequencer

Improved <Animation data used for simulation lags a frame behind UE4 Skinned Mesh animation data>

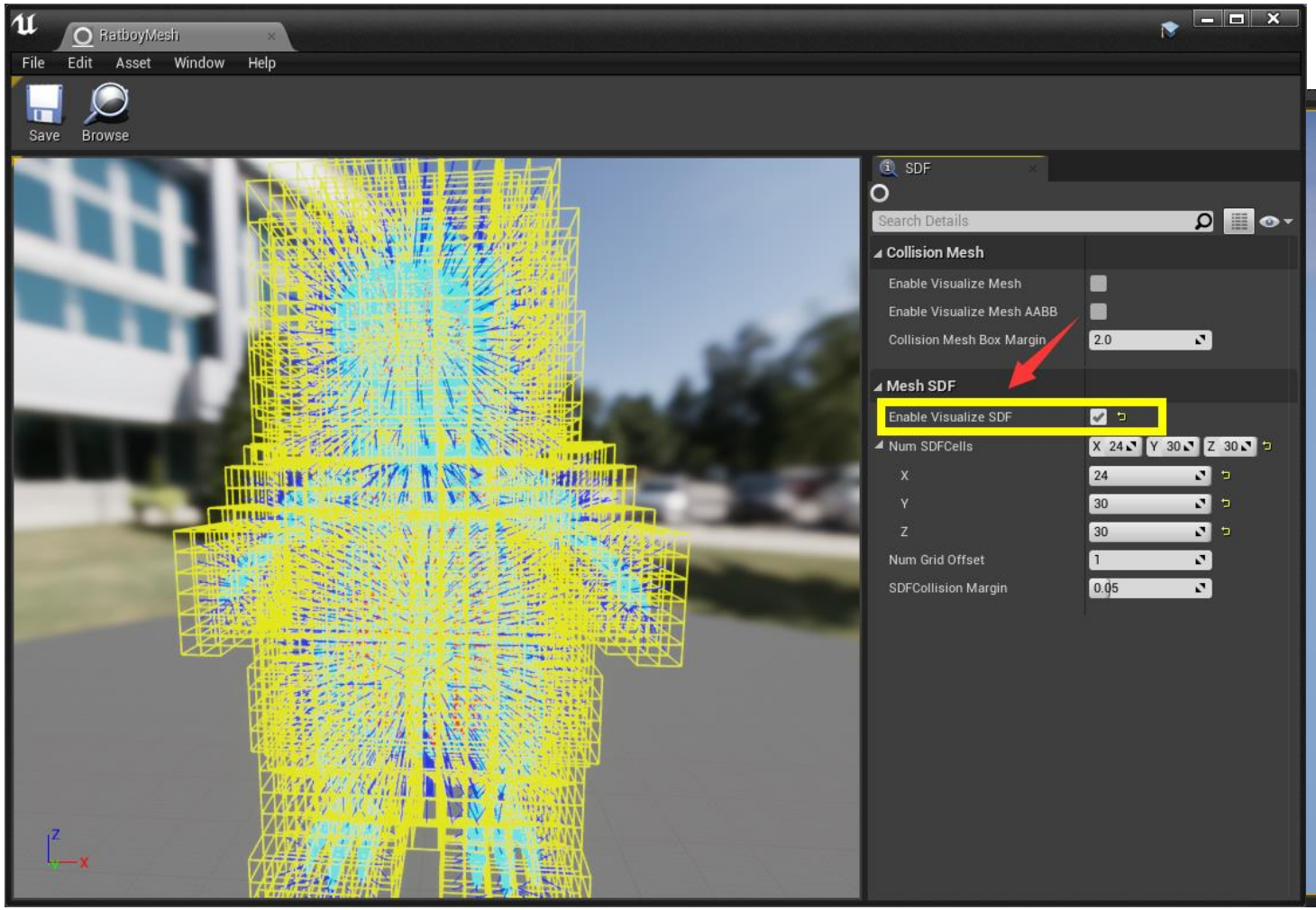
Validate the SDF Computation

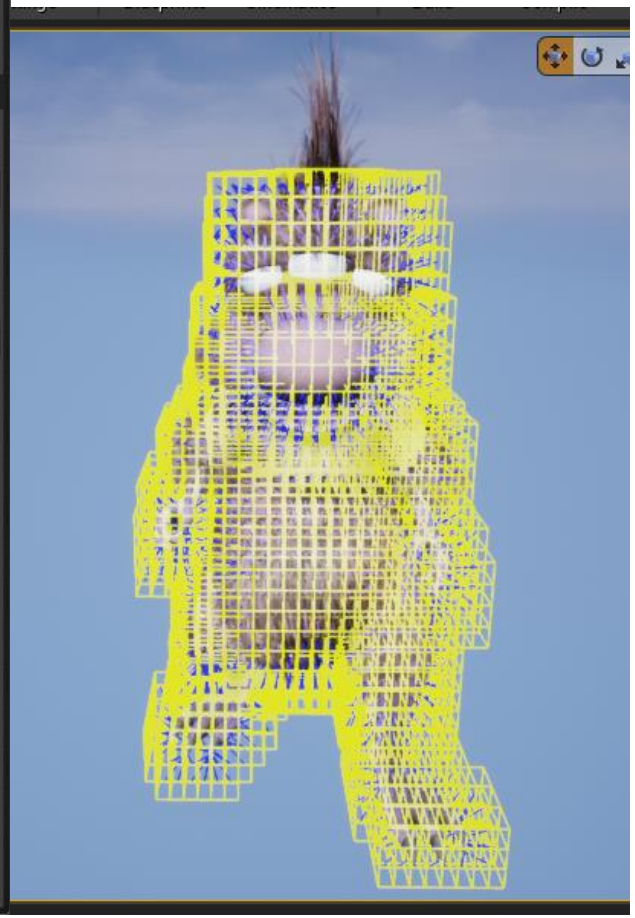


- Implement SDF Visualization
- SDF Visualization Algorithm:

<Per Voxel Linked List>,
it's a 3D version of <Per Pixel Linked List>

Validate the SDF Computation





SDF Avoid Penetration

SDF based Interaction with hands

New Resource Management to implement Editors

- TressFXComponent
  - InitResources
    - Gen TressFXGroupInstance and Register in TressFXManager
  - ReleaseResources
    - Unregister in TressFXManager and delete TressFXGroupInstance

- TressFXGroupInstance
  - WorldType – to handle different kinds of Editors
  - GuidesRestResources – static data
  - GuidesDeformedResources – do the simulation
  - StrandsResources – do the interpolation and rendering

Rendering Improvements

- ShortCut Simplification
- Directly use UE4 Hair Shading Model
- DeepShadow Optimization
- Strands RootUV and StrandUV Feature
- Support TAA

ShortCut Simplification

- Transparent
  - K-Layers Default Blend Formula (K=3)

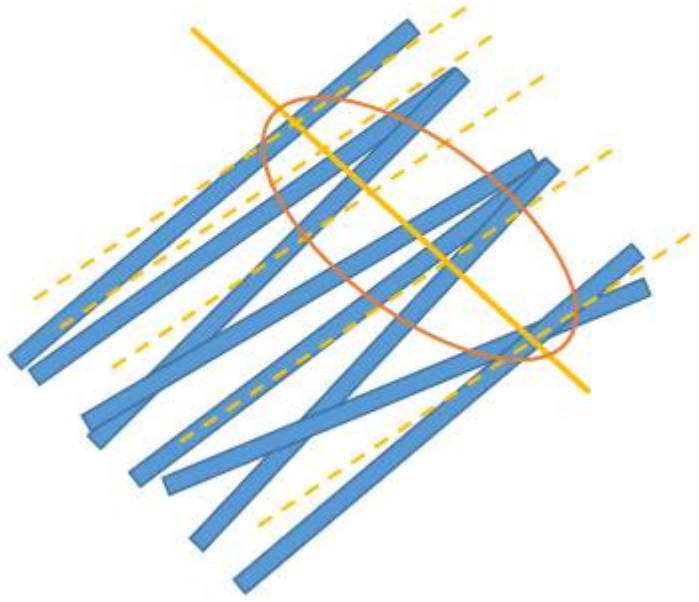
$$C_{final} = \alpha_0 C_0 + (1-\alpha_0)(\alpha_1 C_1 + (1-\alpha_1)(\alpha_2 C_2 + (1-\alpha_2)C_3))$$
$$C_{final} = \alpha_0 C_0 + (1-\alpha_0)\alpha_1 C_1 + (1-\alpha_0)(1-\alpha_1)\alpha_2 C_2 + (1-\alpha_0)(1-\alpha_1)(1-\alpha_2)C_3$$

  - K-Layers ShortCut Blend Formula (K=3)

$$C_{final} = \frac{(\alpha_0 C_0 + \alpha_1 C_1 + \alpha_2 C_2)}{(1+\alpha_0+\alpha_1+\alpha_2)}(1-(1-\alpha_0)(1-\alpha_1)(1-\alpha_2)\cdots(1-\alpha_n))$$
$$+(1-\alpha_0)(1-\alpha_1)(1-\alpha_2)\cdots(1-\alpha_n)C_{opaque}$$

  - ShortCut Simplification just shading the 1st Layer

DeepShadow Optimization



- New Shading Model needs Hair Count info to do Global Scattering
- Hundreds of layers texture IO may happen to many pixels
- PPLL to randomly sample 20 layers to approximate

Strands RootUV and StrandUV Feature

TressFXVertexFactoryCommon.ush | TressFXVertexFactory.ush | LightRendering.cpp | DeferredShadingRenderer.cpp | TressFXSDFComponent.cpp | TressFX

```
42
43  struct FVertexFactoryInterpolantsVSToPS
44  {
45      TANGENTTOWORLD_INTERPOLATOR_BLOCK
46
47  #if INTERPOLATE_VERTEX_COLOR
48      half4   Color : COLOR0;
49  #endif
50
51  #if USE_INSTANCING
52      // x = per-instance random, y = per-instance fade out amount, z = hi
53      float4  PerInstanceParams : COLOR1;
54  #endif
55
56  #if NUM_TEX_COORD_INTERPOLATORS
57      float4  TexCoords[(NUM_TEX_COORD_INTERPOLATORS+1)/2]    : TEXCOORD0;
58  #elif USE_PARTICLE_SUBUVS
59      float4  TexCoords[1] : TEXCOORD0;
60  #endif
61
```

mmon.ush | TressFXVertexFactory.ush | LightRendering.cpp | DeferredShadingRenderer.cpp | TressFXSDFComponent.cpp | Tress

```
Interpolants = (FVertexFactoryInterpolantsVSToPS)0;

const FVertexInfo VertexInfo = GetVertexInfo(Input);
uint StrandID = VertexInfo.VertexIndex / TressFXVF_NumVerticesPerSt
StrandID = TressFXVF_StrandsIDBuffer[StrandID];
float2 RootUV = TressFXVF_RootUVBuffer[StrandID].xy;
float2 StrandUV = float2(VertexInfo.IsLeft ? 0 : 1.0, float(VertexI

#if NUM_TEX_COORD_INTERPOLATORS > 0
    Interpolants.TexCoords[0].xy = RootUV;
    #if NUM_TEX_COORD_INTERPOLATORS > 1
        Interpolants.TexCoords[0].zw = StrandUV;
    #endif
#endif
```

Local Windows Debugger

ommon.ush | TressFXVertexFactory.ush | LightRendering.cpp | DeferredShadingRenderer.cpp | TressFXSDFComponent.cpp

```
ndif

Result.TwoSidedSign = 1;
Result.PrimitiveId = GetPrimitiveId(Interpolants);
Result.HairPrimitiveId = Interpolants.HairPrimitiveId;
Result.HairPrimitiveUV = float2(Interpolants.HairPrimitiveUV);

#if NUM_TEX_COORD_INTERPOLATORS > 0
    Result.TexCoords[0] = Interpolants.TexCoords[0].xy;
    #if NUM_TEX_COORD_INTERPOLATORS > 1
        Result.TexCoords[1] = float2(Interpolants.HairPrimitiv
    #endif
#endif
```

New Mainflow of TressFX Simulation and Rendering

- FDeferredShadingSceneRenderer::Render
  - InitViews
  - ❖ TressFXSimulation
    - ❖ ProcessSDFGen
    - ❖ ProcessGuideSimulation
    - ❖ ProcessStrandsInterpolation
  - RenderBasePass
  - ❖ RenderTressFXPrePass
    - ❖ DeepShadow
  - ❖ RenderTressFXBasePass
    - ❖ Translucency/MaterialData/VelocityBuffer
  - ❖ RenderLights
  - ❖ RenderEnvLight

UE4 TressFX 5.0 Improvements

- Maya Python Exporter
  - Both Strands and Collision Mesh vertices support the number of binding bones up to 16
  - Strands/Collision Mesh should be exported in the right initial position and keyframe
- Asset Editor & Visualization Tools
  - Support LevelMap/Asset/Blueprint Editors and fixed previous bugs
  - Visualization tools to check whether asset is correct, like tangents, collision mesh
- Simulation
  - Improved <Animation data used for simulation lags a frame behind UE4 Skinned Mesh animation data>
  - Improved Simulation Editor and implement SDF Editor
  - SDF BoundingBox is computed on GPU side
  - Improved SDF feature according to developer feedback
- Rendering
  - Support TAA/SkyLight/StrandsUV
  - Support Marschner ShadingModel
  - Support Cast/Receive Shadows
  - Improved ResourceManagement which is very important to implement Editors

UNREAL ENGINE INTEGRATION

Integration

- Asset
- Engine
- Snapshots
- Tools
- README.md

Asset › Content ›

名称

- Ratboy
- NewWorld.umap

Asset › Content › Ratboy

名称

- Ratboy.uasset
- Ratboy_Anim.uasset
- Ratboy_Eyes_MAT.uasset
- Ratboy_PhysicsAsset.uasset
- Ratboy_Skeleton.uasset
- RatboyBP.uasset

Engine ›

名称

- Plugins
- Shaders
- Source

Plugins › Runtime › TressFX › Source ›

名称

- TressFXCore
- TressFXEditor
- TressFXImportTranslator

Shaders › Private

名称

- TressFX
- DeferredLightPixelShadersTFX.usf
- DeferredLightVertexShadersTFX.usf
- MaterialTemplate.ush

LightRendering.cpp | DeferredShadingRenderer.cpp | TressFXSDFComponent.cpp | TressFXI

UE4 | (Global Scope)

```
24  // AMD TressFX BEGIN
25  #include "TressFX/TressFXRendering.h"
26  // AMD TressFX END
```

Source › Runtime › Renderer › Private ›

名称

- TressFX
- DeferredShadingRenderer.cpp
- DeferredShadingRenderer.h
- IndirectLightRendering.cpp
- LightGridInjection.cpp
- LightRendering.cpp
- SceneRendering.cpp
- SceneRendering.h
- SceneVisibility.cpp
- ShadowRendering.cpp
- ShadowRendering.h

Integration <UE4.26.2>

- Directly Copy and Replace the Engine folder to your local Engine folder
  - Engine/Plugins
  - Engine/Shaders
  - Engine/Source
- Double Click GenerateProjectFiles.bat
- Recompile UE4.sln
- Create a new Project with StarterContent
- Enable the Plugin TressFX 5.0 in PluginManager
- Copy the Asset/Content folder to the new project's Content folder
  - Content/Ratboy
  - Content/NewWorld
- Startup the project and Open NewWorld LevelMap
- The Lights(except SkyLight) in your LevelMap should enable CastDeepShadow before TressFX Render correctly

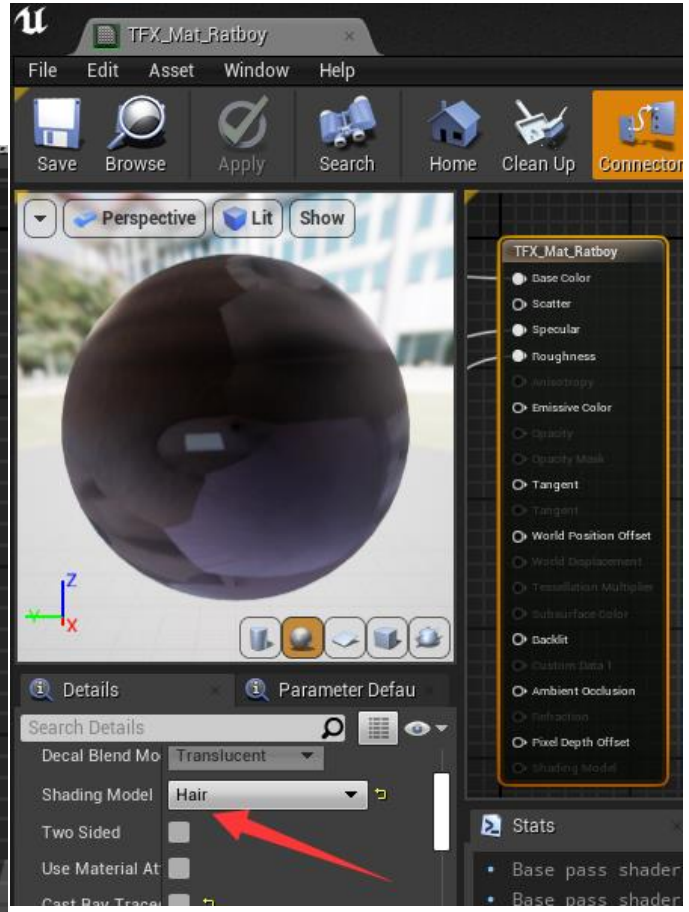
HOW TO USE IT

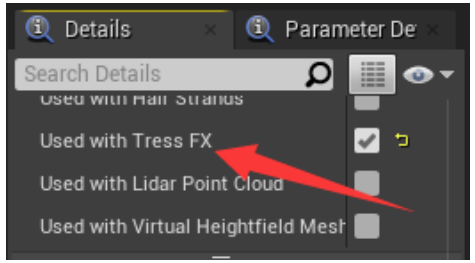
How to Use in UE4

- TressFX Material
- TressFX/TressFXMesh Asset Editor
- TressFX Blueprint Editor

TressFX Material

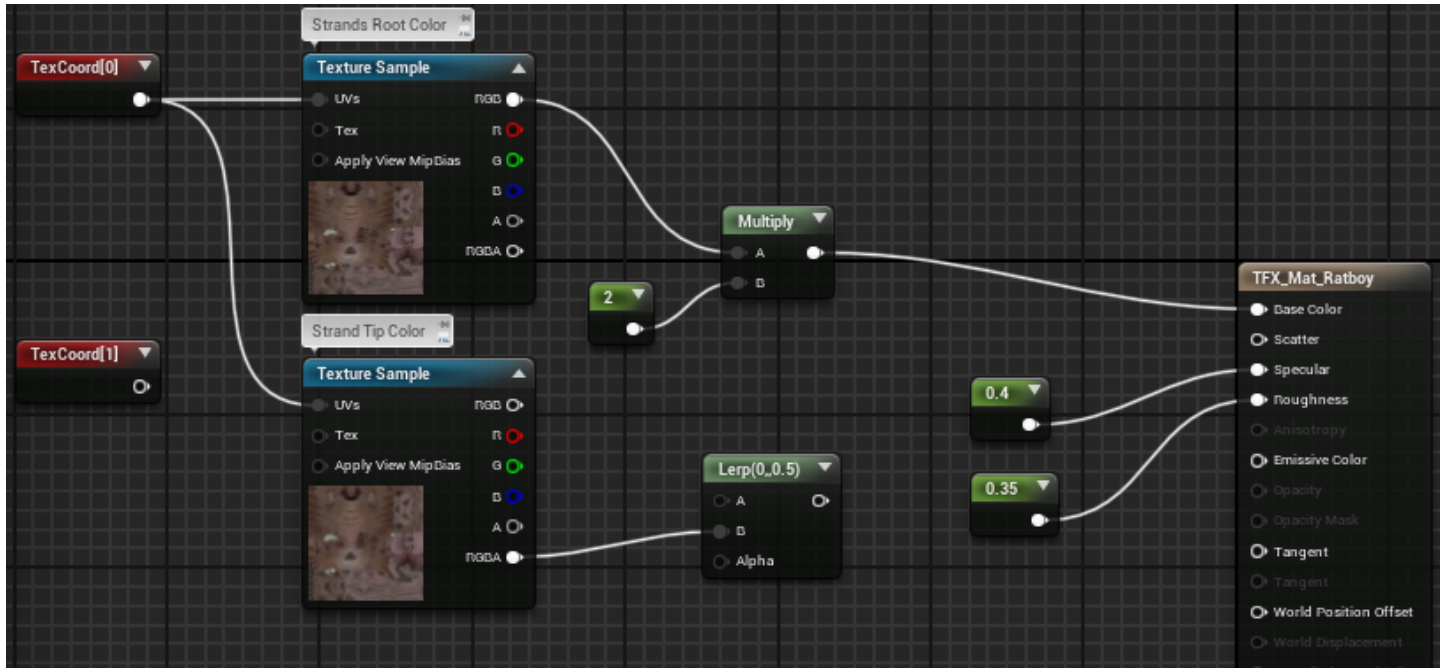
- Select <Result node of the Material>
- Set <Shading Model> to <Hair>
- Enable <Used with TressFX>



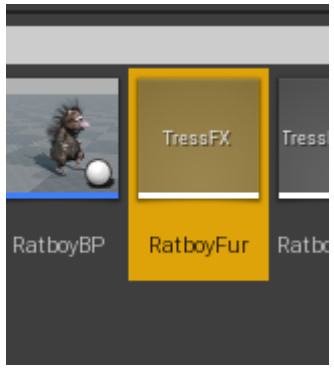


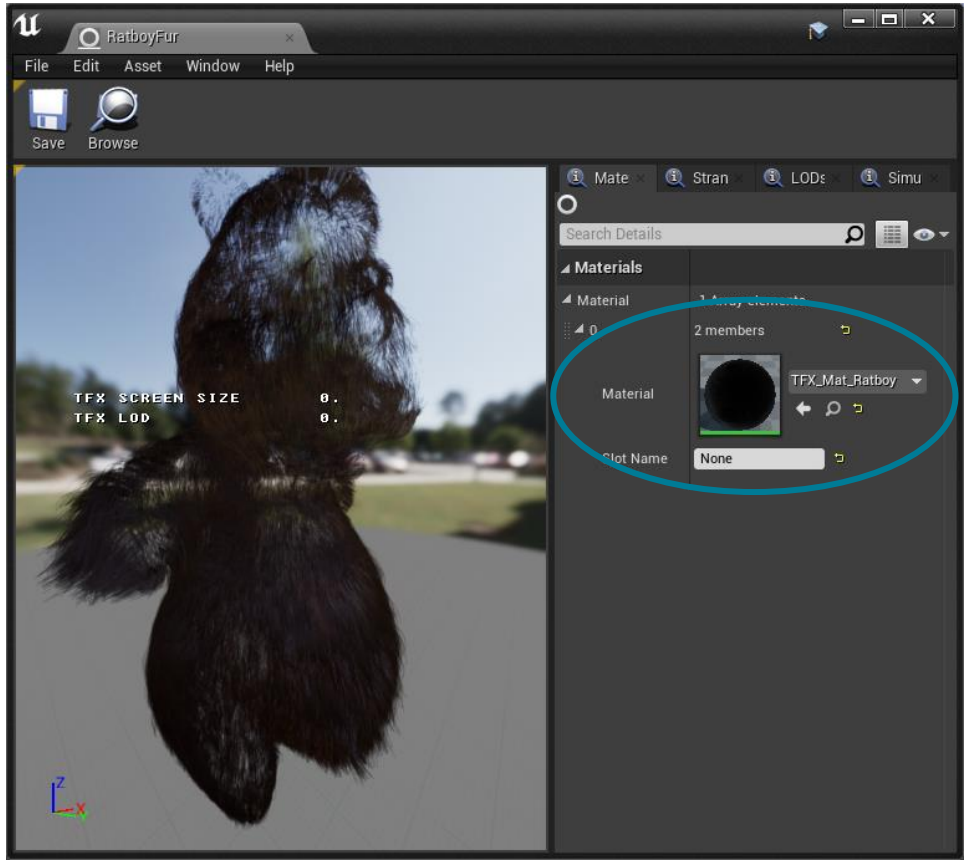
TressFX Material

- Recommend to Name your TressFX Material: TFX_Mat_*
- TexCoord[0] is RootUV
- TexCoord[1] is StrandUV



TressFX Asset Editor

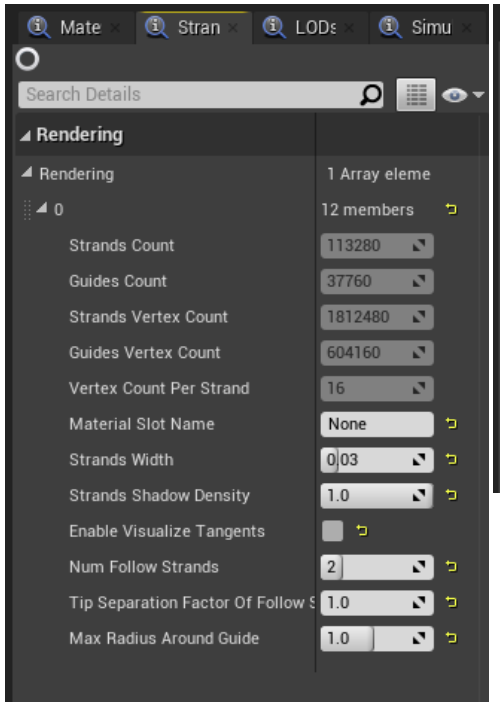


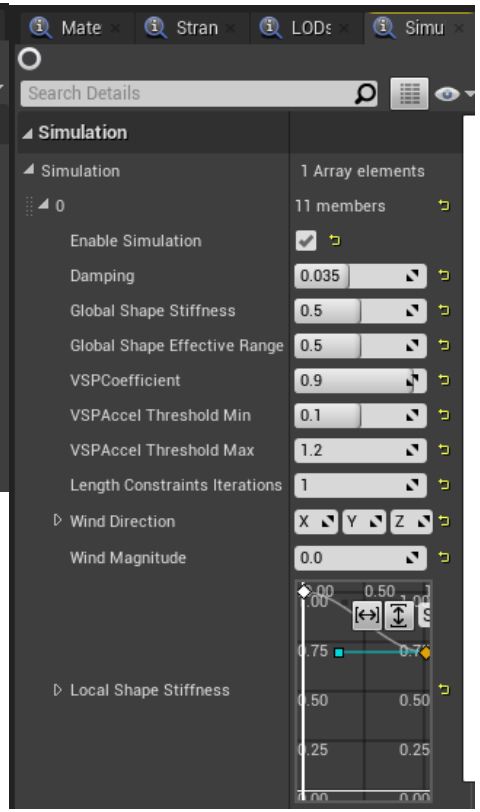


- Double Click RatboyFur Asset Open the AssetEditor
- Material Panel
- Choose and Set TFX_Mat_Ratboy Material

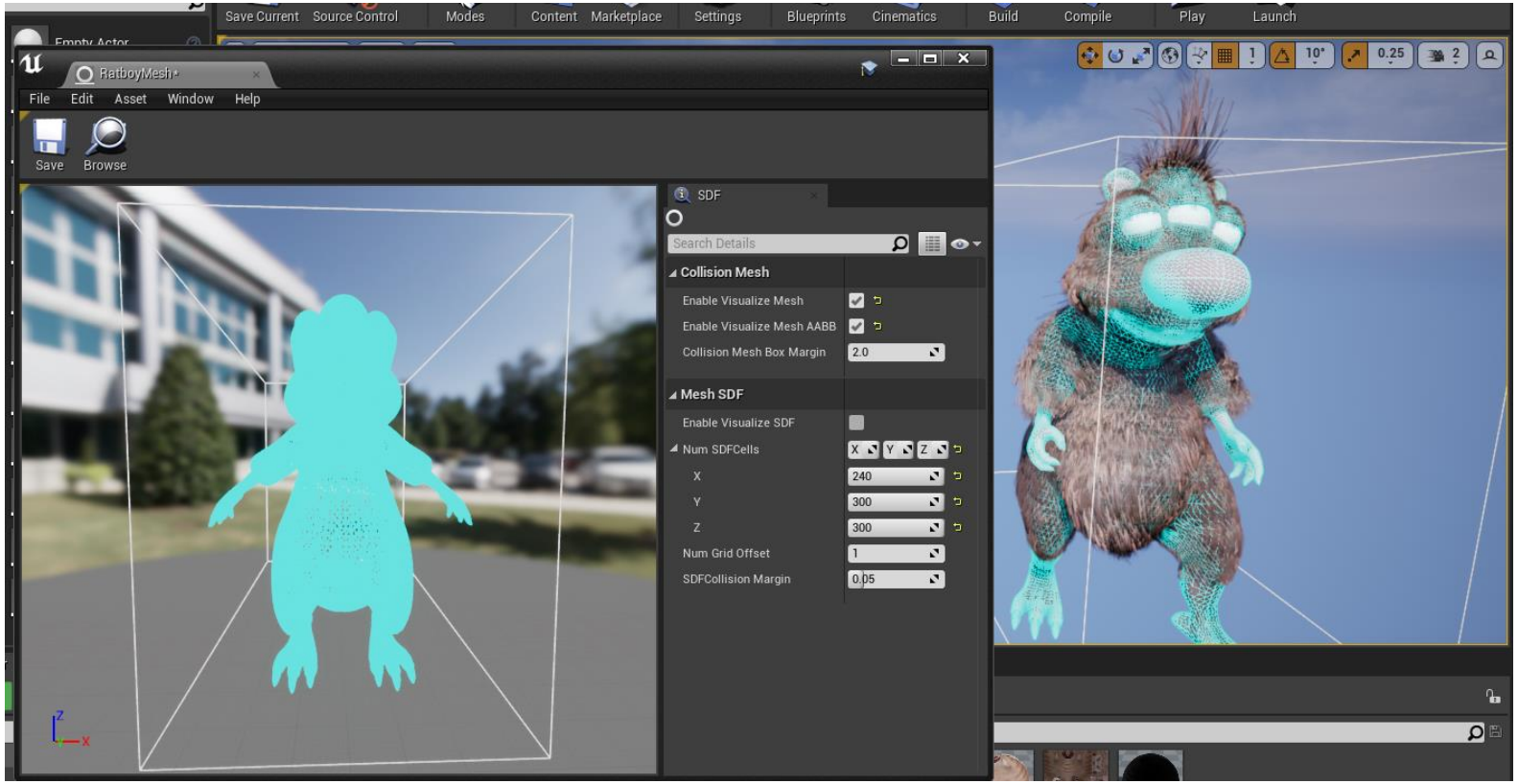
TressFX Asset Editor

- Strands Panel
- LOD Panel
- Simulation Panel





TressFXMesh Asset Editor

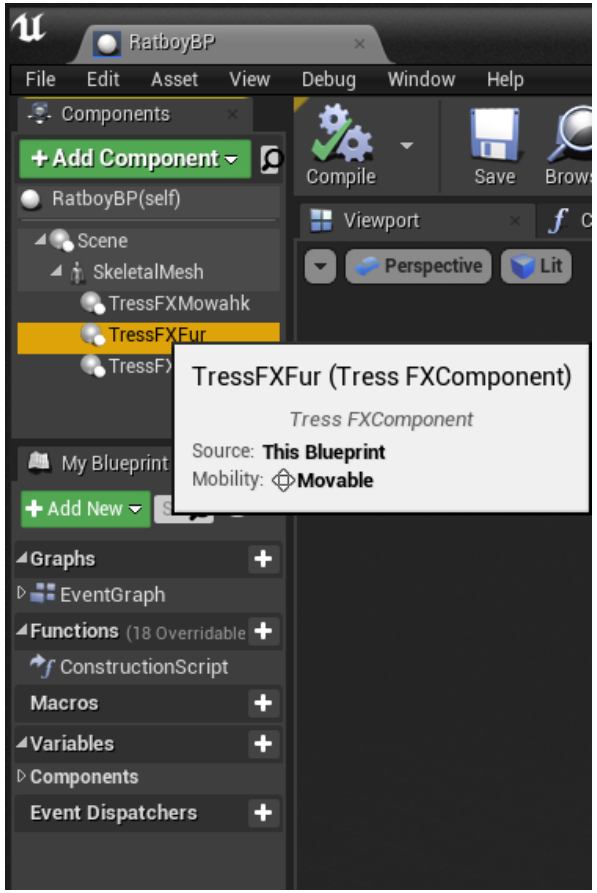


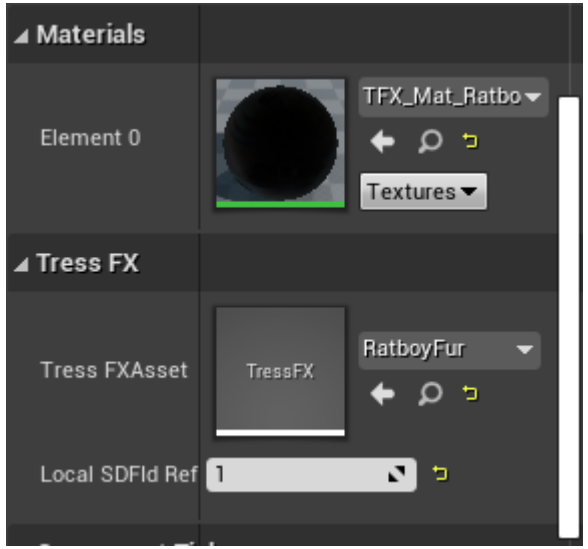
- Double Click RatboyMesh Asset
- Open the TressFXMesh AssetEditor
- Collision Mesh
  - Enable Visualize Mesh
  - Enable Visualize MeshAABB

TressFX Blueprint Editor

- Attach TressFXComponent to SkeletalMesh
- Set TressFX Asset
- Set Local SDFId Ref to Enable

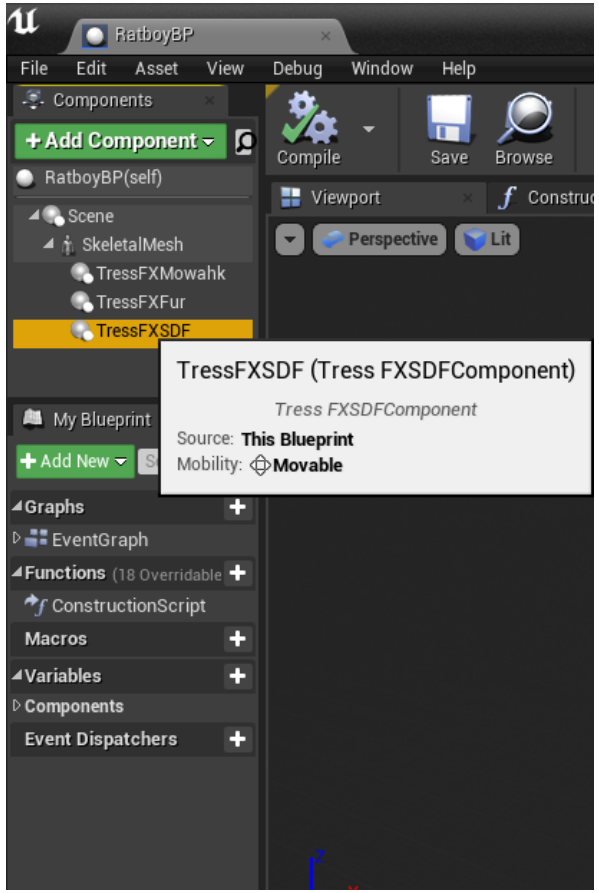
  SDF Collision Feature

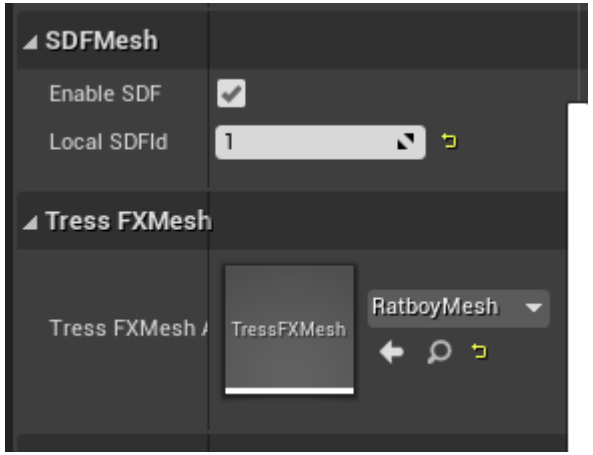




TressFX Blueprint Editor

- Attach TressFXSDFComponent to SkeletalMesh
- Set TressFXMesh Asset
  - Enable SDF
  - Set Local SDFId



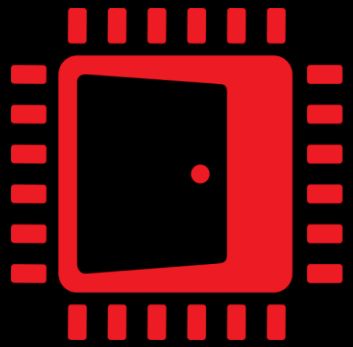


How to Use in UE4

FUTURE WORK

Future Work

- Support UE4.27 / UE5
- Support BlendShape Vertex Animation
- Research more about Rendering Optimization



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