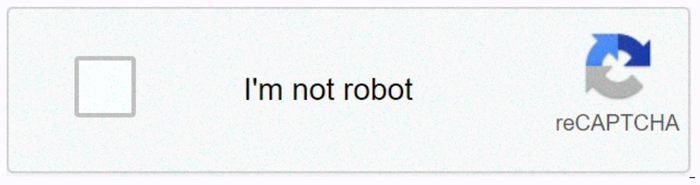

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Unity water normal map

Featured Due to the popular request, I am posting the source code of my Unity3D animated water shader. It's a complete rewrite of Alzahiel/GraphicRunner's shading. Short list of changes: - It is a shading surface (not Vertex + Fragment) - Does not require script file, all animations are made in shading using built-in _Time variable - Supports transparency - Support mirror lighting - Supports reflection map - Configurable cycle length and water flow speed By changing normal tile maps, main color, reflection color, mirror color, flow speeds and cycle lengths a variety of impacts are possible: I'm also connecting the flow map and noise map from demo GraphicsRunner and water hit map and Sunny sky cube from Standard Unity Assets, so you've also been placing the flow map and noise map from demo GraphicsRunner and water map hitting and Sunny sky cube from Standard Unity Assets , so you also have something to start with in the game. I'm using the same normal map twice, but the result should be even cooler with two different normal maps. Enjoy! Remember, that to create flow map you can use FlowEd. SOURCE CODE (Simplified BSD): AnimatedWaterShader.zip This is the first tutorial in a series to create the appearance of flowing materials. In this case, it is done by using a flow map to distort a texture. This tutorial assumes that you have gone through the Basics series, as well as the Performance series until at least part 6, Bumpiness. This tutorial is done with section 2017.4.4f1. When a liquid does not move, it is visually indistinguishable from a solid. Are you looking at water, jelly or glass? Is the pool still frozen or not? To be sure, disturb it and notice if it deforms, and if so how. Simply creating a material that looks like moving water is not enough, it really needs to move. Otherwise it's like a glass sculpture of water, or water frozen in time. This is good enough for an image, but not for a movie or a game. Most of the time, we just want a surface to be made of water, or mud, or lava, or some magical effect that behaves visually like a liquid. You don't have to be interactive, you just appear believable when observed occasionally. So we don't have to find a complex water physics simulation. All we need is some movement added to a normal material. This can be done by anipping the UV coordinates used for texturing. The technique used in this seminar was first described in public detail by Alex Vlachos from Valve, SIGGRAPH2010 water flow presentation at Gate 2. For this tutorial, you can start with a new project that is configured to use linear color rendering. If you're using Unity 2018, select the default 3D conductor, not light or HD. As we're about to simulate a flowing surface by distorting texture mapping, name it DistortionFlow. Below is the new shading, with all comments and unnecessary parts removed. Shader Custom/DisclaimerFlow { Properties { _Color (Color, Color) = (1,1,1,1) _MainTex (Albedo (RGB), 2D) = = {} _Glossiness (Softness, Range(0.1)) = 0.5 _Metallic (Metal, Range(0.1)) = 0.0 } Secondary lens { Tags { RenderType=Opaque } LOD 200 CGPROGRAM #pragma surf surface Standard fullforwardshaws #pragma target 3.0 sampler2D _MainTex; structural Input { float 2 uv_MainTex; }; half _Glossiness; half _Metallic; fixed4 _Color; empty surf (Input IN, inout SurfaceOutputStandard o) { fix4 c = tex2D(_MainTex, IN.uv_MainTex) * _Color; o.Albedo = c.rgb; o.metallic = _Metallic; o.Smoothness = _Glossiness; o.Alpha = c.a; } ENDCG } Diffuse Alternative } To make it easy to see how UV coordinates are distorted, you can use this test texture. UV test texture. Create a material that uses our shading, with the test texture as albedo's map. Set its tile to 4 so that we can see how the texture repeats. Then add a quad to the scene with this material. For better viewing, rotate it 90° around the X-axis so that it is flat at the XZ level. This makes it easy to see from any angle. Distortion Flow material on a quad. The code for uv coordinates is generic, so we'll put it in a separate Flow.cginc inclusion file. All it needs to contain is a FlowUV function that has uv and a time parameter. You have to return the new uv coordinates. We start with the simplest shift, which simply adds time to both coordinates. #if !defined(FLOW_INCLUDED) #define FLOW_INCLUDED float2 FlowUV (float2 uv, float time) { return uv + time; } #endif Include this file in our shading and invoke FlowUV with the main texture coordinates and current time, which Unity makes available via _Time.y. Then use the new UV coordinates to test our texture. #include Flow.cginc2D sampler _MainTex; ... empty surf (Input IN, inout SurfaceOutputStandard o) { float2 uv = FlowUV(IN.uv_MainTex, _Time.y); fix2D(_MainTex, uv) * _Color; o.Albedo = c.rgb; o.Metallic = _Metallic; o.Smoothness = _Glossiness; o.Alpha = c.a; } Diagonal UV slip. As we increase both coordinates by the same amount, the texture glides diagonally. Because we add the time, it slips from top right to bottom left. And because we use the default wrap mode for our texture, the loop animation every second. Traffic is visible only when the time value increases. This occurs when the processor is in playback mode, but you can also turn on time progression in edit mode by activating moving materials through the scene window toolbar. Activated moving materials. In fact, the time value used by the materials every time the processor redesigns the scene. So when moving materials are turned off you will see the texture slide a little every time you edit something. Animated Materials just forces the processor to redesign the scene all the time. So if you only turn it on when you need it. Instead of always flowing in the same direction, you can use a speed vector to control the direction and and flow. You can add this vector as a property to the hardware. However, then we're still limited to using the same vector for the entire material, which looks like a rigid sliding surface. To make something look like flowing liquid, it needs to change locally over time in

addition to moving in general. We could get rid of the static appearance by adding another speed vector, using this to test the texture a second time, and combining both samples. When using two slightly different vectors, we end up with a morphing texture. However, we are still limited to the flow of the entire surface in the same way. This is often enough for open or straight flows, but not in more complex situations. To support more interesting flows, we must somehow differentiate the flow vector on the surface of our material. The simplest way to do this is through a flow map. This is a texture that contains 2D vectors. Here is such a texture, with the carrier U element in channel R and element V in channel G. It doesn't have to be large because we don't need sudden sudden changes and we can rely on bilinean filtering to keep it smooth. Flow map. This texture was created with the curl noise, which is explained in the tutorial Noise derivatives, but the details of its creation do not matter. Contains multiple clockwise and counterclockwise rotating flows, without sources or sinks. Make sure that it is inserted as a normal 2D texture that is not sRGB, as it does not contain color data. Insert as a texture that is not sRGB. Add a property for the flow map to our hardware. You don't need a separate ultraviolet tile and compensation in order to give it the NoScaleOffset feature. The default is that there is no flow, which corresponds to a black texture. _MainTex (Albedo (RGB), 2D) = white {} [NoScaleOffset] _FlowMap (Flow (RG), 2D) = black {} Material with flow map. Add a variable for the flow map and try it to get the flow vector. Then visualize temporarily by using it as the albedo. _MainTex _FlowMap sampler2D, _FlowMap; ... empty surf (In, inout SurfaceOutputStandard o) { float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg; float2 uv = FlowUV(IN.uv_MainTex, _Time.y); fix4 c = tex2D(_MainTex, uv) * _Color; o.Albedo = c.rgb; o.Albedo = float3(flowVector, 0); Tiled flow vectors; texture appears brighter on stage because it's linear data; it doesn't matter, because we shouldn't use it as color anyway. , our flow map gets tiled as well. we need a tile flow map, so set the hardware tile to 1. Non-tile flow vectors. Now that we have flow vectors, we can add support for them to our FlowUV function. Add a parameter for them, then multiply them by the time before subtracting from the original UV. We remove because this makes the flow flow in the direction of the operator. float2 FlowUV (float2 uv, float2 flowVector, float time) { return uv - flowVector * time; } Pass the flow vector to the function, but before you do this make sure that the vector is valid. As with a normal map, the vector can point in any direction, so it can contain negative components. Therefore, the vector is encoded in the same way as on a normal map. We need to decode it manually. Also, go back to the original albedo. float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; float2 uv = FlowUV(IN.uv_MainTex, flowVector, _Time.y); fixed4 c = tex2D(_MainTex, uv) * _Color; o.Albedo = c.rgb; o.Albedo = float3(flowVector, 0); excessive distortion. We quickly end up with a texture that is too distorted. This is because the texture moves in multiple directions, stretching and crushing more and more as time progresses. To prevent it from turning into chaos, we need to restore the animation at some point. The simplest way to do this is by using only the fractional part of the time to move. Thus, it evolves from 0 to 1 as usual, but then reverts to 0, forming a saw pattern. Sawtooth progress. Since this is especially for flow motion rather than time in general, create saw progress in FlowUV. float2 FlowUV (float2 uv, float2 flowVector, float time) { float progress = frac(time); return uv - flowVector * progress; } Reset evolution every second. We can now see that the texture actually gets distorted in different directions and at different speeds. In addition to the sudden reset, what is most obvious is that the texture quickly becomes blocked as its deformation increases. This is caused by the compression of the flow map. The default compression setting uses the DXT1 format from which the block originates. These artifacts are usually not obvious when using organic textures, but they are blatant when they distort clear patterns, such as our test texture. So I have used an uncompressed flow map for all screenshots and movies in this tutorial. No compression. While this is possible, flow maps often cover large areas and thus end up with low effective resolution. As long as you don't use extreme distortion, there's no problem. The distortions that appear in this tutorial are too powerful to make them visually obvious. unitypackage At this point we can liven up a non-flow format, but it resets every second. To make loop without discontinuity, they must somehow get the UV back to their original values before distorting. Time Only up front, so we can't turn the distortion. Trying that will lead to a flow that goes back and forth instead in a consistent direction. We have to find another way. We cannot avoid restoring the evolution of deformation, but we can try to hide it. What we could do is weaken the texture to black as we approach maximum deformation. If if you start with black and fade to texture at the beginning, then the sudden reset occurs when the entire surface is black. While this is very obvious, at least there is no sudden visual discontinuity. To make it fade, let's add a blending weight to the FlowUV output by renaming it FlowUVW. The weight is put on the third ingredient, which actually has 1 so far, so let's start with that. float3 FlowUVW (float2 uv, float2 flowVector, float time) { float progress = frac(time); float3 uvw; uvw.xy = uv - flowVector * progress; uvw.z = 1; return uvw; } We can weaken the texture by multiplying it by the weight that is now available in our shading. float3 uvw = FlowUVW(IN.uv_MainTex, flowVector, _Time.y); fixed4 c = tex2D(_MainTex, uvw.xy) * uvw.z * _Color; Now we need to create a weight function 'w(p)' where 'w(0) = w(1) = 0'. And halfway should reach full power, so 'w(1/2) = 1'. The simplest function that matches these criteria is a triangular wave, 'w(p) = 1 - |1 - 2p|'. Use this for our weight. Sawtooth with matching the wave triangle. uvw.z = 1 - abs(1 - 2 * progress) Wave triangle configuration. You could also use a sinusoidal wave or apply the smoothstep function. But these functions make shading more complicated while not affecting the end result much. A triangular wave is enough. While technically we have removed visual discontinuity, we have introduced a black pulsating effect. The pulse is very obvious, because it happens everywhere at the same time. It would be less obvious if we could spread it over time. We can do this by offsetting time by a different amount across the surface. Some low frequency Perlin noise is very suitable for this. Instead of adding another texture, we'll pack the noise into our flow map. Here's the same streaming map as before, but now with the noise in channel A's. Noise is not related to flow carriers. Flow map with noise on channel A. To indicate that we expect noise on the flow map, update its label. [NoScaleOffset] _FlowMap (Flow (RG, A noise), 2D) = black {} float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; flotation noise = tex2D(_FlowMap, IN.uv_MainTex).a; flotation time = _Time.y + noise; float3 uvw = FlowUVW(IN.uv_MainTex, flowVector, time) Time with compensation. Just to point out that the shading compiler will optimize that in a single texture sample. The black pulse is still there, but it has changed to a wave that spreads across the surface in an organic way. This is much easier to disguise than uniform pulsating. bonus, the time compensation also made the evolution of the nonuniform distortion, resulting in a more varied distortion overall. Instead of fading into black, we could mix with something else, for example the original unadulted texture. But then we will see a firm texture fade in and out, which destroy the illusion of flow. We can solve this by mixed with another distorted texture. This requires us to test the texture twice, each with different UVW data. So we end up with two pulsating patterns, A and B. When the weight of A is 0, B should be 1, and vice versa. That's how the black pulse is hidden. This is done by shifting phase B by half of its period, which means adding 0.5 to its time. But this is a detail of how FlowUVW works, so let's add a binary parameter to indicate if we want the UVW for variant A or B. float3 FlowUVW (float2 uv, float2 flowVector, float time, float flowB) { float phaseOffset = flowB ? 0.5 : 0? float progress = frac(time + phaseOffset); float3 uvw; uvw.xy = uv - flowVector * progress; uvw.z = 1 - abs(1 - 2 * progress); return uvw; } Weights of A and B always add up to 1. Now we have to invoke FlowUVW twice, once falsely and once with truth as its last argument. Then try the texture twice, multiply both with their weights, and add them to get to the final albedo. flotation time = _Time.y + noise; float3 uvwA = FlowUVW(IN.uv_MainTex, flowVector, time, false) float3 uvwB = FlowUVW(IN.uv_MainTex, flowVector, time, truth) fixed4 texA = tex2D(_MainTex, uvwA.xy) * uvwA.z; fixed4 texB = tex2D(_MainTex, uvwB.xy) * uvwB.z; fixed4 c = (texA + texB) * _Color; Mixing two phases. The black pulsating wave is no longer visible. The wave is still there, but now it is the transition between the two phases, which is much less obvious. One side effect of mixing between two patterns that are compensated by half of their period is that the duration of our animation has been halved. Now loops twice per second. But we don't have to use the same pattern twice. We can offset the UV coordinates of B by half a unit. This makes patterns different—while using the same texture—without entering any directional bias. uvw.xy = uv - flowVector * progress + phaseOffset; Different UV for A and B. Because we use a normal test pattern, the white gridlines of A and B overlap. But the colors of their squares are different. As a result, the final animation alternates between two color configurations and again takes a second to repeat. Apart from always offsetting the UV of A and B by half a unit, it is also possible to offset the UV per phase. This will cause the movement to change over time, so it takes longer before loops back to exactly the same state. We could just slip the UV based on time, but this would cause the entire animation to slip, introducing a directional bias. We can avoid visual slippage by keeping uv displacement constant during each phase, and jumping into a new shift between phases. In other words, we do the UV jump every time the weight is zero. This is done by adding some jump offset to the UV, multiplied by the whole portion of time. Set FlowUVW to support it, with a new parameter to Vector. float3 FlowUVW (float2 uv, float2 flowVector, float2 jump, float time, bool flowB) { float phaseOffset = flowB ; 0.5 : 0; float progress = frac(time + phaseOffset); float3 uvw; uvw.xy = uv - flowVector * progress + phaseOffset; uvw.xy += (time - progress) * jump; uvw.z = 1 - abs(1 - 2 * progress); return; uvw; add two parameters to our shading to control the jump. We use two floats instead of a single vector so that we can use range sliders. jump shift is added above it. , which produces '0 -> 1/2 -> 1/4 -> 3/4 -> 1/2 -> 0 -> 3/4 -> 1/4' in four phases. A negative compensation of a maximum of a quarter is also possible. This will produce the sequence '0 -> 1/2 -> 3/4 -> 1/4 -> 1/2 -> 0 -> 1/4 -> 3/4'. [NoScaleOffset] _FlowMap (Flow (RG, A noise), 2D) = black {} _UJump (U jump per phase, Range (-0.25, 0.25)) = 0.25 _VJump (V jump per phase, Range(-0.25, 0.25)) = 0.25 Add the required flotation variables to our shading, use them to construct the jump vector and pass it to FlowUVW. _MainTex _FlowMap sampler2D, _FlowMap; _UJump flotation, _VJump; ... empty surf (In, inout SurfaceOutputStandard o) { float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; float noise = tex2D(_FlowMap, IN.uv_MainTex).a; float time = _Time.y + noise; float2 jump = float2(_UJump, _VJump); float3 uvwA = FlowUV(IN.uv_MainTex, flowVector, jump, time, false); float3 uvwB =FlowUVW(IN.uv_MainTex, flowVector, jump, time, true); ... At the maximum jump we end up with a sequence of eight UV offsets before it repeats itself. As we go through two shifts per phase and each phase is one second, our animations now loop every four seconds. To get a better look at how UV jumping works, you can set flow vectors to zero so you can focus on shifts. First, look at the animation without any jumping, only the original alternating patterns. Jump 0, duration 1s. You can see that each square alternates between two colors. You can also see that we're alternating between the same texture offset by half, but that's not immediately obvious and there's no directional bias. Then look at the animation with a maximum jump in both dimensions. Jump 0.25, duration 4s. The result looks different because the jump by a quarter moving the gridlines of our test texture, alternating between squares and crosses. The white lines still don't show a directional bias, but the colored squares now do. The pattern moves diagonally, but not in an immediately obvious way. It takes half a step forward, then a fourth step back, I repeat. If we had used the minimum −0.25, then it will take half a step forward, followed by a fourth step forward, repeat. To make directional bias more obvious, use a jump that is not symmetrical, for example 0.2. Jump 0.2, duration 2.5s. In this case, the white gridlines also appear to move. But because we're still using a big jump that's close enough to symmetrical, the motion can be interpreted to go in multiple directions, depending on how we focus on the image. If you change your focus, you can easily lose track of the direction you thought was rolling. Because we use a 0.2 jump, the movement repeats after five phases, so five seconds. However, because we mix between two hedging phases there is a possible crossing point in the middle of each phase. If the traffic will loop after an unnecessary number of phases, in fact loops twice as the phases cross halfway. So in this case the duration is only 2.5s. You don't have to you and V for the same amount. In addition to changing the nature of directional bias, the use of different jump values per dimension also affects the duration of the loop. For example, consider a jump of U 0.25 and a jump of V 0.1. U loops every four cycles, while V loops every ten. So after four cycles U has looped, but V hasn't yet, so the drive hasn't completed a loop either. Only when you and v complete a circle at the end of the same phase do we reach the end of the animation. When you use logical numbers for jumps, the duration of the loop is equal to the least common multiple of their denominators. In the case of 0.25 and 0.1, i.e. 4 and 10, for which the least common multiple is 20. There is no obvious way to choose a jump vector so you will end up with a long loop duration. For example, if we use 0.25 and 0.2 instead of 0.25 and 0.1, do we have a longer or shorter duration? Since the least common multiple of 4 and 5 is also 20, the duration is the same. Also, while you could come up with values that theoretically take a long time or even forever to loop, most are not practically useful. We cannot perceive changes that are too small, plus that there are numerical precision limitations, which can theoretically cause good jump values to appear either unchanged under occasional observation, or to rotate much faster than expected. I think good prices jump-apart from zero-sit somewhere between 0.2 and 0.25, either positive or negative. I have come up with 6/25 = 0.24 and 5/24 ~~ 0.2083333 as a nice simple pair matches the criteria. The first value completes six jump cycles after 25 phases, while the second completes five cycles after 24 phases. The total theoretical loop lasts 600 phases, which is ten minutes at the speed of one phase per second. I'll let prices jump to zero for the rest of this tutorial, just so I can keep the looping animation short. unitypackage Now that we have a basic flow drive, let's add a little more configuration configuration in it, so we can perfect its appearance. Firstly, let us make it possible to quote the distorted texture. We can't rely on the main tile and offset the surface shading, because this also affects the flow map. Instead, we need a separate tile property for texture. Usually it only makes sense to distort a square texture, so we only need a single tile value. To keep the flow the same, regardless of the tile, we need to apply it to UV after the flow, but before adding the compensation for phase B. So it must be done in FlowUVW, which means that our operation needs a tiles parameter. float3 FlowUVW (float2 uv, float2 flowVector, float2 jump, float tilling, float time, bol flowB) { ... // uvw.xy = uv - flowVector * progress + physoffset; uvw.xy = uvw.xy = empto; uvw.xy *= tiling; uvw.xy += phaseOffset; ... } Add a tile property to our shading as well, with 1 as the default value. _UJump (U jump per phase, Range(-0.25, 0.25)) = 0.25 _VJump (Jump V per phase, Range(-0.25, 0.25)) = -0.25 _Tiling (Tiles, Float) = 1 Then add the required variable and pass it to FlowUVW. _UJump of floats, _VJump, _Tiling; ... empty surf (In, inout SurfaceOutputStandard o) { ... float3 uvwA = FlowUVW (IN.uv_MainTex, flowVector, jump, _Tiling, time, false) float3 uvwB = FlowUVW (IN.uv_MainTex, flowVector, jump, _Tiling, time, truth) ... } Tiles set to 2, duration still 1s. When the tile is set to 2, the motion seems to flow twice as fast as before. But that's just because the texture has escalated. The drive takes another second to loop when you don't jump the UV. The speed of the animation can be controlled directly by scaling time. This affects the entire animation, but also its duration. Add a speed shading property to support it. _Tiling (Quote, Float) = 1 _Speed (Speed, Float) = 1 Just multiply _Time.y by the corresponding variable. The noise value should then be added so that the time shift remains unaffected. _UJump _Speed _VJump, _Tiling _Speed _VJump, _VJump· ... empty surf (In, inout SurfaceOutputStandard o) { float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; float noise = tex2D(_FlowMap, IN.uv_MainTex).a; float time = _Time.y* _Speed + noise; ... } Speed set to 0.5, duration now 2s. The speed of flow is dictated by the flow map. We can speed it up or slow it down by adjusting the movement speed, but this also affects phase length and drive duration. Another way to change the apparent flow rate is by scaling the flow vectors. By adjusting the we can accelerate, slow it down, or even reverse it, without affecting time. This also changes the amount of distortion. Add a flow force shading property to make this possible. _Speed (Speed, Float) = 1 _FlowStrength (Flow Power, Float) = 1 Simply multiply the flow vector by the corresponding variable variable use. _UJump, _VJump, _Tiling, _Speed, _FlowStrength· ... empty surf (In, inout SurfaceOutputStandard o) { float2 flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; flowVector *= _FlowStrength; ... } The flow force is set to 0.25, duration still 2s. Another possible tweak is to check where the animation starts. Up to this point we have always started at zero deformation at the beginning of each phase, proceeding to maximum deformation. As the phase weight reaches 1 in the middle, the pattern is clearer when the deformation is at half strength. So we mostly see a half-distorted texture. This configuration is often nice, but not always. For example, in Gate 2, the floating texture of debris appears mainly in its unadulted state. This is done by offsetting the flow by −0.5 when the UV coordinates are distorted. Let's support this as well by adding a flowOffset parameter to FlowUVW. Add it to progress when multiplying only with the flow vector. float3 FlowUVW (float2 uv, float2 flowVector, float2 jump, float flowOffset, float tilping, float time, bool flowB) { float phaseOffset = flowB ; 0.5 : 0; float progress = frac(time + phaseOffset); float3 uvw; uvw.xy = uv - flowVector * (progress + flowOffset); uvw.xy *= tiling; uvw.xy += phaseOffset; uvw.xy += (time - progress) * jump; uvw.z = 1 - abs(1 - 2 * progress); return uvw; } Then add a property to control the flow shift of shading. Its practical values are 0 and −0.5, but you can experiment with other values. _FlowStrength (Flow Power, Float) = 1 _FlowOffset (Flow Shift, Float) = 0 Pass the corresponding variable to FlowUVW. _UJump of floats, _VJump, _Tiling, _Speed, _FlowStrength, _FlowOffset; ... empty surf (In, inout SurfaceOutputStandard o) { ... float3 uvwA = FlowUVW (IN.uv_MainTex, flowVector, jump, _FlowOffset, _Tiling, time, false) float3 uvwB = FlowUVW (IN.uv_MainTex, flowVector, jump, _FlowOffset, _Tiling, time, truth) ... } The flow offset is set to −0.5. With flow offset −0.5 there is no distortion at the top of each phase. However, the overall result is still distorted due to the time compensation. unitypackage Distortion flow shading is now fully functional. Let's see how it looks with something other than the test texture we've used so far. The most common use of the deformation effect is the simulation of a surface of water. But because the distortion may be in any direction we cannot use a texture that indicates a specific flow direction. It is not really possible to make proper waves without proposing a direction, but we do not need to be realistic. It just has to look like water when composition is distorted and mixed. For example, here is a simple noise texture that combines an octave of low-frequency perlin and Voronoi noise. It is an abstract representation of water on a gray scale, dark at the bottom and light at the top of the waves. Wave. Texture. Use this texture for the albedo map of our hardware. Other than that, I've used no jump, a tile of 3, speed 0.5, flow force of 0.1, and no flow shift. Running water. Even if the noise texture itself doesn't really look like water, the distorted and moving effect begins to look like this. You can also control how it would look without distortion by temporarily setting the flow power to zero. This would represent stagnant water, and it should at least seem somewhat acceptable. Stagnant water. The albedo map is just a preview, as flowing water is mostly determined by the way its surface changes vertically, which changes the way it interacts with light. We need a regular map for that. Here is one, created by interpreting the albedo texture as a height map, but with heights escalating by 0.1 so the result is not very strong. Normal map. Add a shading property for the regular map. [NoScaleOffset] _FlowMap (Flow (RG, A noise), 2D) = black {} [NoScaleOffset] _NormalMap (Normals, 2D) = bump {} Sample the normal map for both A and B, apply their weights and use the normalized sum as the normal final surface. _MainTex _NormalMap _NormalMap sample _FlowMap 2D; ... empty surf (In, inout SurfaceOutputStandard o) { ... float3 normalA = Unzip (tex2D(_NormalMap, uvwA.xy)) * uvwA.z; float3 normalB = UnpackNormal (tex2D(_NormalMap, uvwB.xy)) * uvwB.z; o.Normal = normalA + normalB? fixed4 texA = tex2D(_MainTex, uvwA.xy) * uvwA.z; fixed4 texB = tex2D(_MainTex, uvwB.xy) * uvwB.z; ... } Add the regular map to our hardware. Also, increase its softness to something like 0.7, then change the light so you have plenty of mirror reflections. I kept the view the same but rotated the directional light 180° to (50, 150, 0). Also, they albedo in black, so we only see the result of normal animation. Running water. The distorted and moving normal map creates a fairly convincing illusion of flowing water. But how does it last when the flow force is zero? Stagnant water. At first glance it may seem fine, but if you focus on specific highlights it quickly becomes apparent that they alternate between two states. Fortunately, this can be solved by using jump values outside of zero. Maximum jump, speed set to 1. Although the resulting normal looks good, the average normal doesn't make much sense. As explained in Rendering 6, Bumpiness, the correct approach would be to convert normal vectors to height derivatives, add them, and then convert them back to a normal vector. This is particularly true for waves travelling a surface. As we usually use DXT5nm compression for our normal maps, we must first reconstruct the Z element of both normal—which requires square root calculation—and then convert to derivatives, combine and normalize. But we don't need the original normal vectors, so we could also skip the conversion conversion storage of derivatives on a map, instead of normal. A derivative map works just like a normal map, except that it contains height derivatives in dimensions X and Y. However, without additional scaling the derivative map can support only surface angles up to 45°, because its derivative is 1. Since you will not usually use such sudden waves, this restriction is acceptable. Here is a derivative map that describes the same surface as the previous normal map, with the X derivative stored in channel A and the Y derivative stored in channel G, just like a normal map. As a bonus, it also contains the original height map on channel B. But again derivatives are calculated by scaling the height by 0.1. Derivative plus height map. Height data is stored at full power to minimize loss of accuracy. Because the texture is not a normal map, enter it as a normal 2D texture. Import settings. Replace the normal map shading property with one for the derivative-plus-height map. [NoScaleOffset] _NormalMap (Normally, 2D) = Hit {} [NoScaleOffset] _DerivHeightMap (Height (B) (B) (Production De (AG), 2D) = Black {} Also replace the shading variable, sampling and normal construction. We can't use UnpackNormal anymore, so create a custom unpackderilativeHight function that puts the right data channels into a float vector and decodes derivatives. _MainTex _DerivHeightMap _FlowMap sampler2D; ... float3 Unzip (float4 textureData) { float3 dh = textureData.agb; dh.xy = dh.xy * 2 - 1; return dh; } empty surf (Input IN, inout SurfaceOutputStandard o) { ... // float3 normalA = UnpackNormal(_NormalMap, uvwA.xy)) * uvwA.z; float3 normalB = UnpackNormal(tex2D(_NormalMap, uvwB.xy)) * uvwB.z; o.Normal = normalA + normalB? float3 dhA = UnpackDerivativeHeight(tex2D(_DerivHeightMap, uvwA.xy)) * uvwA.z; float3 dhB = UnpackDerivativeHeight (tex2D(_DerivHeightMap, uvwB.xy)) * uvwB.z; o.Normal = normalization(float3(-(dhA.xy + dhB.xy), 1);); ... With a derivative map instead of a regular map. The resulting surface normally looks almost the same as when using the normal map, it's just cheaper to calculate. Since we now also have access to height data, we could use this to paint the surface as well. This can be useful for debugging, so let's temporarily replace the original albedo. o.Albedo = c.rgb; o.Albedo = dhA.z + dhB.z; Using height as albedo. The surface appears lighter than when using the albedo texture, even through two contain the same height data. different because we now use linear data, while the albedo texture is interpreted as sRGB data. To get the same result, we'll need to manually convert gamma height data into linear color space. We can just announce it by squaring it up. o.Albedo = pow(dhA.z + dhB.z, 2)· Using square height. Other Other derivatives instead of normal vectors is that they can easily be scaled. Derivatives would normally match the custom surface. This makes it possible to properly scale the height of the waves. Let's add a height scale property to our shading to support this. _FlowOffset (Flow Shift, Float) = 0 _HeightScale (Height Scale, Float) = 1 All we need to do is take into account the height scale in the sample derivative plus height data. _HeightScale flotation; ... empty surf (In, inout SurfaceOutputStandard o) { ... float3 dhA = UnzipDeribativeHeaight (tex2D(_DerivHeightMap, uvwA.xy)) * (uvwA.z * _HeightScale). float3 dhB = UnpackDerivativeHeight(tex2D(_DerivHeightMap, uvwB.xy)) * (uvwB.z * _HeightScale). ... } But we can go one step further. We can make the height scale variable, based on the flow rate. The idea is that you get higher waves when there is strong flow, and lower waves when there is weak flow. To control this, add a second-scale height property for the formatted height based on the flow rate. The other property remains a constant scale. The final height scale is found by combining both. _HeightScale (Height Scale, Fixed, Float) = 0.25 _HeightScaleModulated (Height Scale, Shaped, Float) = 0.75 The flow rate is equal to the length of the flow vector. Multiply it by the configuration scale, then add the fixed scale and use it as the final scale for derivatives plus height. _HeightScale flotation, _HeightScaleModulated; ... empty surf (In, inout SurfaceOutputStandard o) { ... float finalHightScale = length (flowVector) * _HeightScaleModulated + _HeightScale. float3 dhA = UnzipDeribativeHeaight(tex2D(_DerivHeightMap, uvwA.xy)) * (uvwA.z * finalHightScale); float3 dhB = UnpackDerivativeHeight(tex2D(_DerivHeightMap, uvwB.xy)) * (uvwB.z * finalHeightScale); ... } While you could base the height scale purely on the flow rate, it is a good idea to use at least a small fixed scale, so the surface does not become flat where there is no flow. For example, use a fixed scale of 0.1 and a formatted scale of 9. You don't have to add up to 1, the settings depend both on how strong you want the final to be normally and how much variety you want. Fixed plus shaped height force. Instead of calculating the flow rate in the shading, we can save it to the flow map. While filtering during sampling can change the length of vectors nonlinearly, this difference becomes significant only when two very different vectors are inserted. This would only happen if there were sudden changes of direction on our flow map. As long as you don't sampling of stored speed carriers produces almost the same result. In addition, it is not necessary to get an exact match when configuring the height scale. Here's the same flow map as before, but now with the speed values stored on channel B's. Flow map at speed on channel B. Use the data instead of calculating the speed ourselves. Since the speed has no direction, it should not be converted, unlike the speed vector. empty surf (In, inout SurfaceOutputStandard o) { // float flowVector = tex2D(_FlowMap, IN.uv_MainTex).rg * 2 - 1; float3 flow = tex2D(_FlowMap, IN.uv_MainTex).rgb; flow.xy = flow.xy * 2 - 1; flow *= _FlowStrength; ... float3 uvwA = FlowUVW (IN.uv_MainTex, flow.xy, jump, _FlowOffset, _Tiling, time, false) float3 uvwB = FlowUVW (IN.uv_MainTex, flow.xy, jump, _FlowOffset, _Tiling, time, truth) float finalHightScale = flow.z * _HeightScaleModulated + _HeightScale. ... } We conclude with the restoration of the original albedo. I also change the color of the material to a blue tint, specifically (78, 131, 169). o.Albedo = pow(dhA.z + dhB.z, 2)· Final water, with maximum jump. The most important quality of a believable water effect is how good its moving normal surface conditions are. Once these are good, you could add effects such as more advanced reflections, transparency and refraction. But even without these additional features, the surface will already be interpreted as water. The next tutorial is directional flow. PDF PDF package section

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