

TRESSFX 3.X

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HIGH-LEVEL CONTENTS



- Brief TressFX overview
- ▲ TressFX 3.x library
 - Update to AMD's TressFX example implementation
 - Maya plugin
 - Viewer and runtime library (with full source)
 - Fur support
 - Skinning
 - Future optimizations
 - New memory-friendly OIT method (ShortCut)



A BRIEF HISTORY



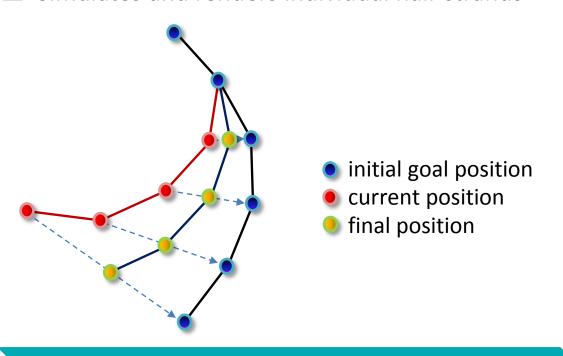
- ⚠ TressFX began as a collaboration between AMD and Crystal Dynamics
- ▲ First used in Tomb Raider.
 - PC and consoles
 - Set new quality bar for hair in games
- Optimized for AMD GCN architecture
 - Radeon HD 7000 or later
 - Consoles
- ▲ AMD is now also collaborating with Eidos-Montréal
 - Started with Tomb Raider code
 - Improvements and additions integrated into Dawn Engine™
 - Will be used in future Deus Ex Universe projects



TRESSFX OVERVIEW



- Two parts to TressFX
 - Physics simulation on the GPU using compute shaders
 - High-quality rendering
- Simulates and renders individual hair strands

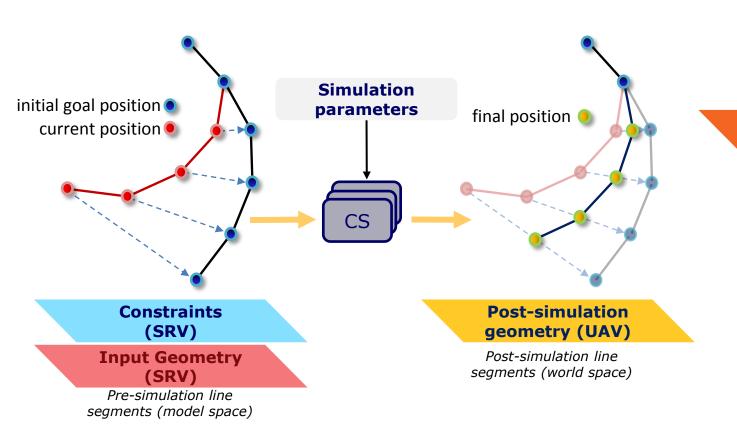




SIMULATION RENDERING

TRESSFX SIMULATION





▲ SIMULATION COMPUTE SHADERS

- Edge length constraint
- Local shape constraint
- Global shape constraint
- Model Transform
- Collision Shape
- External Forces (wind, gravity, etc.)

TRESSFX RENDERING





Good Lighting + Anti-Aliasing + Volume Shadows

+ Transparency





TRESSFX SAMPLE HISTORY



- ✓ TressFX 1.0
 - Example implementation (with full source)
- ▲ TressFX 2.x
 - Simulation performance improvements
 - Master and slave strands
 - Compute shader optimizations
 - $-1.6 \text{ ms} \rightarrow 0.3 \text{ ms}$
 - Rendering performance improvements
 - Deferred rendering
 - Distance adaptive LOD
 - Pixel shader optimizations
 - $-1.7 \text{ ms} \rightarrow 1.2 \text{ ms}$
 - With LOD, 0.3 ms (or lower) at a distance



TRESSFX 3.X



✓ TressFX 3.0

- Maya plugin
 - with full source
- Viewer and runtime library
 - with full source
- Fur support
- Skinning
- Free

▲ TressFX 3.1

- New ShortCut OIT method
 - Lower memory
 - Potentially better performance
 - But at slightly reduced quality vs. standard PPLL TressFX



TRESSFX 3.X VIEWER AND RUNTIME LIBRARY



- Viewer provided
 - Preview TressFX assets
- Runtime reorganized into a library
 - Easier integration
- Full source
 - Free
 - No black boxes

```
TressFX11_2012 - Microsoft Visual Studio (Administrator)
    EDIT VIEW PROJECT BUILD DEBUG TEAM TOOLS TEST ANALYZE WINDOW
                                                                              - Debug - Mixed Platforms - 🛍 _ 🚡 🛅 🐤 🏷 📱 🐧 🦎 👢
                                     ▶ Local Windows Debugger ▼ Auto
                            ▼ 🗓 🗙 TressFXRender.cpp 🕯 🕁 🗙
                                     → TressFXRender

→ RenderHair(ID3D11DeviceContext * pd3dContext)

G O A To - ≥ a Ta A O P D
Search Solution Explorer (Ctrl+;)
Solution 'TressFX11_2012' (5 projects)
▶ ♣ AMD_SDK
                                         // Renders the hair in two passes. The first pass fills an A-buffer by rendering the
DXUT
                                         // hair geometry into a per-pixel linked list which keeps all of the overlapping fragments.
DXUTOpt
                                          // The second pass renders a full screen quad (using a stencil mask set in the first pass

▲ TressFX_Library

                                         // to avoid unecssary pixels) which reads fragments from the per-pixel linked list
  ▶ ■ External Dependencies
                                         // and blends the nearest k fragments (K-buffer) in back to front order.
  ▶ # Header Files
      Resource Files
  Evoid TressFXRender::RenderHair(ID3D11DeviceContext* pd3dContext)
        TressFXRender.hlsl
                                             // Get original render target and depth stencil view
        TressFXSimulation.hlsl
                                             TIMER Begin( 0, L"ABufferFill" );

▲ Source Files

                                             ID3D11RenderTargetView* pRTV = DXUTGetD3D11RenderTargetView();
     ▶ ++ Matrix33.cpp
                                             ID3D11DepthStencilView* pDSV = DXUTGetD3D11DepthStencilView();
     b ++ Matrix44.cpp
     ▶ ++ Ouaternion.cpp
                                             // render hair
     ++ Transform.cpp
                                             const UINT dwClearDataMinusOne[1] = {0xFFFFFFFF};
     ▶ ++ TressFX.cpp
                                             pd3dContext->ClearUnorderedAccessViewUint(m pHeadPPLL UAV, dwClearDataMinusOne);
     ▶ ++ TressFXAsset.cpp
     ++ TressFXMesh.cpp
                                             // Clear stencil buffer to mask the rendering area
     ▶ ++ TressFXRender.cpp
                                             // Keep depth buffer for correct depth and early z
     ▶ ++ TressFXSimulation.cpp
                                             pd3dContext->ClearDepthStencilView(pDSV, D3D10 CLEAR STENCIL, 1.0, 0);
     ▶ ++ Util.cpp
     ▶ ++ Vector3D.cpp
                                              ID3D11UnorderedAccessView* pUAV[] = {m pHeadPPLL UAV, m pPPLL UAV, NULL, NULL, NULL, NULL, NULL};
      ReadMe.txt
                                                     pUAVCounters[] = { 0, 0, 0, 0, 0, 0, 0 };
▶ TressFX11
                                             pd3dContext->OMSetRenderTargetsAndUnorderedAccessViews(1, &pRTV, pDSV, 1, 7, pUAV, pUAVCounters);
                                             // disable color write if there is no need for fragments counting
                                             pd3dContext->OMSetBlendState(m pColorWritesOff, 0, 0xfffffffff);
                                             // Enable depth test to use early z, disable depth write to make sure required layers won't be clipped out in early z
                                             pd3dContext->OMSetDepthStencilState(m_pDepthTestEnabledNoDepthWritesStencilWriteIncrementDSs, 0x00);
                                             // Pass 1: A-Buffer pass
                                             if(m hairParams.bAntialias)
                                                 if(m hairParams.strandCopies > 1)
                                                      RenderHairGeometry(pd3dContext, m_pVSRenderHairAAStrandCopies, m_pPSABuffer_Hair, m_hairParams.density, false, m hairParams.strandCopies);
                                                 else
                                                      RenderHairGeometry(pd3dContext, m pVSRenderHairAA, m pPSABuffer Hair, m hairParams.density, false, 1);
                                             else
```

TRESSFX 3.X FUR SUPPORT

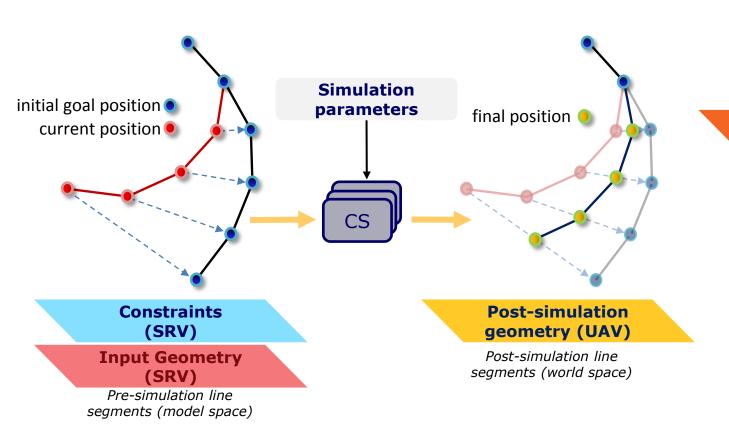


- ▲ Core principles are the same
 - Simulation on GPU using compute
 - Good lighting
 - Anti-aliasing
 - Volume shadows
 - Transparency
- ✓ Texture coordinates
 - Allows variation in fur color
- Skinning
 - A simple head transform was enough for human hair
 - Fur requires skinning support



TRESSFX 3.X FUR SIMULATION





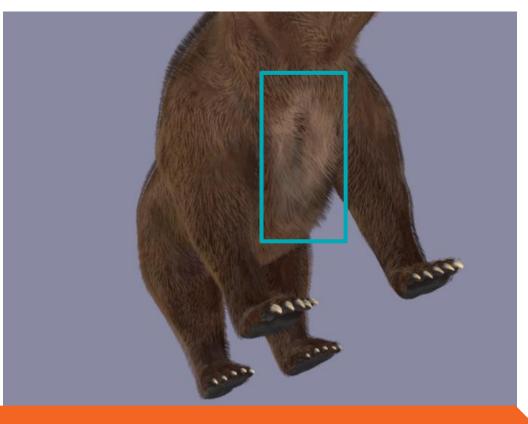
▲ SIMULATION COMPUTE SHADERS

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TRESSFX 3.X TEXTURE COORDINATES

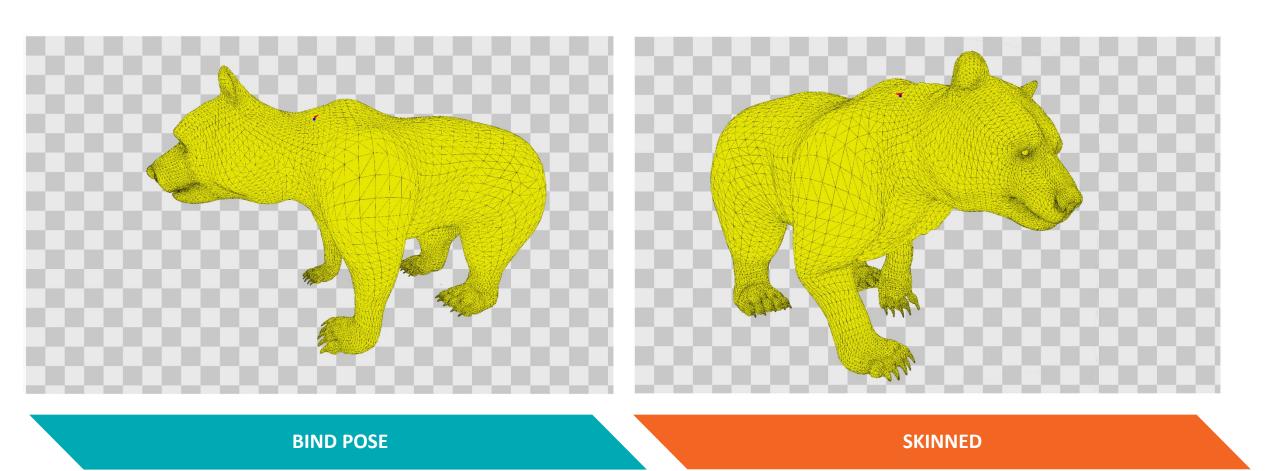






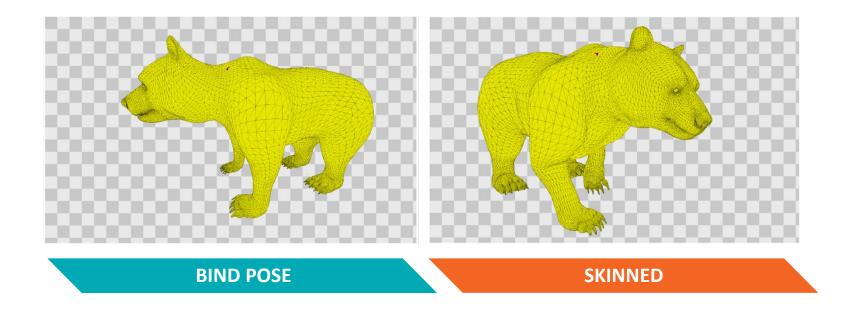
FUR PICKS UP COLOR VARIATION FROM TEXTURE



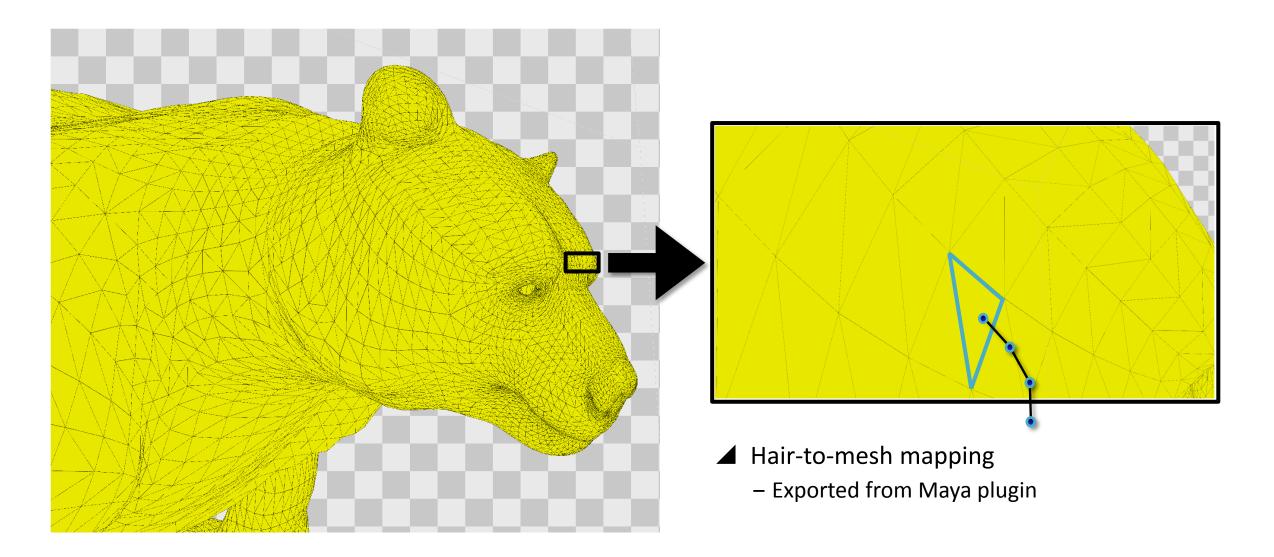




- ⚠ How to get skinned vertex position data to TressFX library?
- Up to you
- ⚠ TressFX viewer currently uses Stream Out
 - DirectX 11
 - No geometry shader
 - See "Getting Started with the Stream-Output Stage" on MSDN
- UAVs at vertex shader stage
 - DirectX 11.1
 - DirectX 12

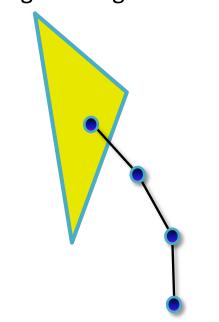




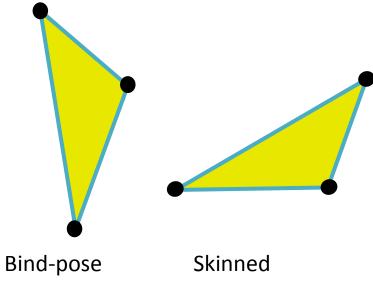




■ Use hair strand index to get triangle index



■ Use triangle index to get bindpose verts and skinned verts

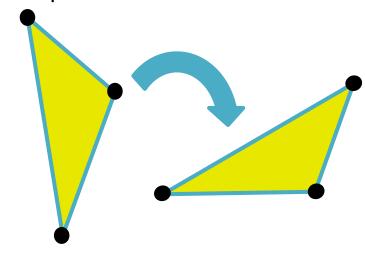


vertex positions

vertex positions



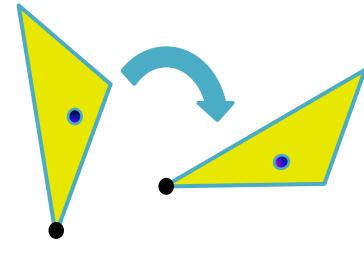
▲ Calculate transform from bind-pose to skinned



Bind-pose vertex positions

Skinned vertex positions

✓ Use barycentric coordinates for hair root to calculate final hair transform

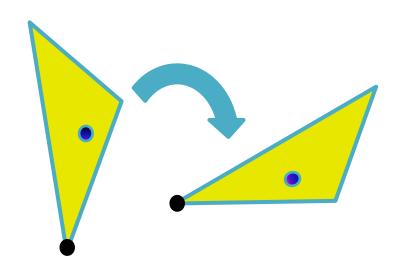


Bind-pose vertex positions

Skinned vertex positions



- ✓ Yeah, okay, but why not just skin the hair directly?
- ▲ This way doesn't impose any requirements on how the game engine does the animation update
 - Morph targets/blend shapes
 - Whatever, we just need the updated vertex positions
- But may code a fast path for ordinary skinning with max 4 bones



TRESSFX 3.X OPTIMIZATIONS



- ▲ Already in TressFX 2.2
 - Master and slave strands
 - Distance adaptive LOD
 - Deferred rendering
 - Lots of shader optimizations
- - Depth pre-pass
 - Adjust K_{overdraw}
 - More shader optimizations



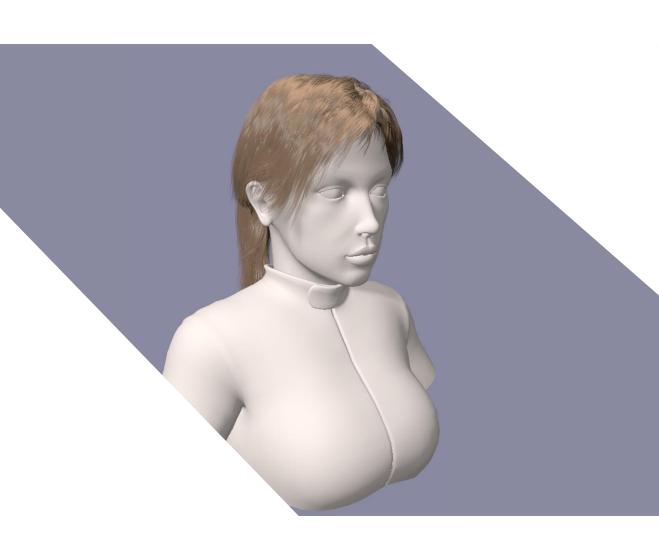




TRESSFX 3.1 SHORTCUT RENDERING



- ▲ A second OIT implementation provided with the 3.1 release
 - Inspired by Eidos-Montréal's GDC
 2015 talk
 - Enabled in the sample with the ShortCut checkbox
- ▲ Alpha is computed from all hair fragments, while color is based on shading a few front layers
- Comparison with current PPLL method
 - Memory requirements reduced due to small and fixed number of layers
 - Relative performance depends on depth complexity
 - Requires an extra geometry and screen pass
 - Potential savings from processing fewer layers
 - Result not quite the same quality as PPLL method



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