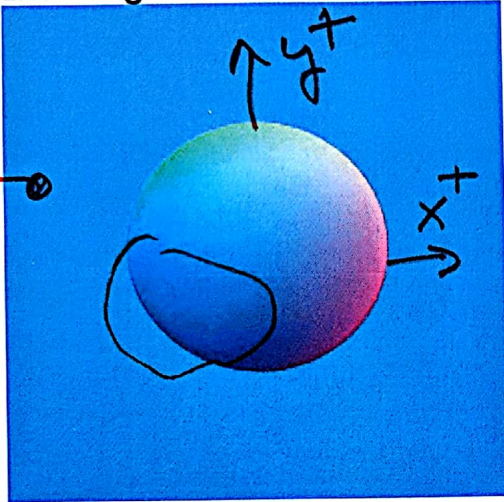


Normal Maps

1. Encoding Normals



Encoding

$$\frac{1}{2} + \frac{1}{2} n_d = n_e$$

Decoding

$$2n_e - 1 = n_d$$

Normal maps encode unit-length vectors in images as colors.

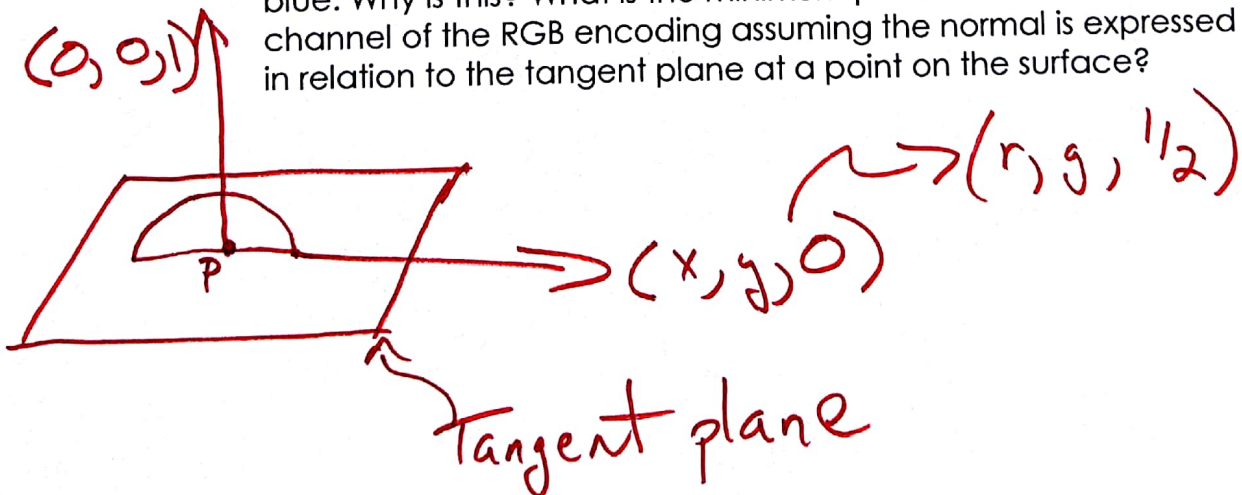
a. Decode it

Suppose you sample a normal map and get a color value of $(0.5, 0, 0.75)$. What is the decoded normal?

not actually $\rightarrow (0, -1, 0.5)$

b. Why so blue?

Normal maps, like the one shown above, typically have a lot of blue. Why is this? What is the minimum possible value the blue channel of the RGB encoding assuming the normal is expressed in relation to the tangent plane at a point on the surface?



2. Implementing Normal Mapping in the Shader Program

There's more than one correct way to do this, but....

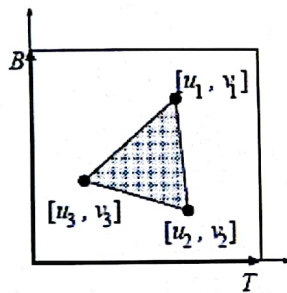
Describe in words what data are passed to the Vertex Shader?

What data are passed to the Fragment Shader?

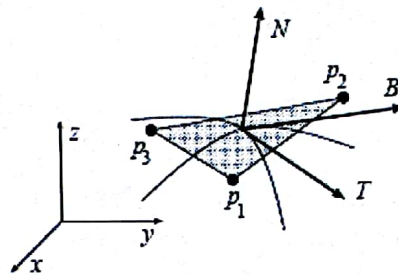
Into Vertex Shader: N, T, B, L, V, u, v
 Convert L, U to Tangent Space
 using NTB matrix

Into Fragment Shader: Normal Map \leftarrow uniform
 $u, v \leftarrow$ varyings
 $L_T, V_T \leftarrow$ varyings

3. Deriving the Tangent and Bitangent Vectors



texture space



local modeling space

From the images shown above we can derive the following equations

$$p_1 = u_1 T + v_1 B$$

$$p_2 = u_2 T + v_2 B$$

$$p_3 = u_3 T + v_3 B$$

Describe in words: what are the P_i ? What are the u_i and v_i ?

Without referring to lecture slides, can you derive expressions for the T(angent) and B(itangent) vectors for a local frame for a triangle?

Hint 1: what are expressions for $p_2 - p_1$ and $p_3 - p_1$?

Hint 2:

$$(v_3 - v_1)(p_2 - p_1) = (v_3 - v_1)(u_2 - u_1)T + (v_3 - v_1)(v_2 - v_1)B - (v_2 - v_1)(p_3 - p_1) - (v_2 - v_1)(u_3 - u_1)T - (v_2 - v_1)(v_3 - v_1)B$$

$$T = \frac{(v_3 - v_1)(p_2 - p_1) - (v_2 - v_1)(p_3 - p_1)}{(u_2 - u_1)(v_3 - v_1) - (v_2 - v_1)(u_3 - u_1)}$$

$$B = \frac{(u_3 - u_1)(p_2 - p_1) - (u_2 - u_1)(p_3 - p_1)}{(v_2 - v_1)(u_3 - u_1) - (u_2 - u_1)(v_3 - v_1)}$$