Normal-Mapping

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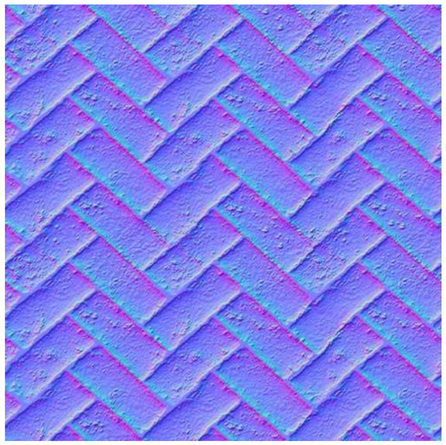


The Next Step in Bump-Mapping

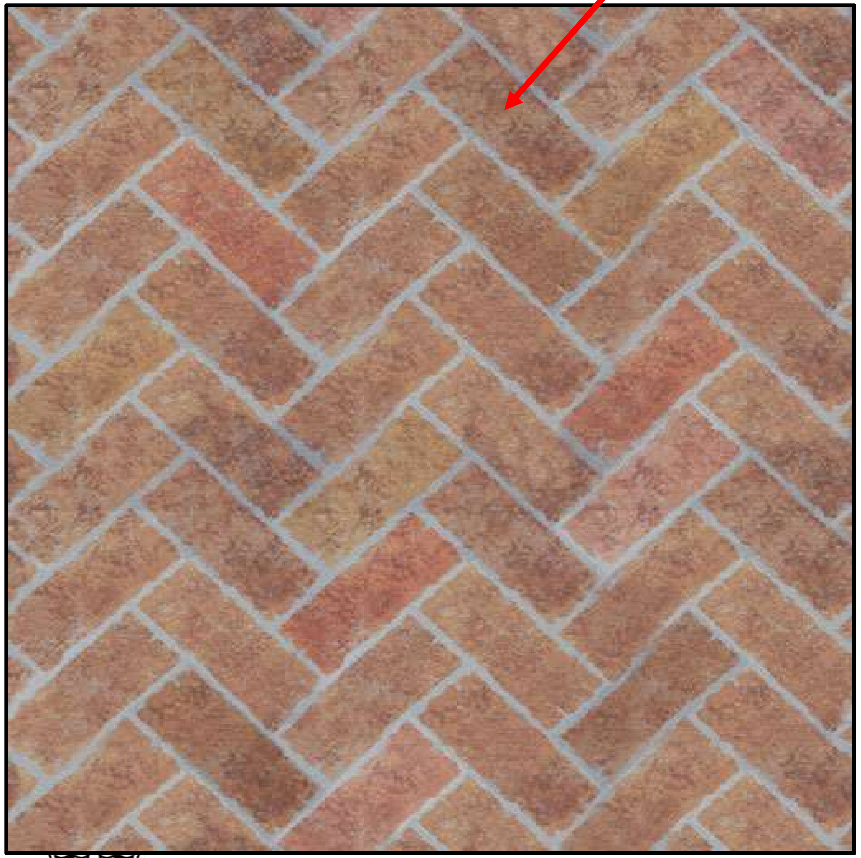
The Scenario:

You want to do bump-mapping. You have a very specific and detailed set of surface normal vectors but don’t have an equation that describes them. Yet you would still like to somehow “wrap” the normal vector field around the object so that you can perform good lighting everywhere.

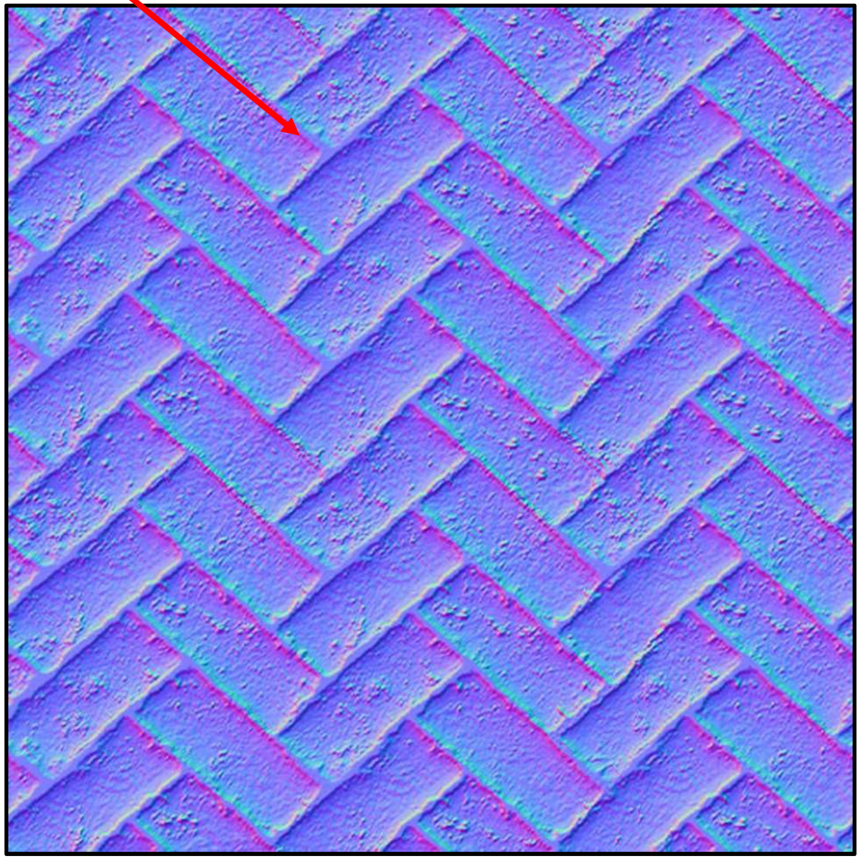
This is a job for ***Normal-Maps!***

What is Normal-Mapping?

Normal-Mapping is a modeling technique where, in addition to you specifying the color texture, you also create a texture image that contains all of the normal vectors on the object



Color Texture



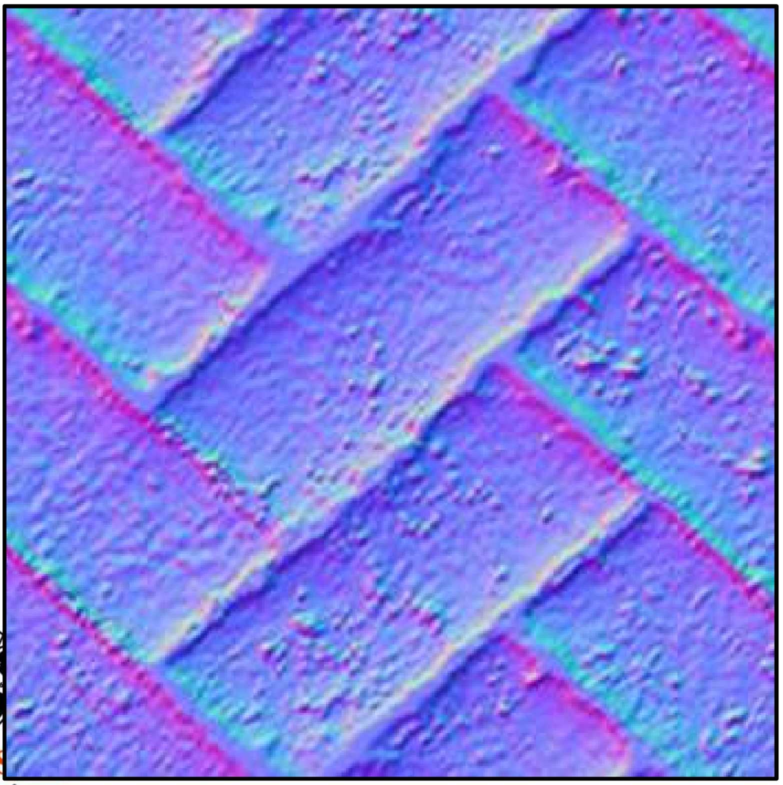
Normal-Map Texture

Color map and normal map provided by Michael Tichenor

How Do You Store a Surface Normal Field in a Texture?

The three components of the normal vector (nx, ny, nz) are mapped into the three color components (red, green, blue) of the texture:

$\begin{Bmatrix} nx \\ ny \\ nz \end{Bmatrix}$ in the range -1. → 1. are placed into the texture's $\begin{Bmatrix} red \\ green \\ blue \end{Bmatrix}$ in the range 0. → 1.



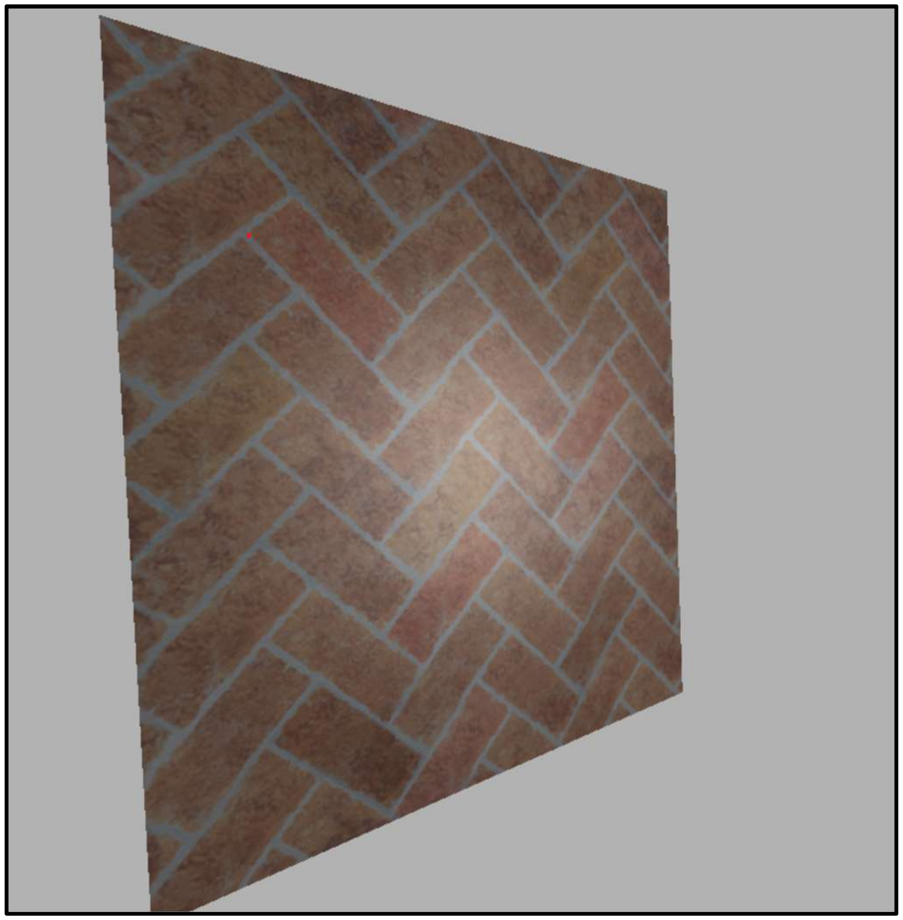
To convert the normal to a color:

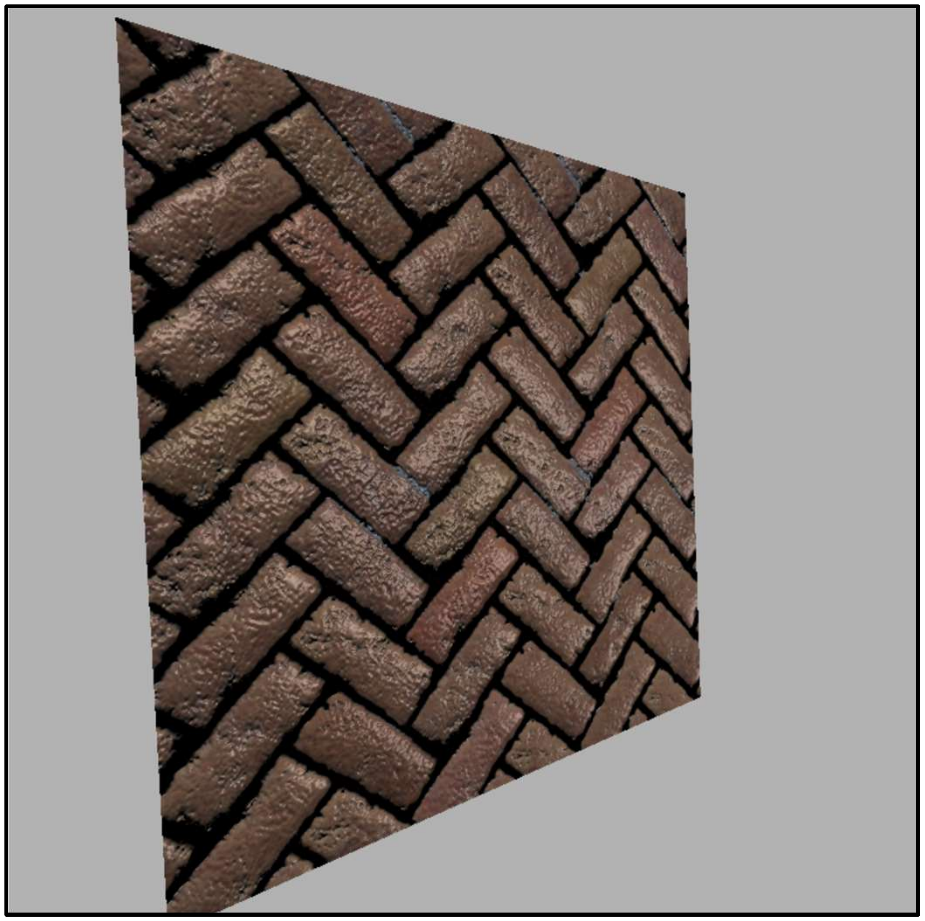
$$\begin{Bmatrix} red \\ green \\ blue \end{Bmatrix} = \frac{\begin{Bmatrix} nx \\ ny \\ nz \end{Bmatrix} + \begin{Bmatrix} 1. \\ 1. \\ 1. \end{Bmatrix}}{2.}$$

To convert the color back to a normal:

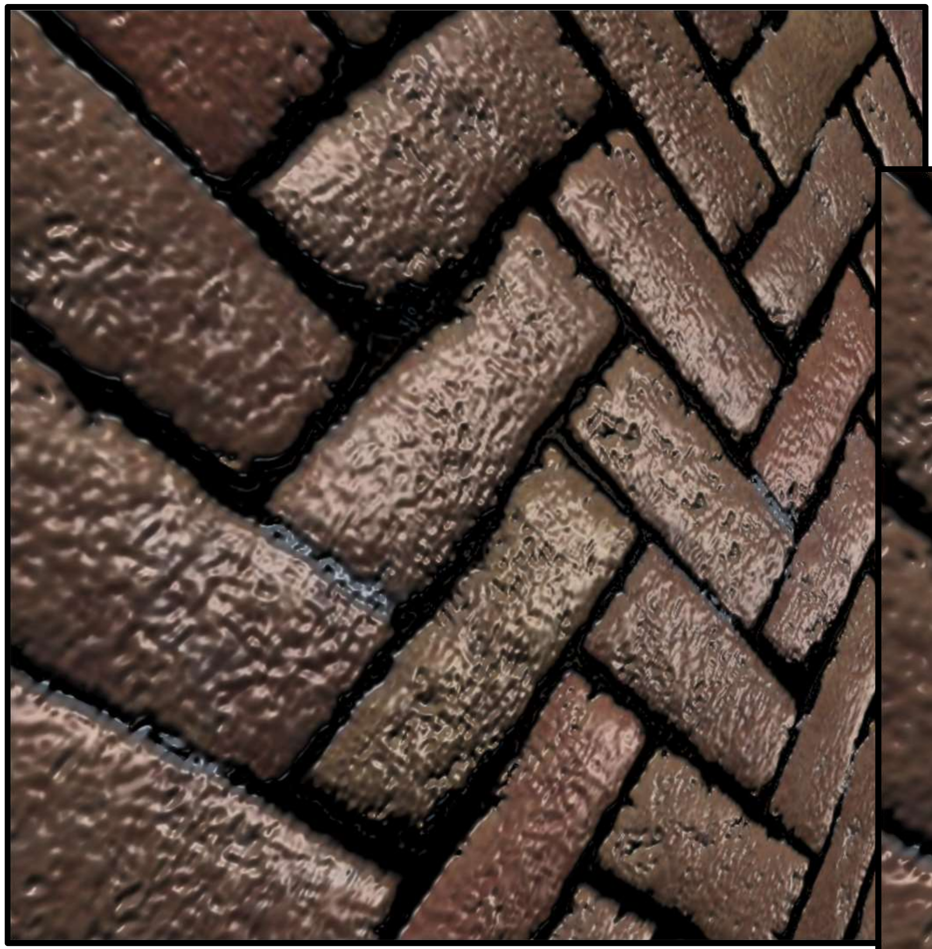
$$\begin{Bmatrix} nx \\ ny \\ nz \end{Bmatrix} = 2. * \begin{Bmatrix} red \\ green \\ blue \end{Bmatrix} - \begin{Bmatrix} 1. \\ 1. \\ 1. \end{Bmatrix}$$

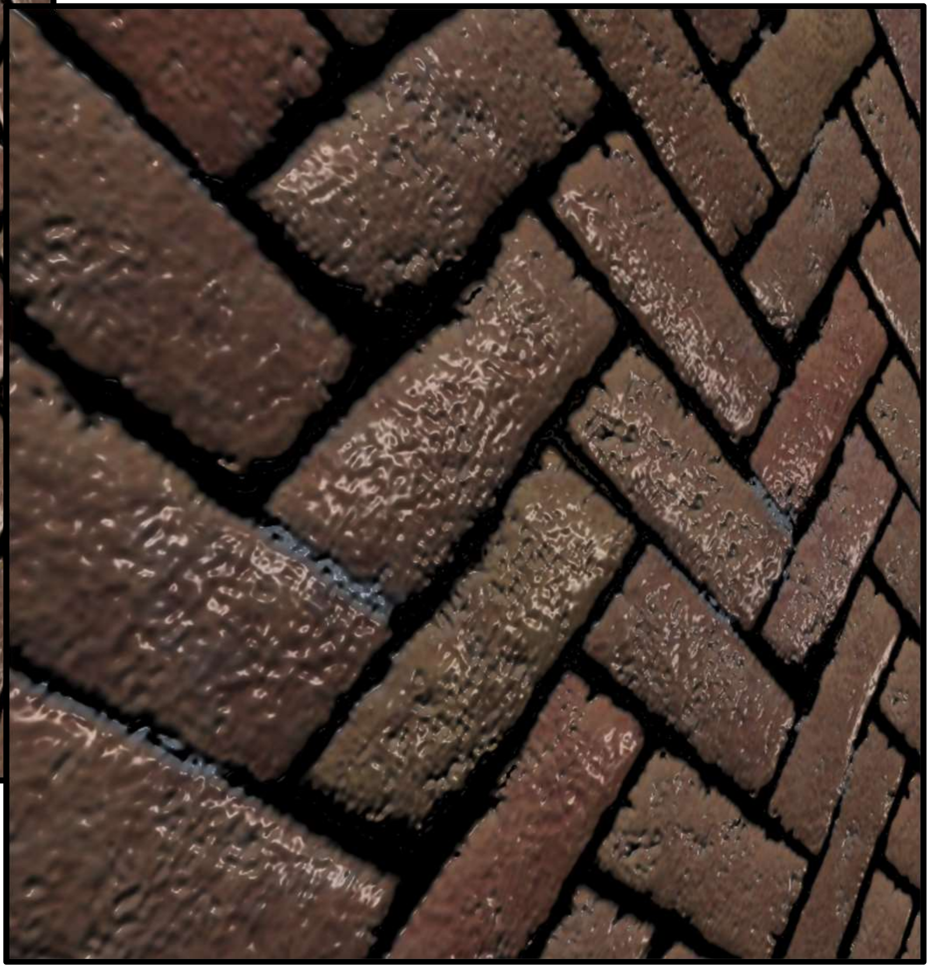
This Gets Us Better Lighting Behavior, While Still Maintaining the Advantages of Bump-Mapping


Ordinary Texture


Normal-Mapping

This Gets Us Better Lighting Behavior, While Still Maintaining the Advantages of Bump-Mapping


Small Specular Shininess


Large Specular Shininess

Vertex shader

```
#version 330 compatibility

out vec3 vSurfacePosition;
out vec3 vSurfaceNormal;
out vec3 vEyeVector;
out vec2 vST;

void
main( )
{
		vSurfacePosition = (gl_ModelViewMatrix * gl_Vertex).xyz;
		vSurfaceNormal = normalize( gl_NormalMatrix * gl_Normal );
		vEyeVector = vec3( 0., 0., 0. ) – vSurfacePosition;

		vST = gl_MultiTexCoord0.st;

		gl_Position = gl_ModelViewProjectionMatrix * gl_Vertex;
}
```

Fragment shader

```
#version 330 compatibility

uniform float uKa;
uniform float uKd;
uniform float uKs;
uniform float uShininess;
uniform float uFreq;
uniform sampler2D Color_Map;
uniform sampler2D Normal_Map;

in vec3 vSurfacePosition;
in vec3 vSurfaceNormal;    // not actually using this – just here if we need it
in vec3 vEyeVector;
in vec2 vST;

const vec3 LIGHTPOSITION = vec3( 0., 10., 0. );
const vec3 WHITE = vec3( 1., 1., 1. );


void
main( )
{
		vec3 P = vSurfacePosition;
		vec3 E = normalize( vEyeVector );
		vec3 N = normalize( gl_NormalMatrix * (2.*texture( Normal_Map, uFreq*vST ).xyz - vec3(1.,1.,1.) ) );
		vec3 L = normalize( LIGHTPOSITION – P );

		vec3 Ambient = uKa * texture( Color_Map, uFreq * vST ).rgb;
		float Diffuse_Intensity = dot( N, L );
		vec3 Diffuse = uKd * Diffuse_Intensity * texture( Color_Map, uFreq * vST ).rgb;
		float Specular_Intensity = pow( max( dot( reflect( -L, N ), E ), 0. ), uShininess );
		vec3 Specular = uKs * Specular_Intensity * WHITE;
		gl_FragColor = vec4(Ambient+ Diffuse + Specular, 1. );
}
```