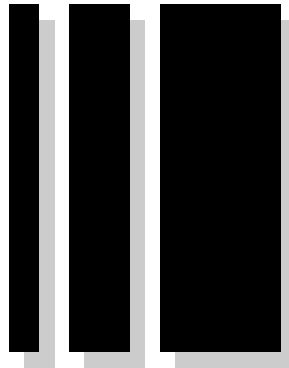


fryrender

physically-based render engine



Normal Mapping: How to create/ use Normals maps in fryrender

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Normal maps lie somewhere in between of bump mapping and displacement mapping. The main problem with normal mapping is 'how to create a normal map'. While height maps can be painted since they are simple grayscale images, normals maps are RGB-packed vectors that just can't be painted without the right tools. vBeta1.7 provides a simple mechanism to create normals maps...

...from existing geometry, based on the Layer Compositing Kernel.

To illustrate how, a golf ball material will be created, using normal mapping to simulate the dimples in the surface.

Creating the dimples

First of all, we need to create the geometry of the surface that we want to simulate with the normals map. In this case, we can create a flat box and then subtract some spheres from it.

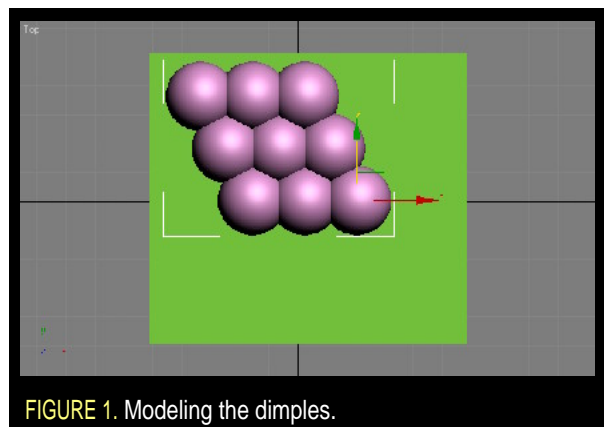


FIGURE 1. Modeling the dimples.

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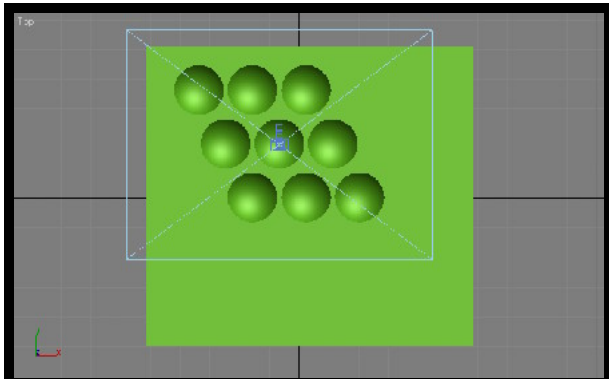


FIGURE 2. We get the dimples after a boolean SUBTRACT.

Make sure that the spheres are evenly spaced, since we would like for the resulting normal map to be tileable. Also note that we have modeled this in the TOP view, so that the geometry is a floor slab. Oh, and you don't need any lights.

Rendering the normals map

Now, add a FRY Target camera (the default parameters are ok) to your scene. Center it in the slab, and make it look from top to bottom exactly. That is, make it perfectly perpendicular to the slab. Also make sure that the target is focusing the slab for perfect focus. This all is depicted in Figure 3.

Select the *FRY R2 - Layered Compositing* kernel in render

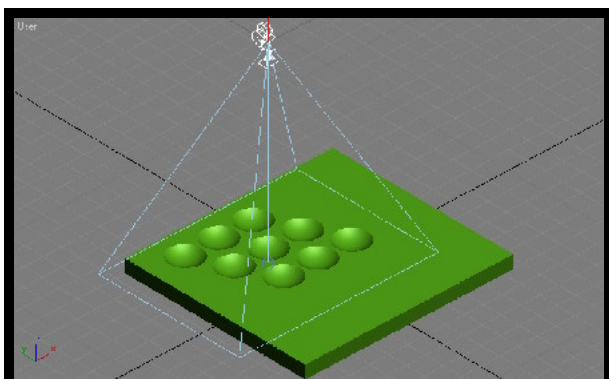


FIGURE 3. Perspective view of the dimples.

properties and then select the *Normals Buffer* layer type. Leave the other parameters as they are.

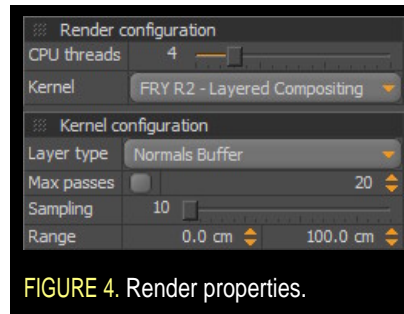


FIGURE 4. Render properties.

Now hit render, and you will get an image like the one that you can see in Figure 5.

That will be your normals map.

The render you will get should be a predominantly blue image, where each pixel is a 3D vector packed into 3 RGB bytes. The meaning of each RGB triplet is the following:

$$\begin{aligned} R &= (X / 2 + 0.5) \cdot 255 \\ G &= (Y / 2 + 0.5) \cdot 255 \\ B &= (Z / 2 + 0.5) \cdot 255 \end{aligned}$$

or, equivalently:

$$\begin{aligned} X &= (R / 255 - 0.5) \cdot 2 \\ Y &= (G / 255 - 0.5) \cdot 2 \\ Z &= (B / 255 - 0.5) \cdot 2 \end{aligned}$$

Normals are always non-null normalized vectors (hence their name \vec{n}) which means that:

$$X \cdot X + Y \cdot Y + Z \cdot Z = 1$$

So not all colors are possible in a normals map. Only those where the normalization condition is met encode a valid normal. Since you rendered the normals map facing it frontally, the slab must have a predominant normal of (0,0,1) (pointing along the Z axis). Using the formula above:

$$\begin{aligned} R &= (0 / 2 + 0.5) \cdot 255 = 127 \\ G &= (0 / 2 + 0.5) \cdot 255 = 127 \\ B &= (1 / 2 + 0.5) \cdot 255 = 255 \end{aligned}$$

That is why normals maps look predominantly blue, and also why normals maps can't be painted manually in the same way a height (bump) map is.

Note that the main advantage of a normals map over a traditional height map is that since normals are packed directly, all kinds of bends, wrinkles and cracks can be faked. You could even make normals face inwards the surf-

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face, while with a height map you are restricted to a more slight bending of normals, that will always face in the same hemisphere the original surface normal is pointing to. Aside from this normals maps do not need a 'height range'.

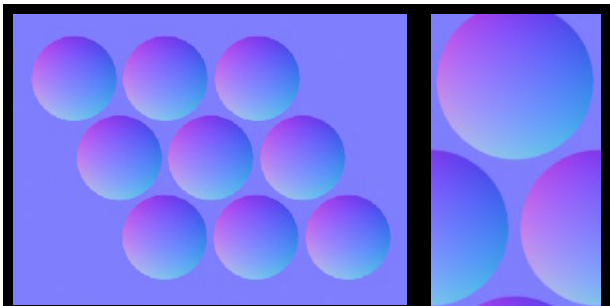


FIGURE 5. This is the normals buffer that we get (left). And a carefully cropped tileable version (right).

Note how the flat surface is blue (0,0,1) -> (127,127,255), and how the left sides of the dimples (which are facing a little towards the right) have a reddish hue (X increases -> R increases), etc...

Showtime

The golf ball material is just some kind of simple plastic. So we will create 2 layers, bump them both with the normals map we just generated, and then apply a diffuse map to the first one and make the second one be highly specular. For the weights we will use 85% (diffuse) and 15% (specular), and the roughness of the specular layer will be 5.

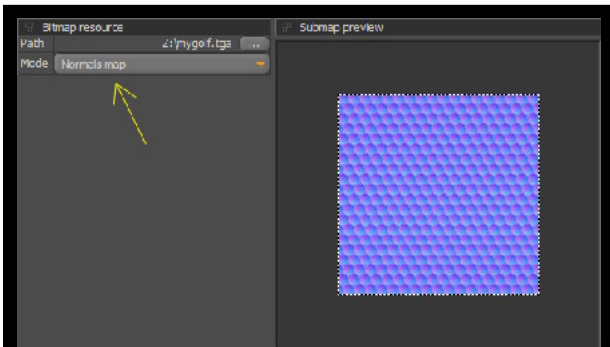


FIGURE 6. Flag the bitmap as a Normals map.

Note that since the cropped map's height is about twice its width, we set a different tiling factor in the U and V directions of the fry map properties. In this case, 18 and 10 were used for both tilings, respectively. Also in the fry map properties dialog, the bitmap was tagged as 'Normals map'. This way, the bump slot knows that we are reading normals instead of heights (see Figure 6).

The exact same map (and tiling) was added to the bump slots in both layers.

This is the result:

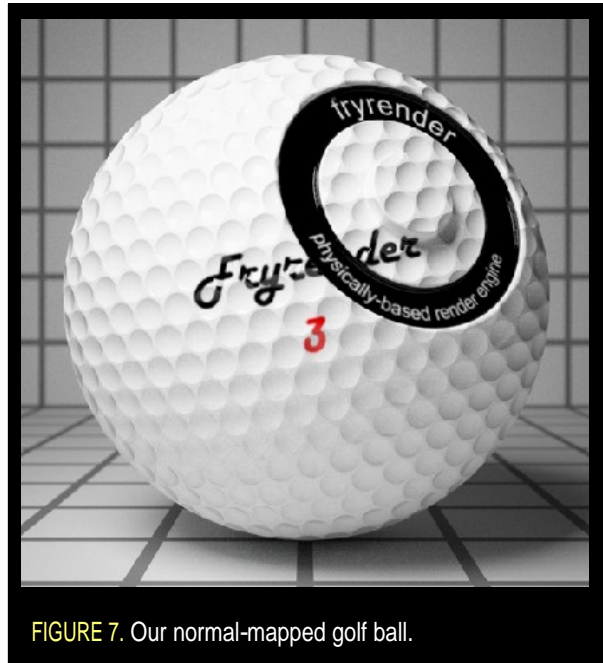


FIGURE 7. Our normal-mapped golf ball.

Summary

Normals maps are a powerful (yet cheap in terms of CPU) method to add strong details. They provide much more precision than a simple bump map. However, their main drawback is that they can't be generated easily.

In this tutorial, a simple technique to create normals maps from flat slabs of geometry in fryrender has been shown, taking advantage of fry's *Layered Compositing Kernel*.

Happy mapping!