AMD SHADOWFX

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AMD

SHADOWFX TECHNIQUES

TRIVIA AND ALGORITHMS DESCRIPTION

SHADOWFX TECHNIQUES

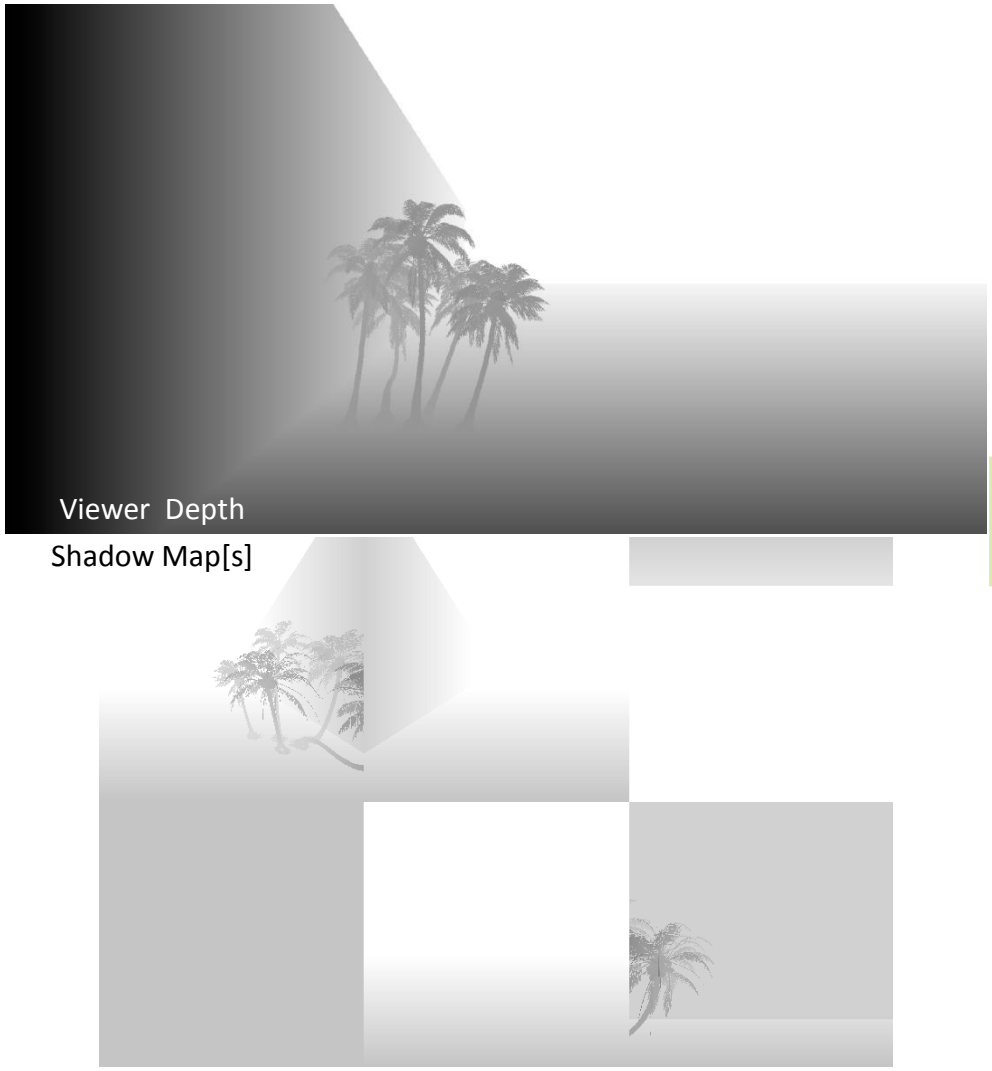
AMD

- ShadowFX implements highly optimized GCN shadow filtering
  - A full screen pass that returns a deferred shadow mask
- Currently ShadowFX supports the following filtering kernels:
  - Uniform Smooth Shadows (http://developer.amd.com/wordpress/media/2012/10/Isidoro-ShadowMapping.pdf)
  - Contact Hardening Shadows (http://amd-dev.wpengine.netdna-cdn.com/wordpress/media/2012/10/TakingAdvantageofDirect3D10.pps)
  - Shader permutations for different filter sizes: 7x7, 9x9, 11x11, 13x13, 15x15

- ShadowFX sample can also serve as a sandbox for shadow filtering technique development and comparison

SHADOWFX TECHNIQUES

SHADOWFX IMPLEMENTS A DEFERRED SHADOW MASK FILTERING



Full screen pass

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SHADOWFX OPTIONS

SHADOWFX OPTIONS

SHADER PERMUTATIONS

- Can process up to 6 shadow maps per full screen pass
- Shadow maps can be arranged in
  - Texture Atlas
    - No UV clamping is done to avoid filtering across different atlas regions
  - Texture Array
- Supports different shadow casting types:
  - Union – a set of shadow casters which contribute to the same deferred shadow mask
    - Filtering shader will process all active lights (and potentially execute filtering up to 6 times)
    - Filtered results are blended with a MIN function
  - Cascade – a set of shadow maps that form different LOD levels of a cascaded shadow map
    - Filtering shader will early out after it finds the nearest cascade that contains the filtered point
  - Cube – a set of shadow maps that form different faces of a cube shadow map
    - Filtering shader will calculate the exact shadow map face and only execute filtering once

SHADOWFX OPTIONS

AMD

- The world space position of a shadow'ed pixel can be used for light transformation directly or:
  - Displaced by a normal fetched form Gbuffer
  - Displaced by a normal calculated from depth buffer
- Shadow filtering texture fetch instructions:
  - Gather4
    - AMD preferred option that results in better performance
  - PCF
- Application can setup up stencil buffer and stencil test
  - Stencil reduces full screen pass to only execute in areas that overlap with shadow caster volume
- Most of the options are orthogonal to each other
  - A high number of shader permutations

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SHADOWFX TECHNIQUE

INTEGRATION GUIDE

INTEGRATION

MINIMUM AMOUNT OF CODE FOR INITIAL INTEGRATION

- Declare, initialize

```
AMD::ShadowFX_Desc g_ShadowsDesc;
g_ShadowsDesc.m_pDevice = pd3dDevice;
AMD::ShadowFX_Initialize(g_ShadowsDesc);
```

- Setup viewer and light cameras, d3d11 resources

- Release

```
AMD::ShadowFX_Release(g_ShadowsDesc);
```

```
g_ShadowsDesc.m_Execution = AMD::SHADOWFX_EXECUTION_UNION;
g_ShadowsDesc.m_NormalOption = AMD::SHADOWFX_NORMAL_OPTION_NONE;
g_ShadowsDesc.m_TapType = AMD::SHADOWFX_TAP_TYPE_FIXED;
g_ShadowsDesc.m_Filtering = AMD::SHADOWFX_FILTERING_CONTACT;
g_ShadowsDesc.m_TextureFetch = AMD::SHADOWFX_TEXTURE_FETCH_GATHER4;
g_ShadowsDesc.m_FilterSize = AMD::SHADOWFX_FILTER_SIZE_7;
g_ShadowsDesc.m_TextureType = AMD::SHADOWFX_TEXTURE_2D_ARRAY;

float2 backbufferDim((float)g_Width, (float)g_Height);

memcpy(&g_ShadowsDesc.m_Viewer.m_View, &g_ViewerData.m_View, sizeof(g_ShadowsDesc.m_Viewer.m_View));
memcpy(&g_ShadowsDesc.m_Viewer.m_Projection, &g_ViewerData.m_Projection, sizeof(g_ShadowsDesc.m_Viewer.m_Projection));
memcpy(&g_ShadowsDesc.m_Viewer.m_ViewProjection, &g_ViewerData.m_ViewProjection, sizeof(g_ShadowsDesc.m_Viewer.m_ViewProjection));
memcpy(&g_ShadowsDesc.m_Viewer.m_View_Inv, &g_ViewerData.m_ViewInv, sizeof(g_ShadowsDesc.m_Viewer.m_View_Inv));
memcpy(&g_ShadowsDesc.m_Viewer.m_Projection_Inv, &g_ViewerData.m_ProjectionInv, sizeof(g_ShadowsDesc.m_Viewer.m_Projection_Inv));
memcpy(&g_ShadowsDesc.m_Viewer.m_ViewProjection_Inv, &g_ViewerData.m_ViewProjectionInv, sizeof(g_ShadowsDesc.m_Viewer.m_ViewProjection_Inv));
memcpy(&g_ShadowsDesc.m_Viewer.m_Position, &g_ViewerData.m_Position, sizeof(g_ShadowsDesc.m_Viewer.m_Position));
memcpy(&g_ShadowsDesc.m_Viewer.m_Direction, &g_ViewerData.m_Direction, sizeof(g_ShadowsDesc.m_Viewer.m_Direction));
memcpy(&g_ShadowsDesc.m_Viewer.m_Up, &g_ViewerData.m_Up, sizeof(g_ShadowsDesc.m_Viewer.m_Up));
memcpy(&g_ShadowsDesc.m_Viewer.m_Color, &g_ViewerData.m_Color, sizeof(g_ShadowsDesc.m_Viewer.m_Color));
memcpy(&g_ShadowsDesc.m_DepthSize, &backbufferDim, sizeof(g_ShadowsDesc.m_DepthSize));

g_ShadowsDesc.m_ActiveLightCount = CUBE_FACE_COUNT;
for (int i = 0; i < CUBE_FACE_COUNT; i++)
{
    float2 shadowDim(g_ShadowMapSize, g_ShadowMapSize);
    float4 shadowRegion(0.0f, 0.0f, 0.0f, 0.0f);
    if (g_ShadowsDesc.m_TextureType == AMD::SHADOWFX_TEXTURE_2D_ARRAY)
    {
        shadowRegion.x = 0.0f;
        shadowRegion.z = 1.0f;
        shadowRegion.y = 0.0f;
        shadowRegion.w = 1.0f;
        g_ShadowsDesc.m_ArraySlice[i] = i;
    }

    memcpy(&g_ShadowsDesc.m_ShadowSize[i], &shadowDim, sizeof(g_ShadowsDesc.m_ShadowSize[i]));
    memcpy(&g_ShadowsDesc.m_ShadowRegion[i], &shadowRegion, sizeof(g_ShadowsDesc.m_ShadowRegion[i]));
    memcpy(&g_ShadowsDesc.m_Light[i].m_View, &g_LightData[i].m_View, sizeof(g_ShadowsDesc.m_Light[i].m_View));
    memcpy(&g_ShadowsDesc.m_Light[i].m_Projection, &g_LightData[i].m_Projection, sizeof(g_ShadowsDesc.m_Light[i].m_Projection));
    memcpy(&g_ShadowsDesc.m_Light[i].m_ViewProjection, &g_LightData[i].m_ViewProjection, sizeof(g_ShadowsDesc.m_Light[i].m_ViewProjection));
    memcpy(&g_ShadowsDesc.m_Light[i].m_View_Inv, &g_LightData[i].m_ViewInv, sizeof(g_ShadowsDesc.m_Light[i].m_View_Inv));
    memcpy(&g_ShadowsDesc.m_Light[i].m_Projection_Inv, &g_LightData[i].m_ProjectionInv, sizeof(g_ShadowsDesc.m_Light[i].m_Projection_Inv));
    memcpy(&g_ShadowsDesc.m_Light[i].m_ViewProjection_Inv, &g_LightData[i].m_ViewProjectionInv, sizeof(g_ShadowsDesc.m_Light[i].m_ViewProjection_Inv));
    memcpy(&g_ShadowsDesc.m_Light[i].m_Position, &g_LightData[i].m_Position, sizeof(g_ShadowsDesc.m_Light[i].m_Position));
    memcpy(&g_ShadowsDesc.m_Light[i].m_Up, &g_LightData[i].m_Up, sizeof(g_ShadowsDesc.m_Light[i].m_Up));
    memcpy(&g_ShadowsDesc.m_Light[i].m_Direction, &g_LightData[i].m_Direction, sizeof(g_ShadowsDesc.m_Light[i].m_Direction));
    g_ShadowsDesc.m_Light[i].m_Aspect = g_LightCamera.GetAspect();
    g_ShadowsDesc.m_Light[i].m_Fov = g_LightCamera.GetFOV();
    g_ShadowsDesc.m_Light[i].m_FarPlane = g_LightCamera.GetFarClip();
    g_ShadowsDesc.m_Light[i].m_NearPlane = g_LightCamera.GetNearClip();
    g_ShadowsDesc.m_SunArea[i] = g_SunSize * g_SunSize; // for the filtering we actually need squared size
    g_ShadowsDesc.m_DepthTestOffset[i] = g_DepthTestOffset;
    g_ShadowsDesc.m_NormalOffsetScale[i] = g_NormalOffsetScale;
}

g_ShadowsDesc.m_pContext = pd3dContext;
g_ShadowsDesc.m_pDevice = pd3dDevice;
g_ShadowsDesc.m_pDepthSRV = g_AppDepth._srv;
g_ShadowsDesc.m_pNormalSRV = g_AppNormal._srv;
g_ShadowsDesc.m_pOutputRTV = g_ShadowMask._rtv;
g_ShadowsDesc.m_pShadowSRV = g_ShadowMap._srv;
g_ShadowsDesc.m_OutputChannels = 1;
g_ShadowsDesc.m_ReferenceDSS = 0;
g_ShadowsDesc.m_pOutputDSS = NULL;
g_ShadowsDesc.m_pOutputDSV = NULL;

AMD::ShadowFX_Render(g_ShadowsDesc);
```

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