White Paper

Subject:	Bump Mapping
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File Name:	Bumpmapping White Paper.doc
Issue Number:	1.0.5
Issue Date:	07 Nov 00

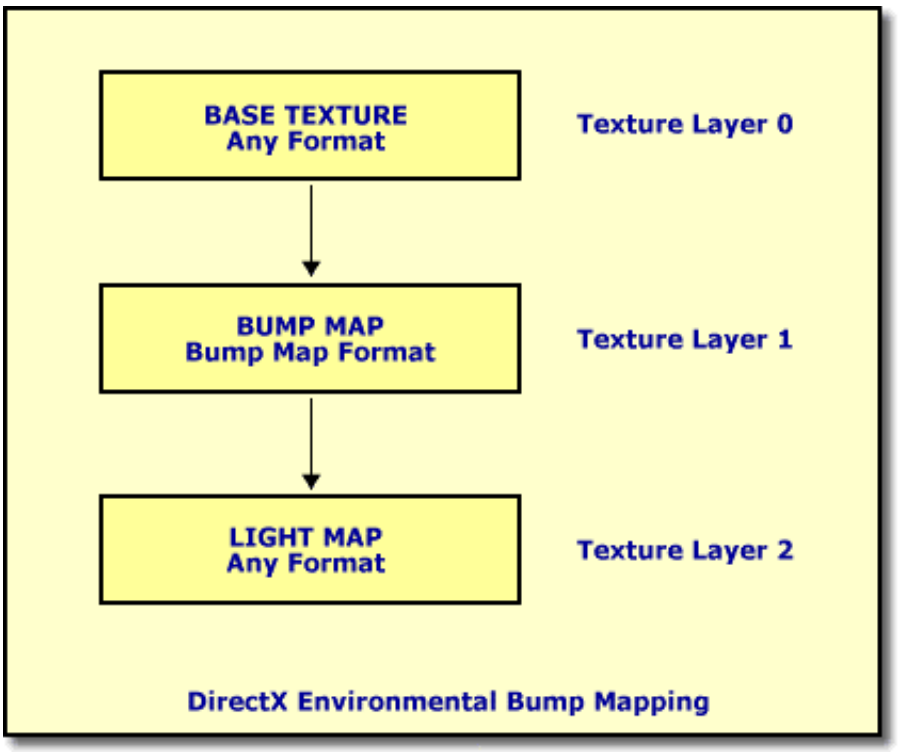
Introduction

Bump mapping is a technique which allows surface irregularities to be represented on an object during the 3D rendering of a scene without requiring the irregularities (or bumps) to each be represented by a separate polygon, which would be hugely expensive for both the CPU and the graphics processor.

Bump mapping works by using a texture map, which represents a polygon's bumpiness, to modify the effect of lighting on that surface in real time. This paper discusses "Environmental Bump Mapping" as used by KYRO for bump mapping. Environmental bump mapping (also known as perturbed UV bump mapping) is supported in DirectX 6 and later and is so called because it is often used to simulate environmental reflections.

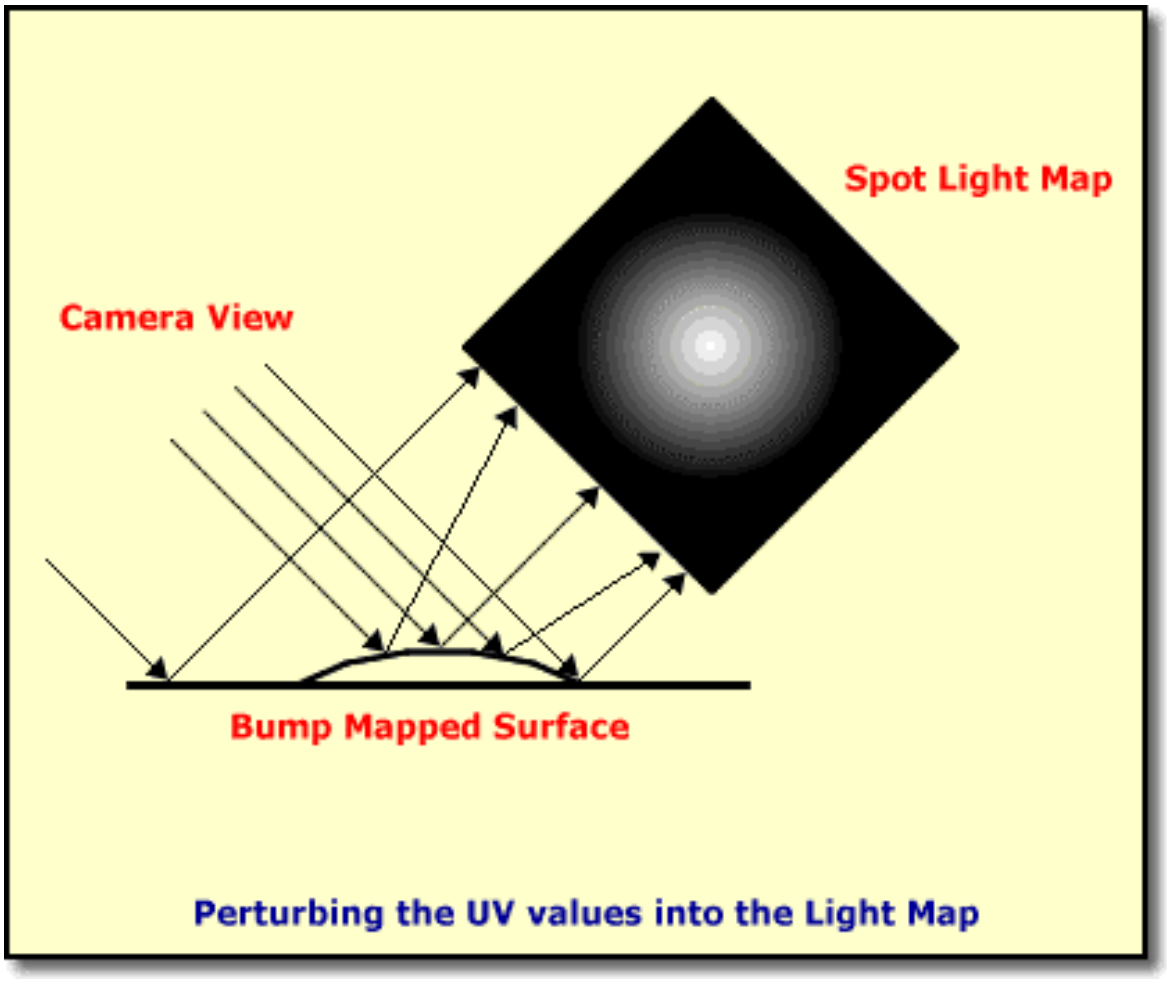
Environmental Bump Mapping

Environmental Bump Mapping is performed through the use of a base texture, a bump map texture and a light or environment map. The bump map texture is a special texture that indicates texture coordinate offsets to be applied to the reflection map.



Light maps are a popular method of representing the effect of lighting on objects in a scene and allow great flexibility in the choice of the number of lights as well as their shape, colour and intensity. Used on their own however tends to lead to objects which appear flat, despite the use of base textures (e.g. bricks or rubber), since the lighting is not changing across the surface of the object due to surface irregularities.

Environmental Bump Mapping changes which pixels of the light map are used on a per pixel basis to simulate the effect of surface irregularities deflecting the light from its normal direction of reflection. For example a spot light is bright in the centre and darkens to black at the edges; a pixel lit by the centre of the spot light would normally use a UV value for the centre of the light map. The bump map indicates a deflection of the reflected light by supplying a "perturbation" in the light maps UV values.



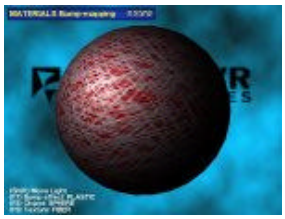
KYRO supports two bump map formats - BUMP UV88 and BUMP UVL556. BUMP UV88 encodes the U and V offsets as signed 8bit values representing U and V offsets of -0.5 to +0.5, while BUMP UVL556 uses 5 bits for the U and V perturbations, and 6 bits for a luminance value used to modulate the intensity of the light/environment map in the next blending stage , this is used to change the "shininess" of the surface.

A perturbed UV bump map is typically derived from a height map of a surface - a map that describes the height of irregularities across the surface. The perturbed UV map simply encodes the change of height in the height map across U and V.

The U and V offsets (Du and Dv) are transformed by a 2x2 matrix before being used. This allows the bump map to be orientated in the same plane as the light/environment map as well as allowing the magnitude of the offsets to be scaled.

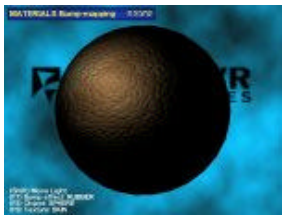
Using Different Parameters

There are a large number of parameter combinations that are possible with Environmental Bump Mapping. By varying blend mode, light intensity, reflection maps and bump maps a wide range of surface effects can be achieved e.g. plastic, metallic, rubber and shiny (wet look) finishes as shown below.



Plastic Effect

Metallic Effect



Rubber Effect

Shiny Effect

Putting the various methods together into one scene demonstrates that a geometrically simple scene can achieve a realistic result through the use of Environmental Bump Mapping.

Without Bump Mapping

With Bump Mapping

Summary

Using Direct3D Bump Mapping on PowerVR KYRO can generate very good effects and improve the overall realism of a scene.

