

Técnicas de Renderização Baseadas em Mapeamento

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UFBA/IM/DCC/BCC - 2018.1

Roteiro

- Mapeamentos
 - Alias e Técnicas de Anti-Alias
- Técnicas de Renderização Baseadas em Mapeamento
 - Detalhes geométricos
 - Luz e Sombra

Leitura de referencia

- Capítulo 7

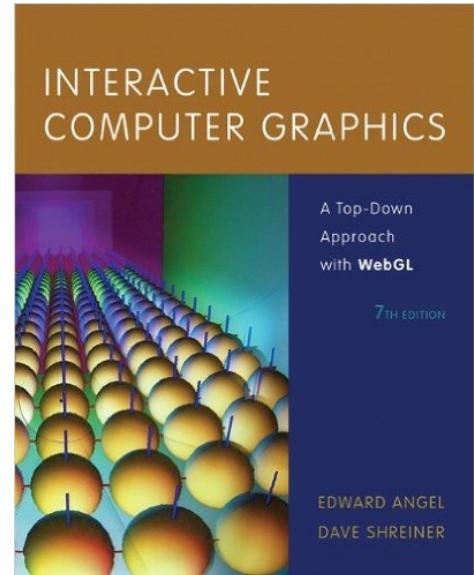
Interactive Computer Graphics - A top-down approach with WebGL

7th Edition

Angel, Edward

Shreiner, Dave

Addison-Wesley. 2014.



Leitura de referencia

- Capítulo 20

Computer Graphics : Principles and Practice Third Edition in C

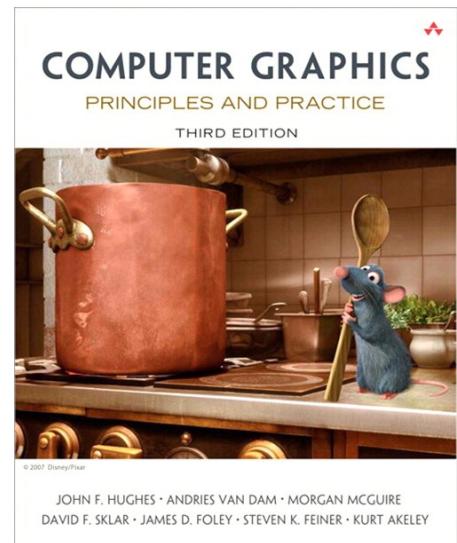
3rd Edition

John F. Hughes / Andries van Dam

Morgan McGuire / David F. Sklar

James D. Foley / Steven K. Feiner

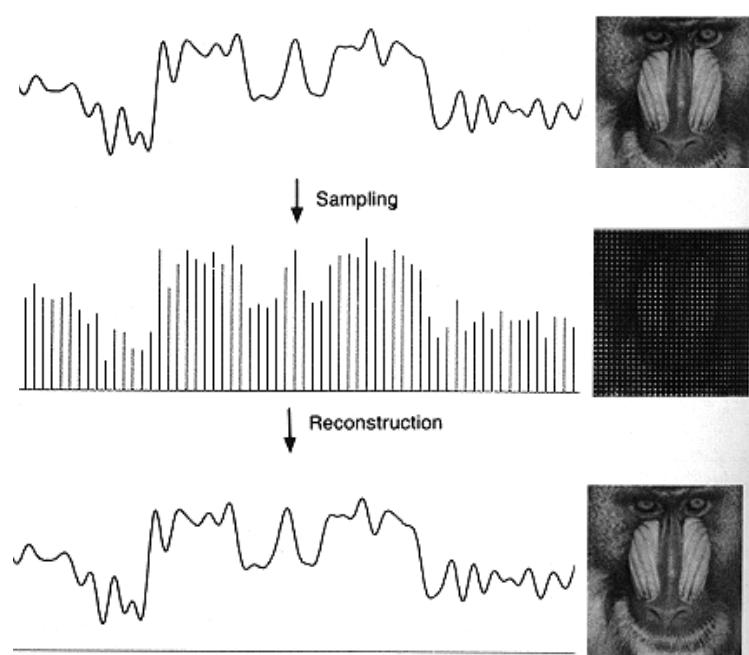
Addison-Wesley. 2013.



Alias e técnicas de Anti-Alias

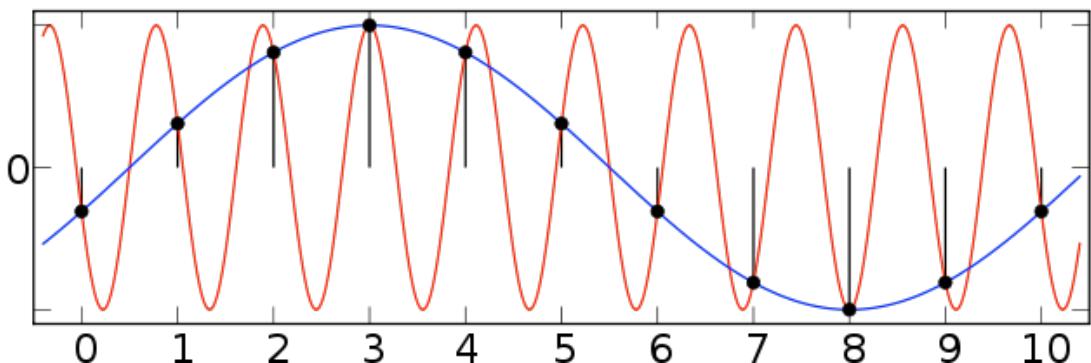
Amostragem

- Dada uma amostragem de um sinal podemos sempre reconstruir o sinal original?



Alias

- Em processamento de sinais:
 - refere-se ao efeito de dois sinais contínuos apresentarem a mesma representação discreta



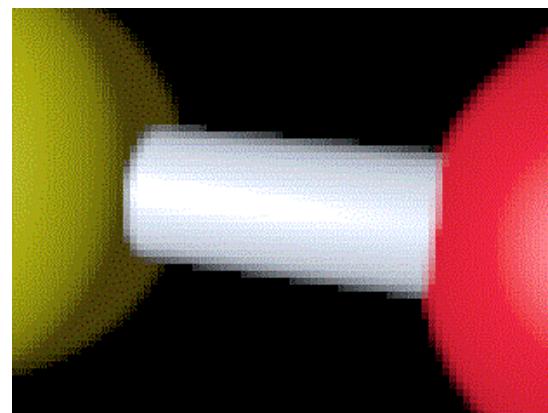
Alias

- Em CG:
 - distorção ou artefatos que aparecem quando o sinal reconstruído a partir de amostras é diferente do sinal original contínuo.



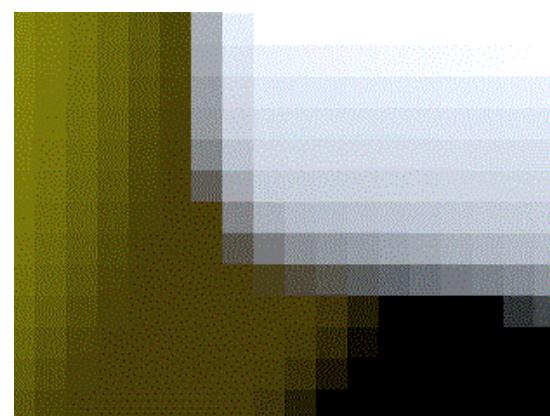
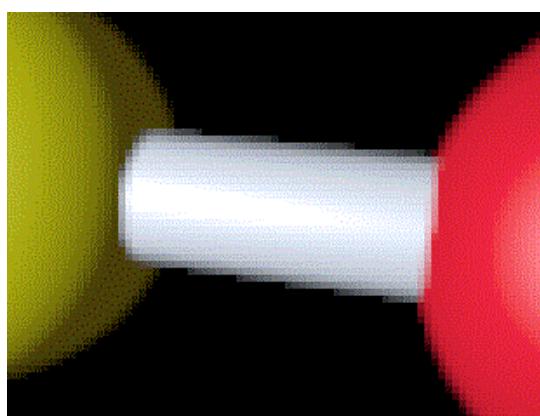
Anti-Alias

- Técnicas que visam minimizar o efeito de serrilhamento nas imagens sintéticas



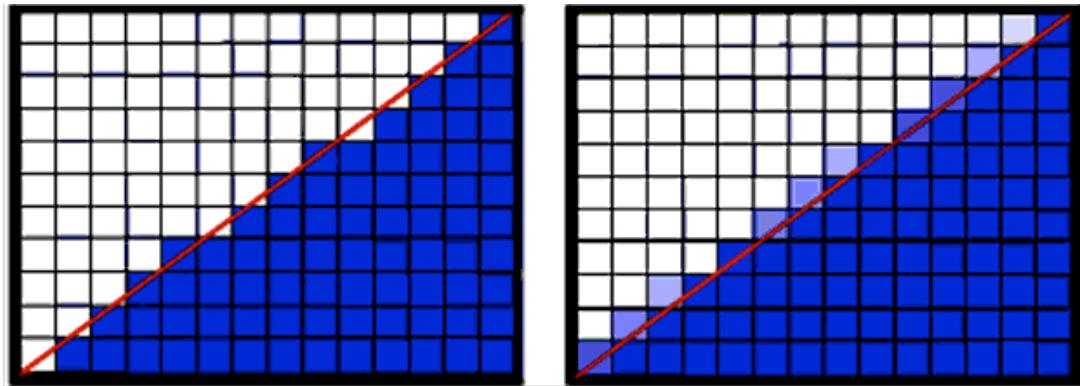
Anti-Alias

- Suavização dos contornos da discretização



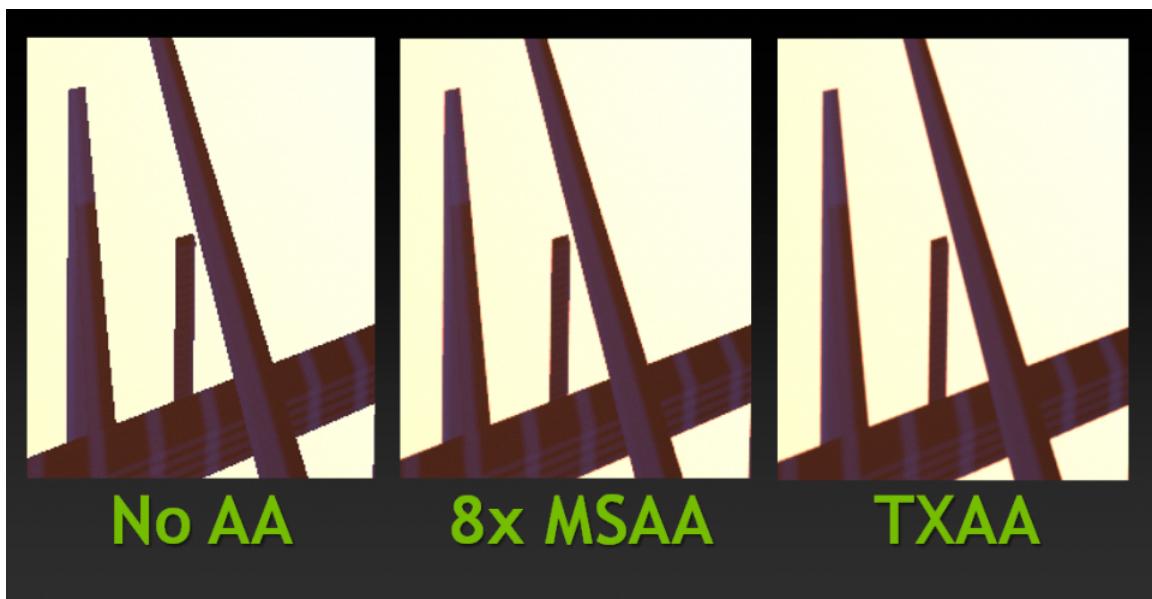
Anti-Alias

- Suavização dos contornos da discretização



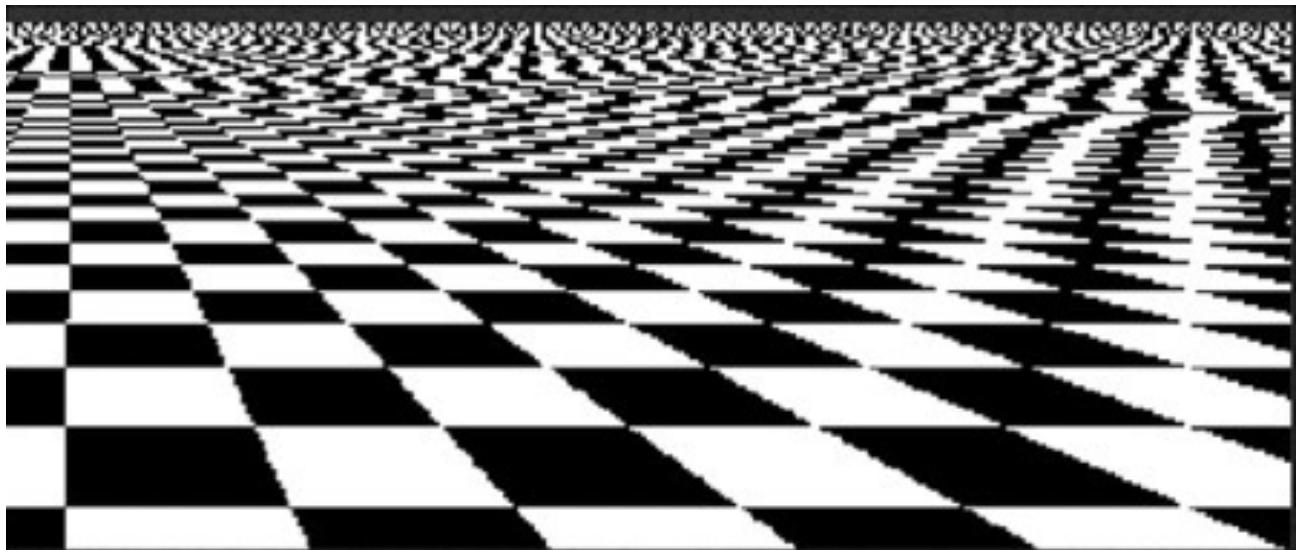
Alias

- Em CG:
 - No processo de rasterização



Alias

- Em CG:
 - No processo de texturização



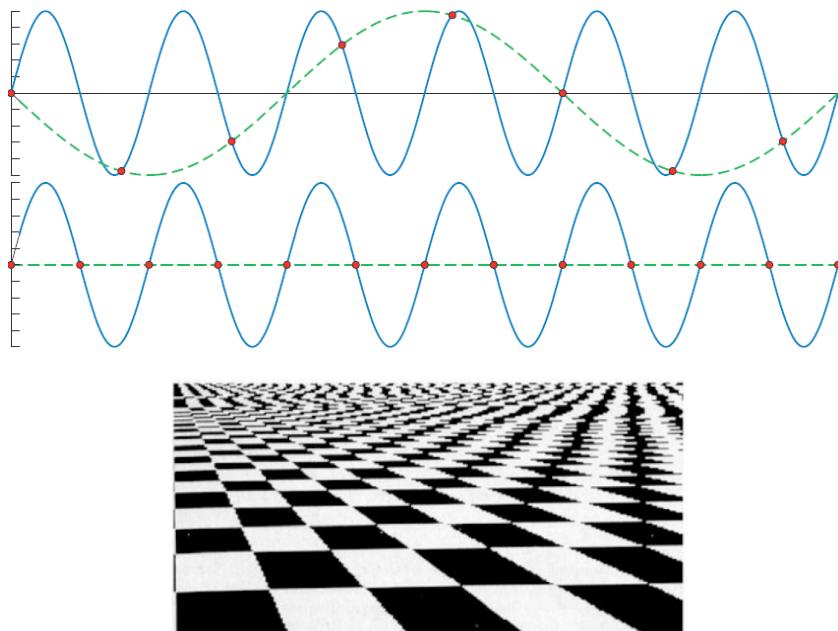
Alias

- Em CG:
 - No processo de animação



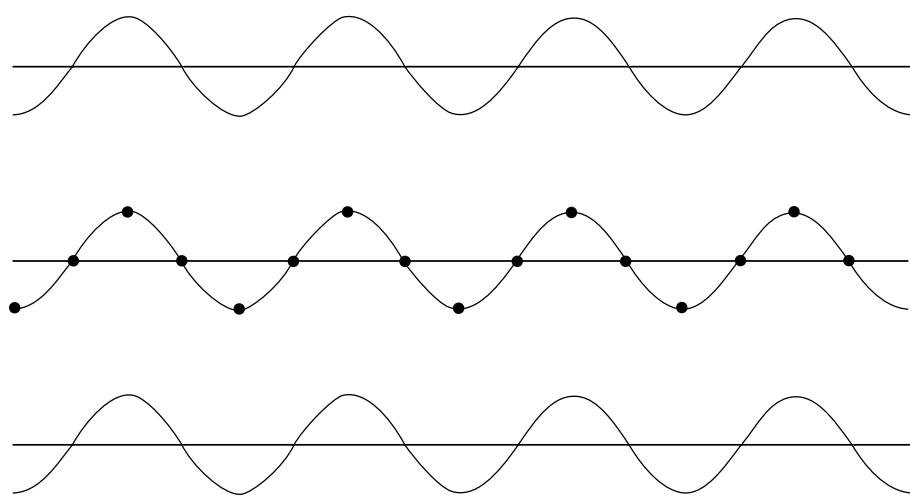
Alias ou Serrilhamento

- A taxa de amostragem do sinal deve ter relação com a freqüência do sinal



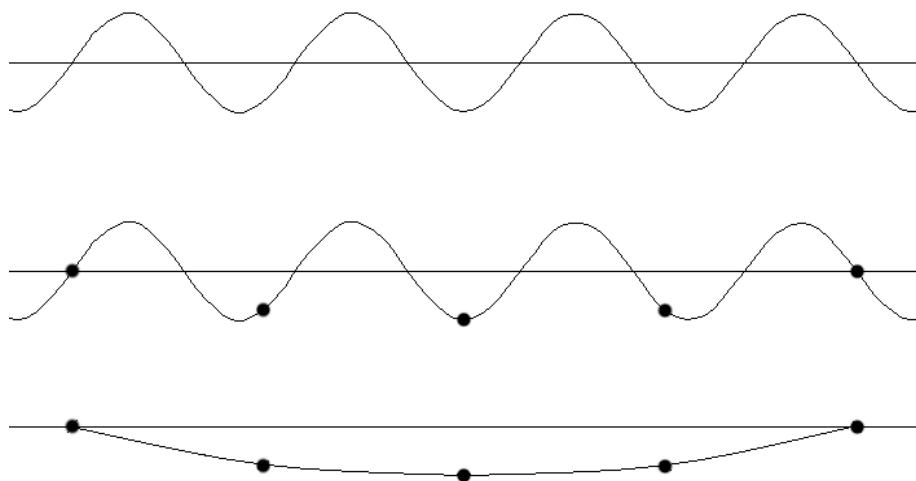
Alias ou Serrilhamento

- Amostragem deve ser feita em uma taxa maior que 2 vezes a maior freqüência do sinal
 - **Limite de Nyquist**



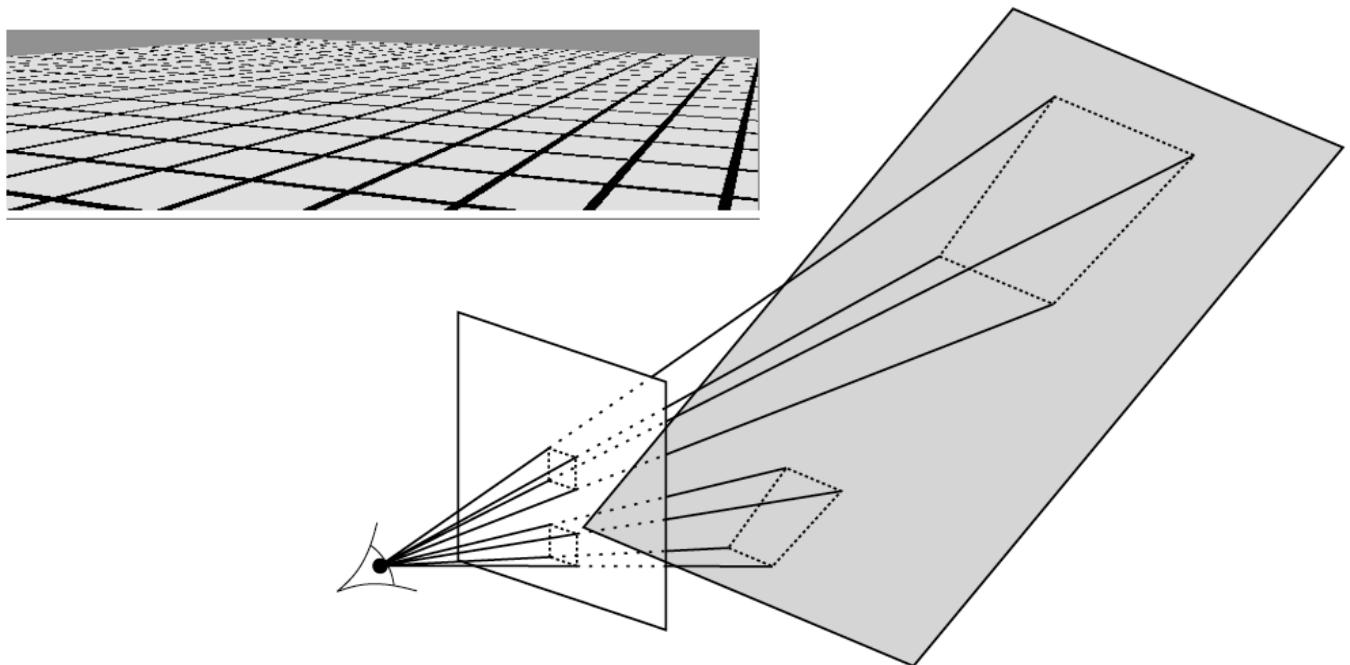
Alias ou Serrilhamento

- Amostragem deve ser feito em uma taxa maior que 2 vezes a maior freqüência do sinal
 - **Limite de Nyquist**



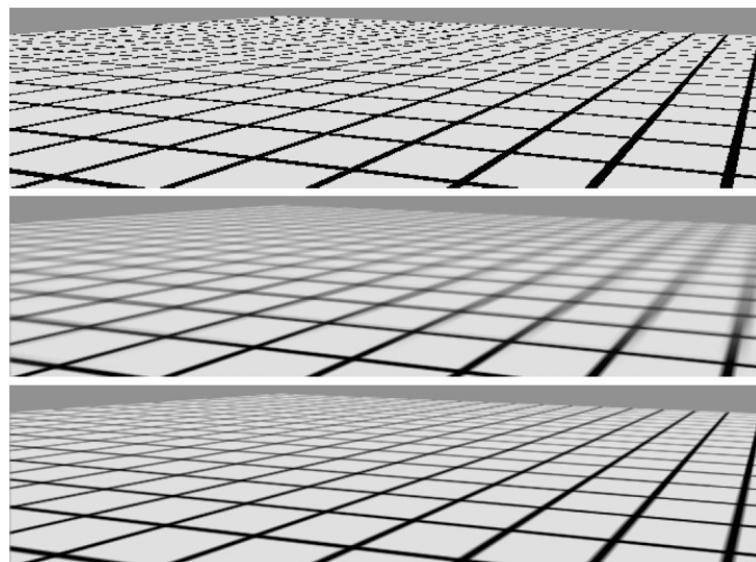
Aliasing

- Alias aparece em função do processo de amostragem



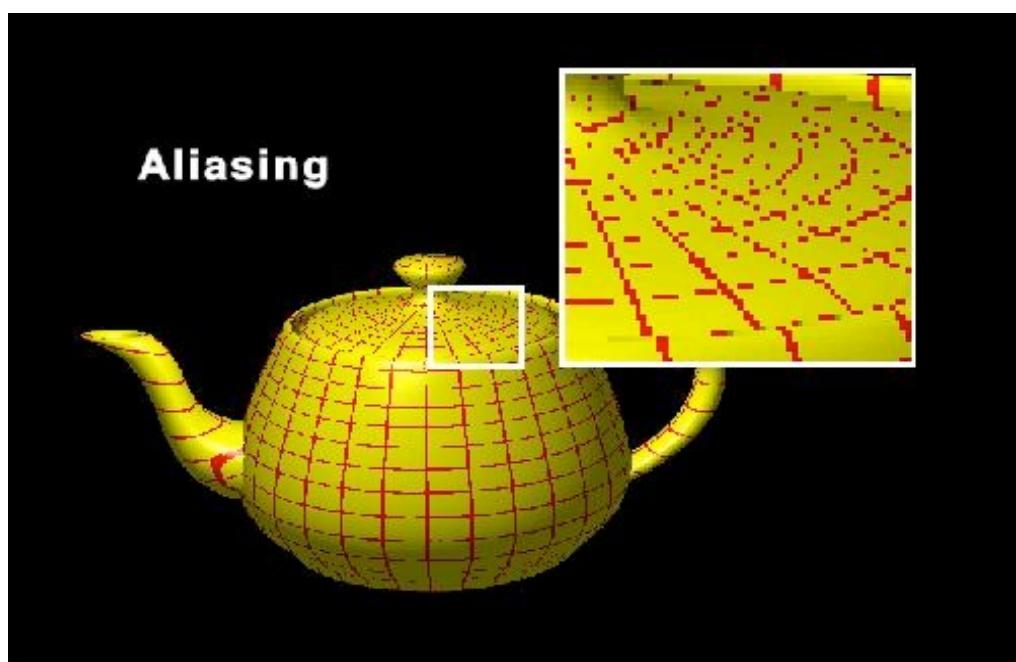
Aliasing

- Alias aparece em função do processo de amostragem
 - Técnicas de anti-alias para correção do problema



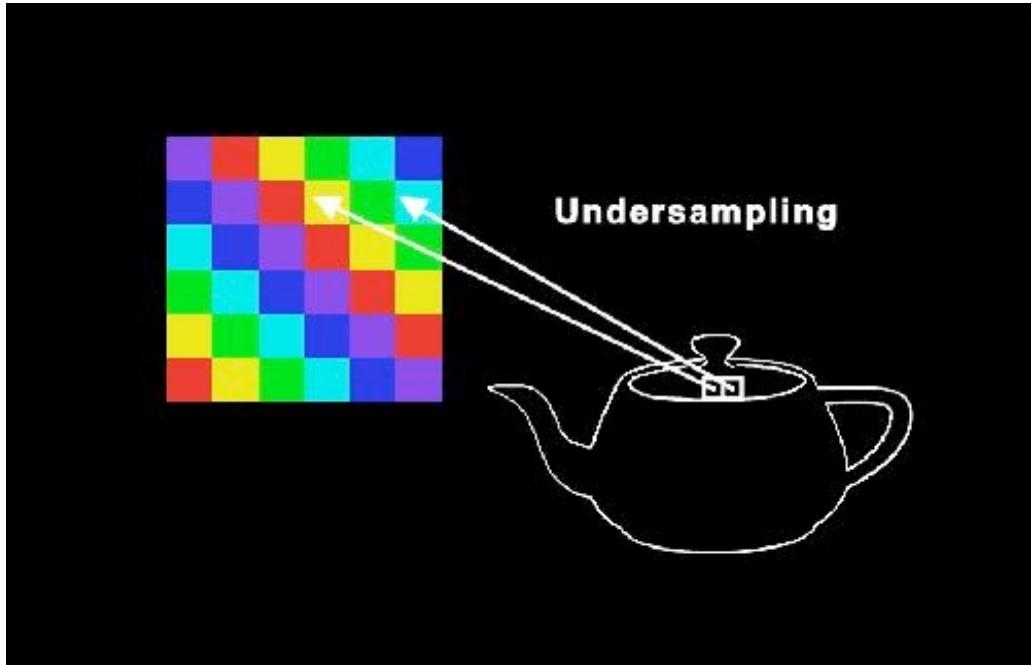
Aliasing

- Mapeamento de texturas esta sujeito a alias



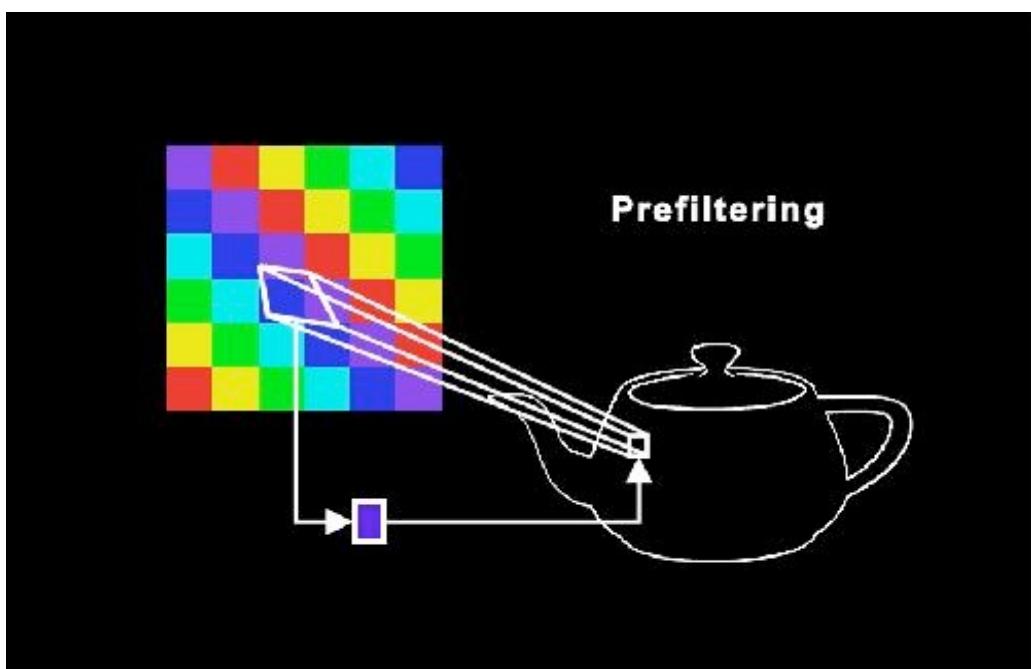
Aliasing

- Amostragem pode causar *undersampling*



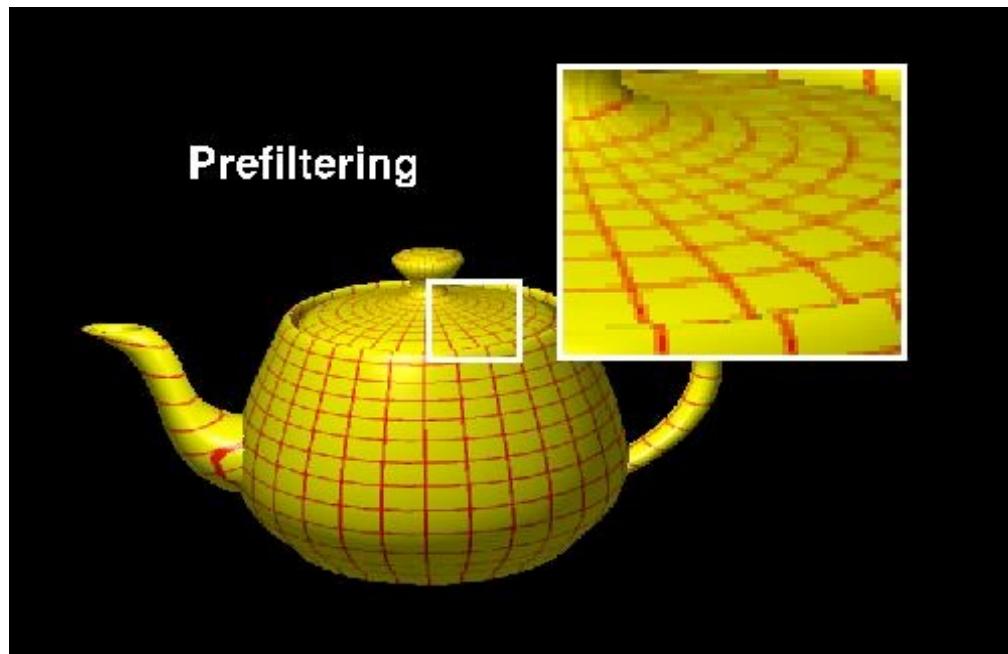
Aliasing

- Solução 1 : Pré filtragem



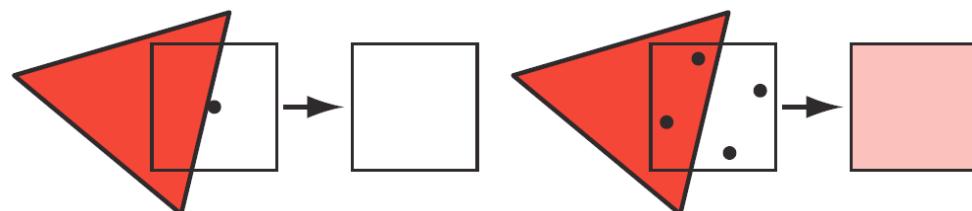
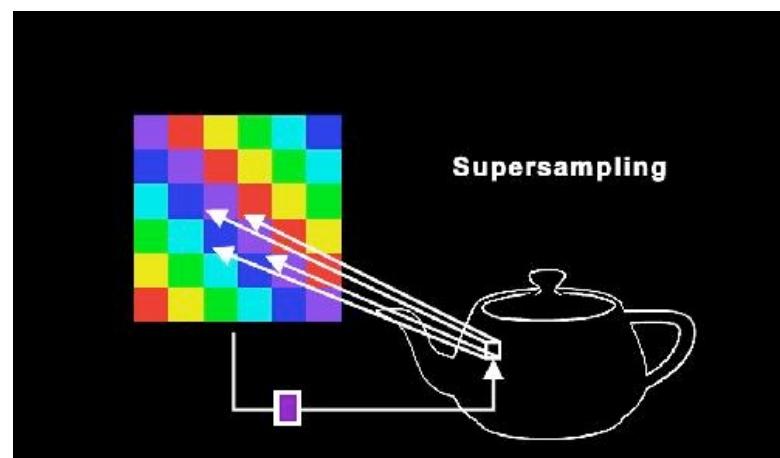
Aliasing

- Resultados : pré filtragem



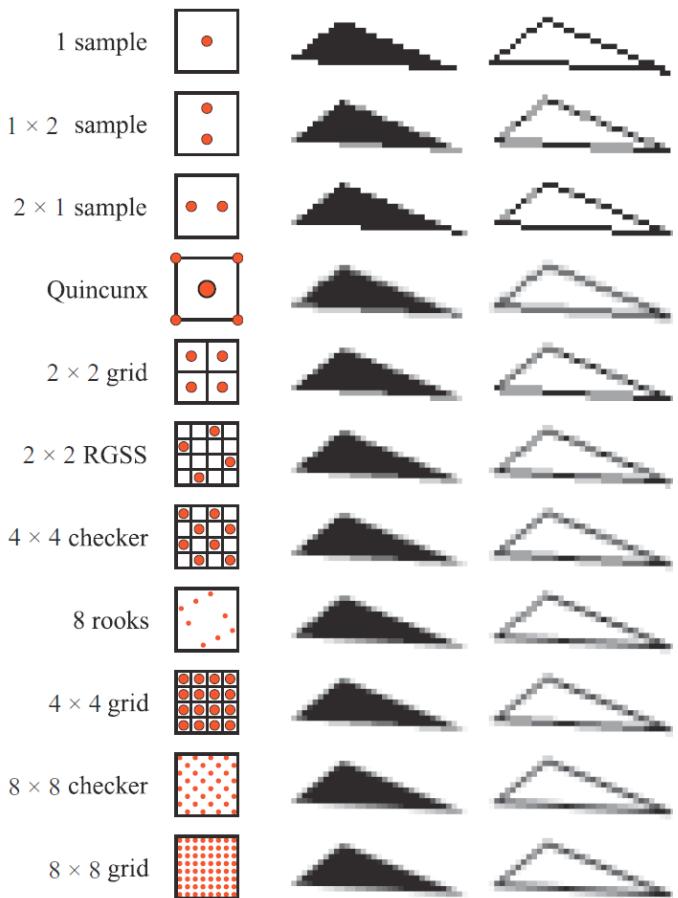
Aliasing

- Solução 2 : super amostragem



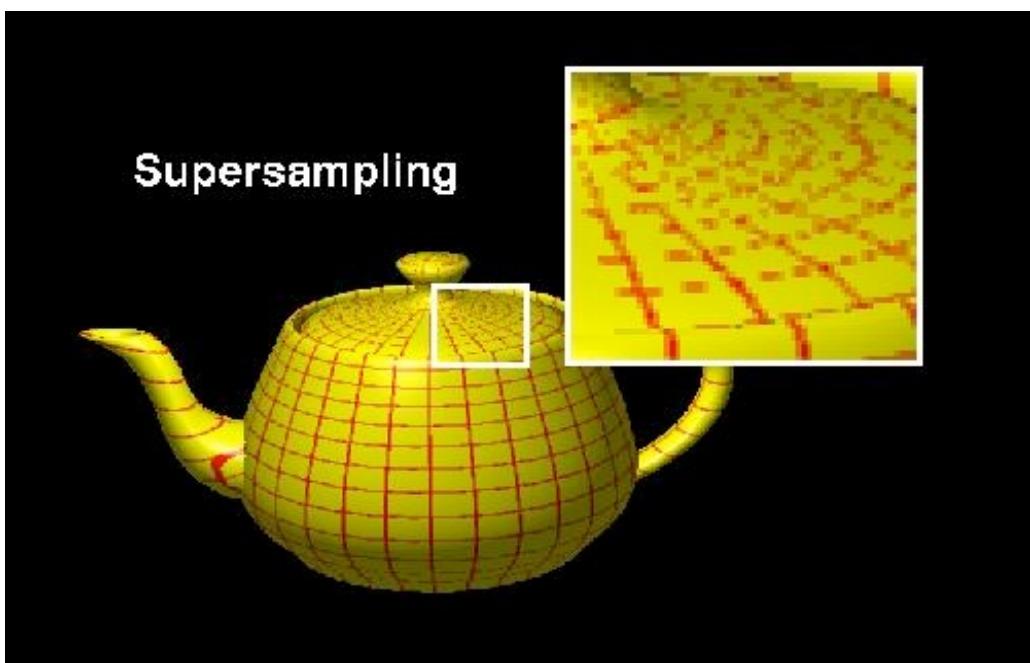
Aliasing

- Super amostragem
 - Várias possibilidades de formas de amostragem



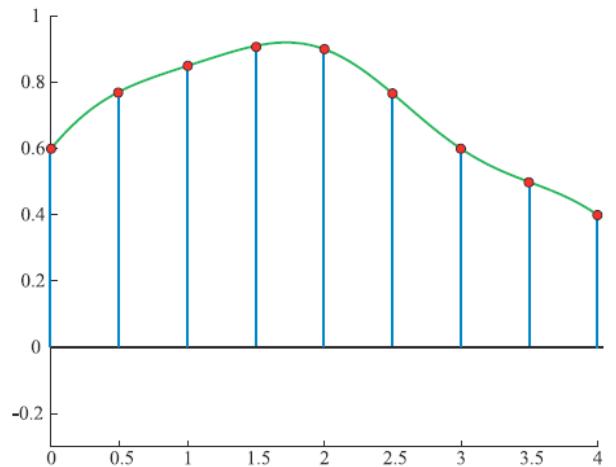
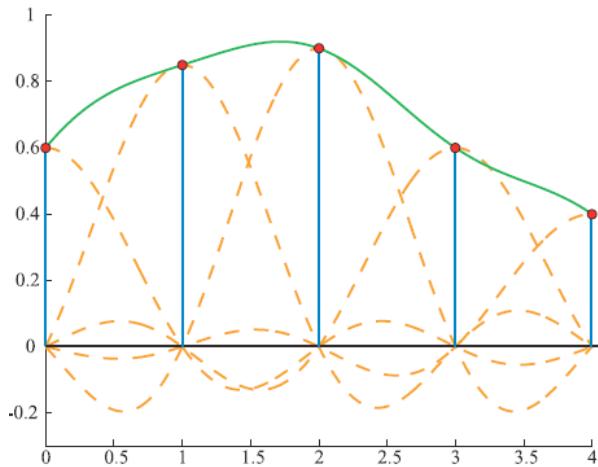
Aliasing

- Resultado : super amostragem



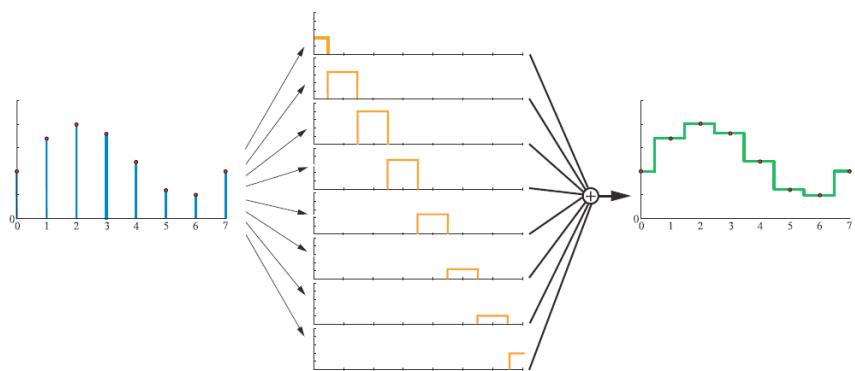
Texture magnification

- A textura tem resolução menor que o necessário para a amostragem no espaço da tela
 - Interpolação



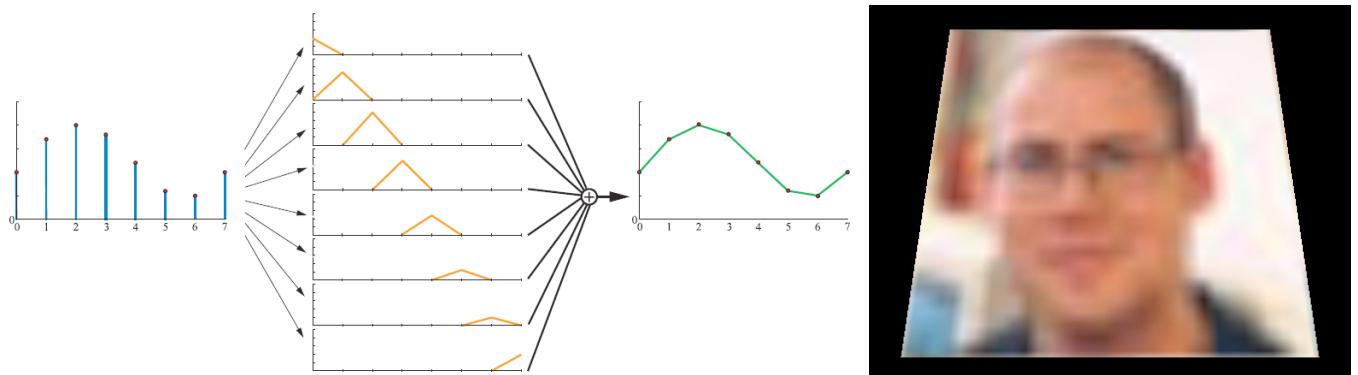
Texture magnification

- A textura tem resolução menor que o necessário para a amostragem no espaço da tela
 - Interpolação: Função Box



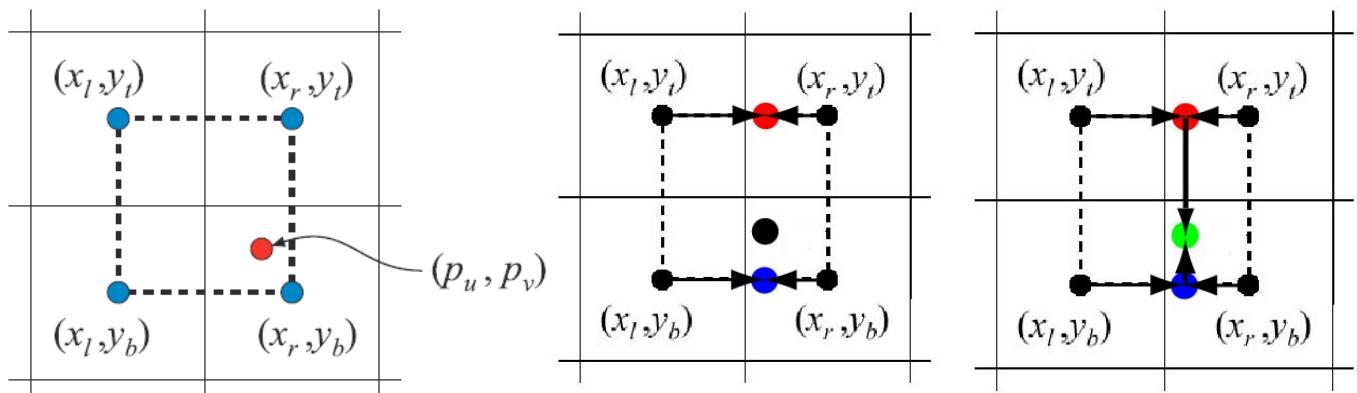
Texture magnification

- A textura tem resolução menor que o necessário para a amostragem no espaço da tela
 - Interpolação: Função Linear



Texture magnification

- Interpolação Linear



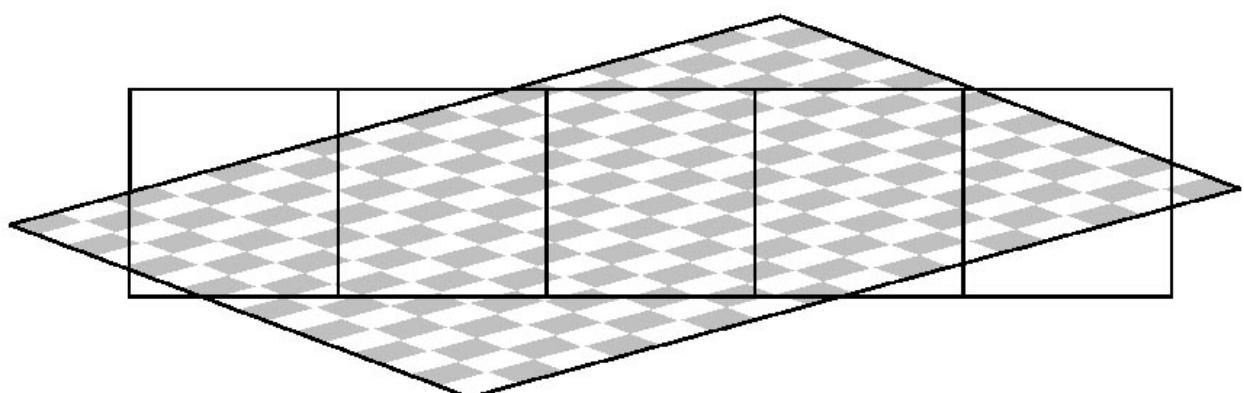
Texture magnification

- Em WebGL:
 - TEXTURE_MAG_FILTER
 - NEAREST
 - LINEAR



Texture minification

- A textura tem resolução maior que o necessário para a amostragem no espaço da tela:
 - Média dos *texels* dentro do pixel
 - *MipMaps*



Texture minification

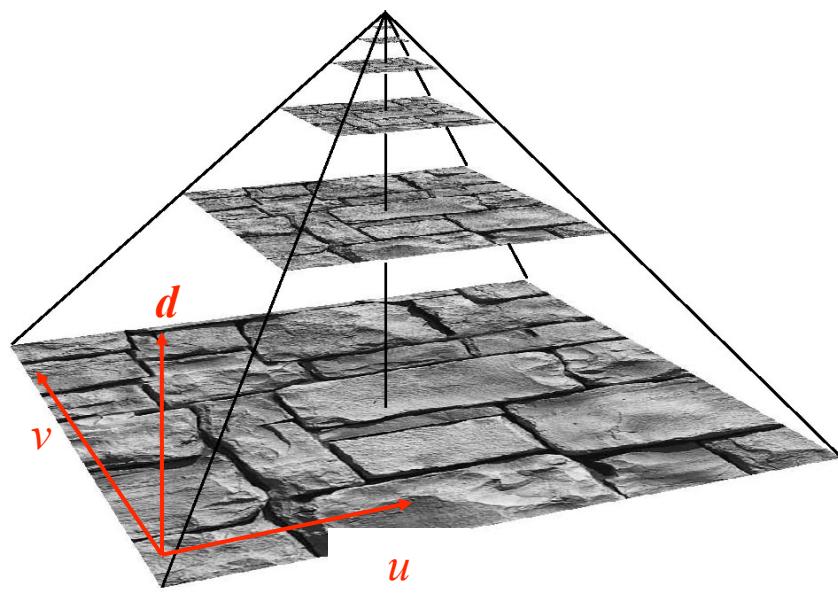
- *Mipmapping*: Uso de várias imagens em diferentes resoluções



Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

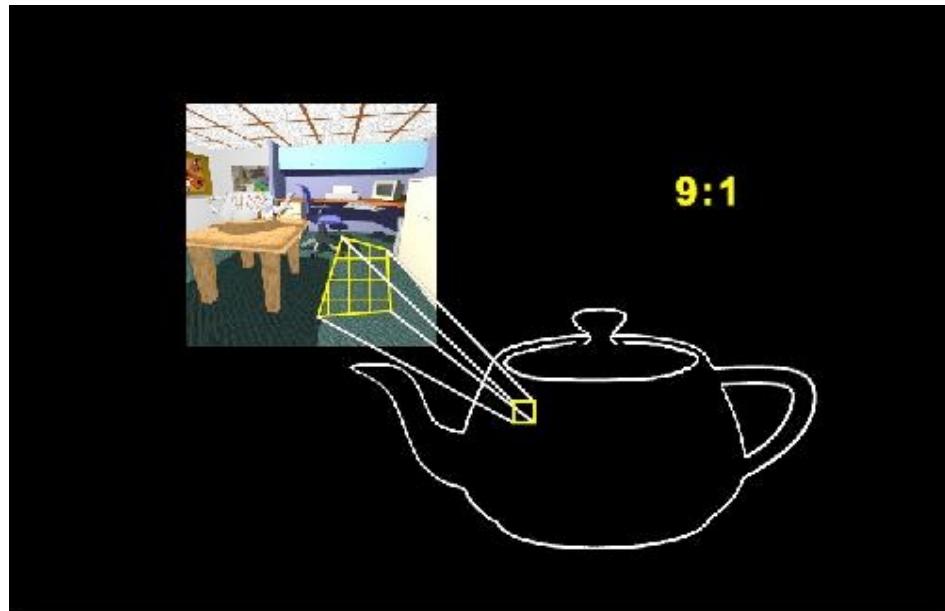
- *Mipmapping*: As varias imagens formam uma “pirâmide”



Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

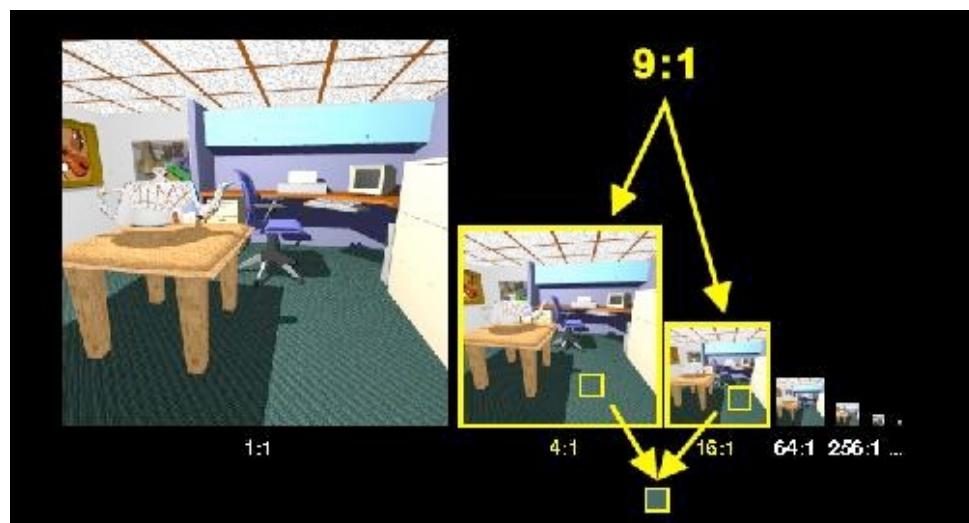
- *Mipmapping*: A imagem é selecionada em função da área do objeto na textura



Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

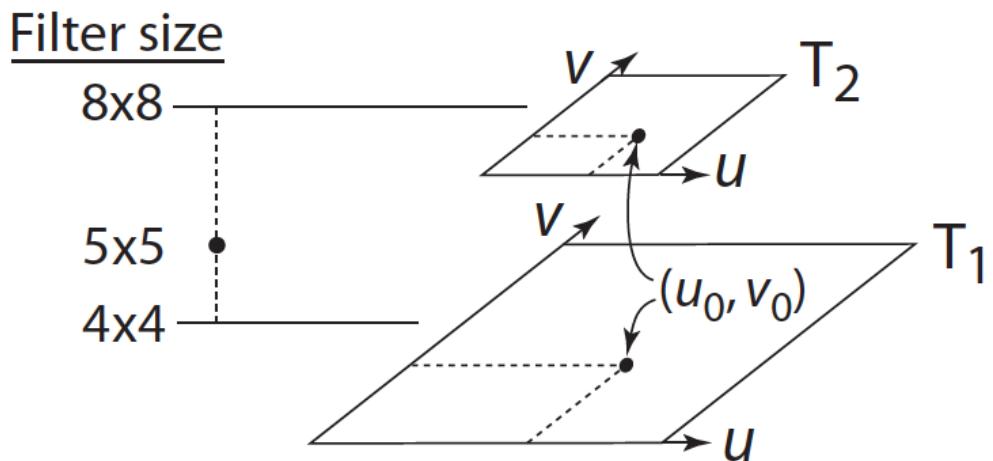
- *Mipmapping*: A imagem é selecionada em função da área do objeto na textura



Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

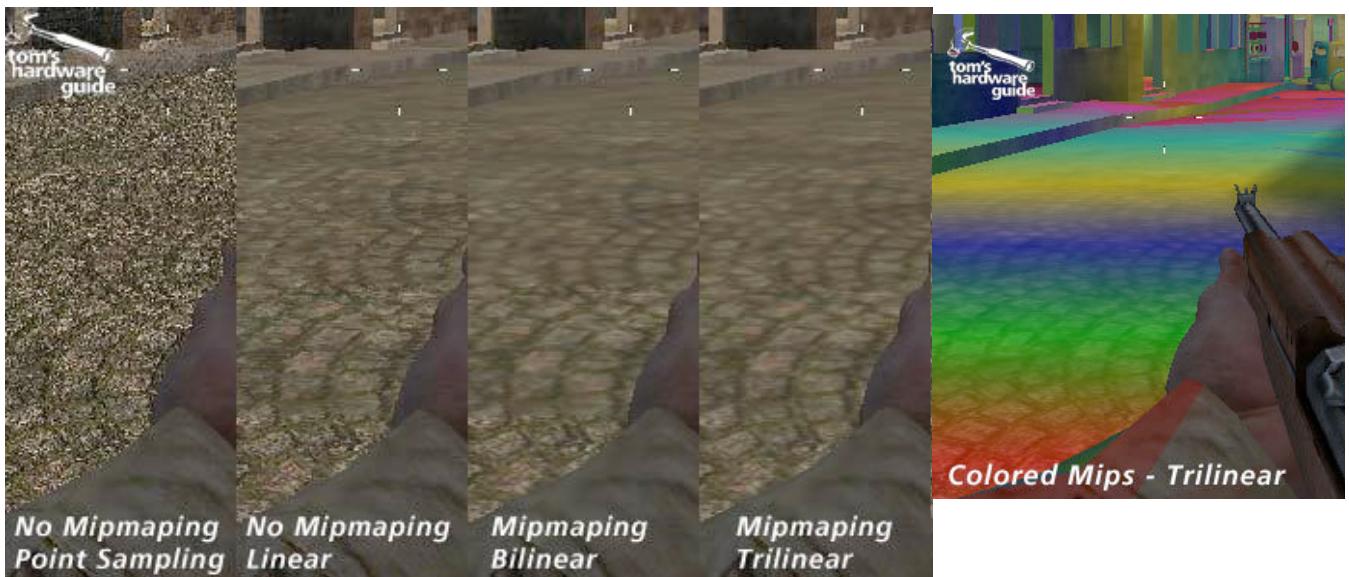
- *Mipmapping*: A imagem é selecionada em função da área do objeto na textura



Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

- *MipMaps*:

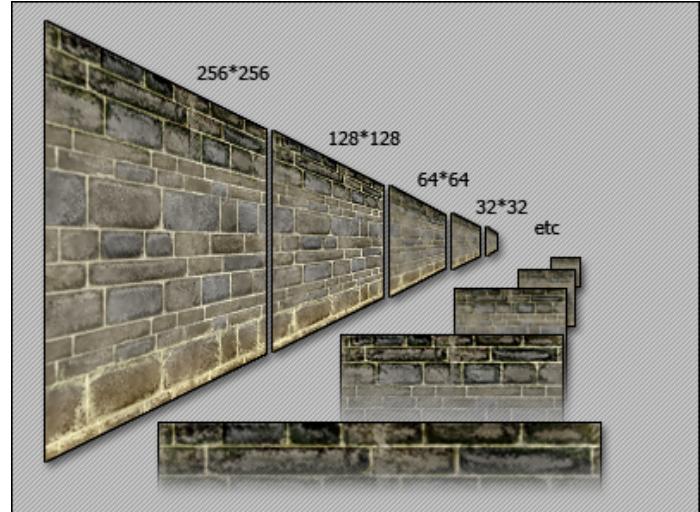


Williams, Lance. "Pyramidal parametrics." *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Texture minification

- Em OpenGL:

- TEXTURE_MIN_FILTER
 - NEAREST
 - LINEAR,
 - NEAREST_MIPMAP_NEAREST,
 - NEAREST_MIPMAP_LINEAR,
 - LINEAR_MIPMAP_NEAREST,
 - LINEAR_MIPMAP_LINEAR

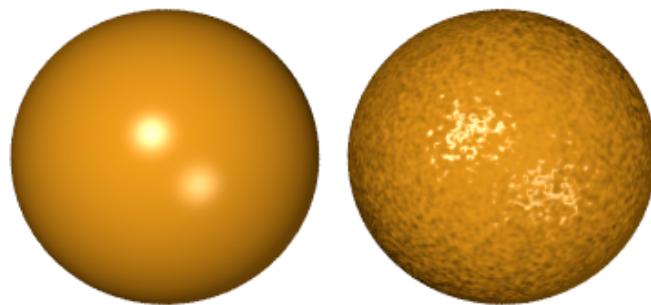


Williams, Lance. "**Pyramidal parametrics.**" *ACM Siggraph Computer Graphics*. Vol. 17. No. 3. ACM, 1983.

Detalhes Geométricos

Detalhes Geométricos

- Superfícies rugosas
 - Caracterizadas por detalhes irregulares na superfície
 - Iluminação não varia suavemente



Detalhes Geométricos



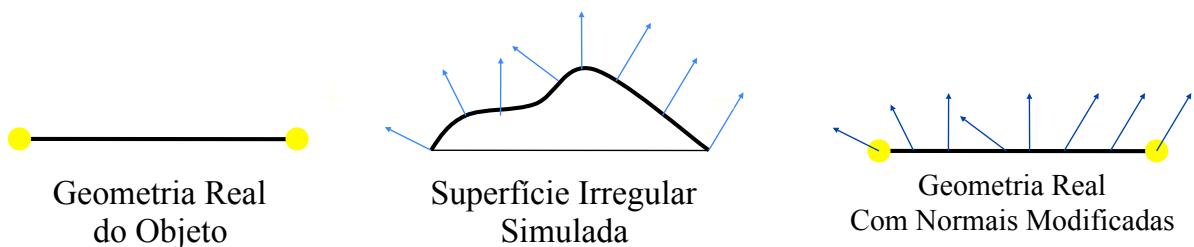
Detalhes Geométricos

- Como representar os detalhes da superfície dos objetos?
 - Refinamento da malha
 - Aumento no custo computacional
 - Simulação do comportamento visual da superfície do objeto



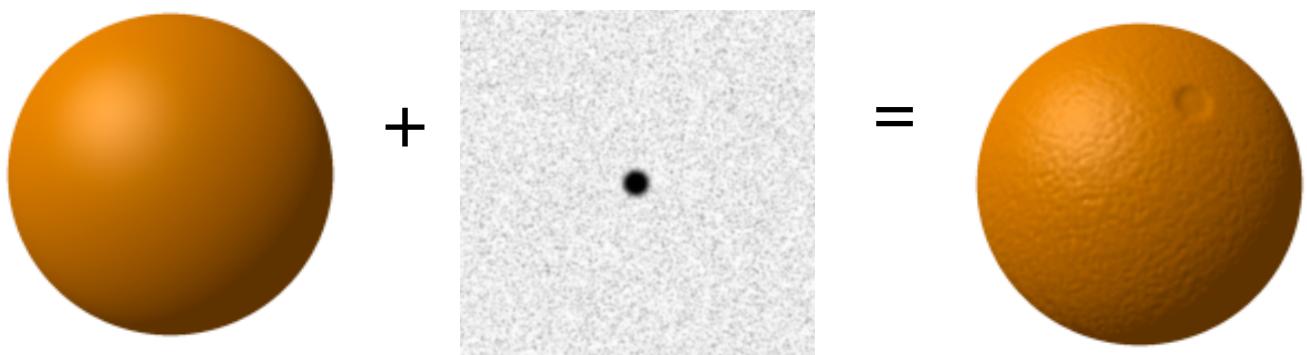
Bump Mapping

- Superfícies lisas
 - Lisa: normal varia suavemente
 - Rugosas: normal varia de forma não suave e irregular
- Simular a variação perturbando o comportamento suave da normal durante o processo de renderização



Bump Mapping

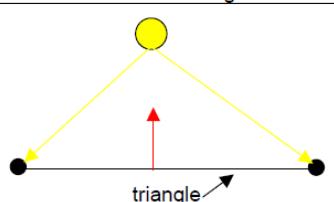
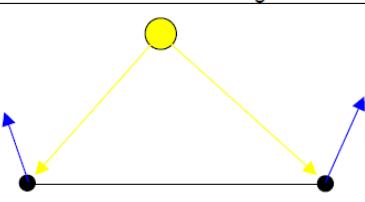
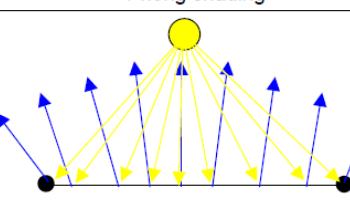
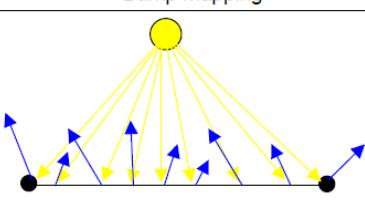
- *Bump Mapping*
 - Técnica que associa uma função que perturba o comportamento suave da normal nas superfícies poligonais



Blinn, James F. "Simulation of wrinkled surfaces." *ACM SIGGRAPH computer graphics*. Vol. 12. No. 3. ACM, 1978.

Bump Mapping

- Como aplicar nos algoritmos de reflexão?

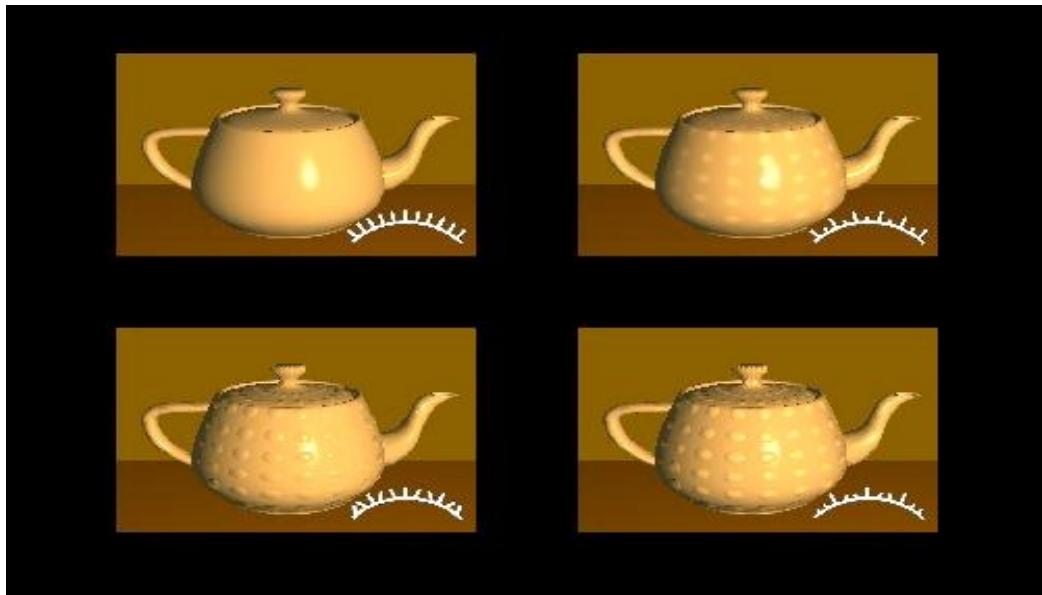
| Flat shading | Gouraud shading |
|--|--|
|  <p>Only the first normal of the triangle is used to compute lighting in the entire triangle.</p> |  <p>The light intensity is computed at each vertex and interpolated across the surface.</p> |
| Phong shading | Bump mapping |
|  <p>Normals are interpolated across the surface, and the light is computed at each fragment.</p> |  <p>Normals are stored in a bumpmap texture, and used instead of Phong normals.</p> |



Blinn, James F. "Simulation of wrinkled surfaces." *ACM SIGGRAPH computer graphics*. Vol. 12. No. 3. ACM, 1978.

Bump Mapping

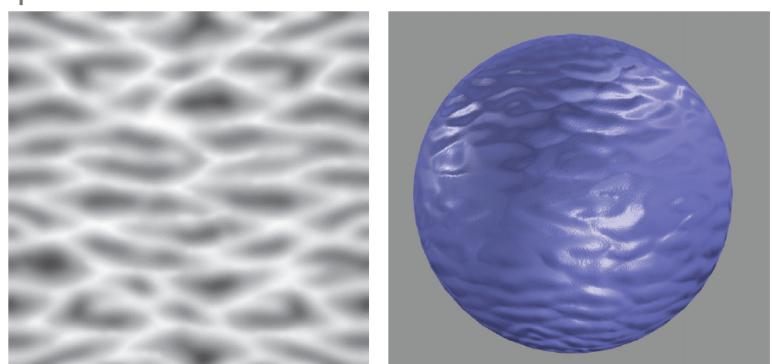
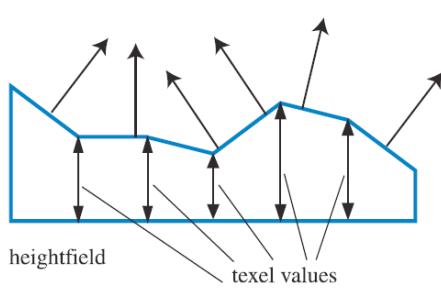
- Técnica que associa uma função que perturba o comportamento da normal nas superfícies poligonais



Blinn, James F. "Simulation of wrinkled surfaces." *ACM SIGGRAPH computer graphics*. Vol. 12. No. 3. ACM, 1978.

Bump Mapping

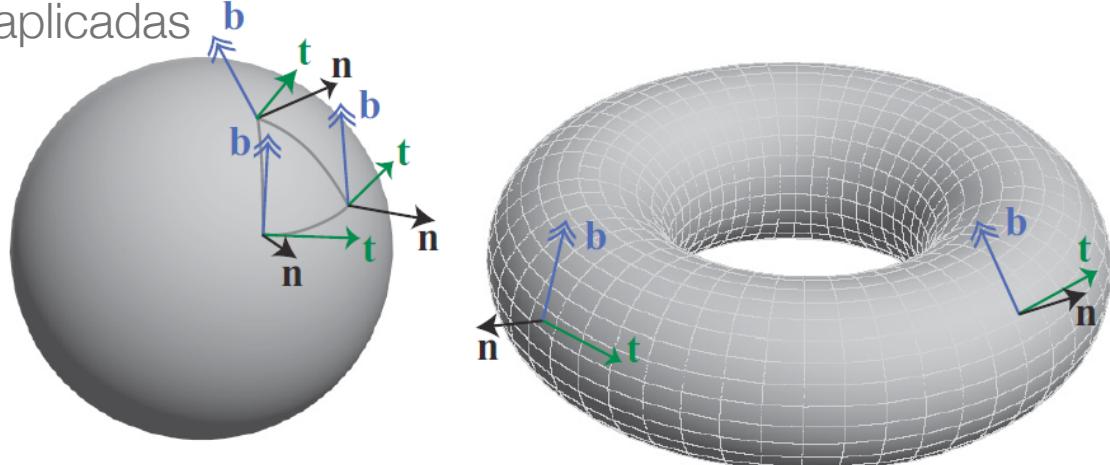
- Perturbação da normal é armazenada como uma textura que representa:
 - Um mapa de alturas que modifica a altura dos fragmentos
 - Vetor normal é recalculado baseado na geometria modificada da superfície.



Blinn, James F. "Simulation of wrinkled surfaces." *ACM SIGGRAPH computer graphics*. Vol. 12. No. 3. ACM, 1978.

Bump Mapping

- Como perturbar a normal no espaço do objeto quando a iluminação é definida no espaço da câmera?
 - Criar um sistema de referência no espaço do objeto, onde a perturbação da normal e a iluminação podem ser aplicadas

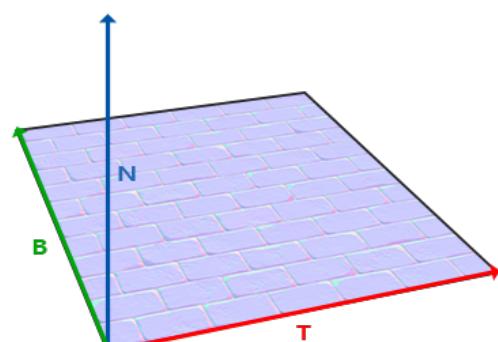


Blinn, James F. "Simulation of wrinkled surfaces." ACM SIGGRAPH computer graphics. Vol. 12. No. 3. ACM, 1978.

Bump Mapping

- Espaço Tangente (*Tangent Space*)
 - Definido por 3 vetores unitários (não necessariamente ortogonais)
 - Normal (**N**)
 - Tangente (**T**)
 - Bitangente (ou Binormal) (**B**)

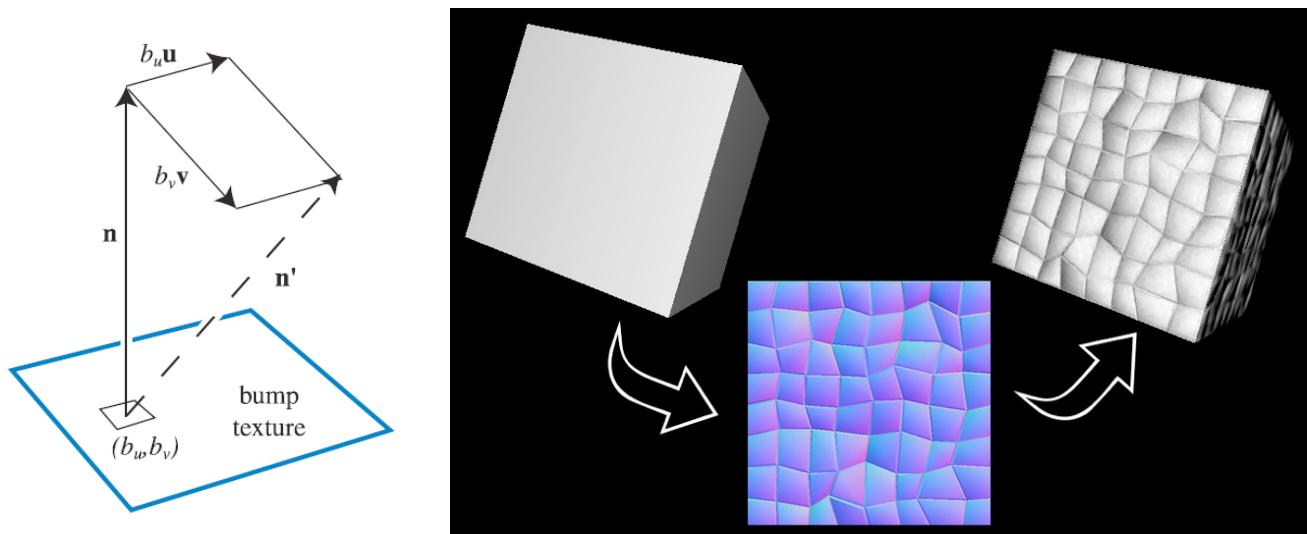
$$\begin{pmatrix} t_x & t_y & t_z & 0 \\ b_x & b_y & b_z & 0 \\ n_x & n_y & n_z & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$



Blinn, James F. "Simulation of wrinkled surfaces." ACM SIGGRAPH computer graphics. Vol. 12. No. 3. ACM, 1978.

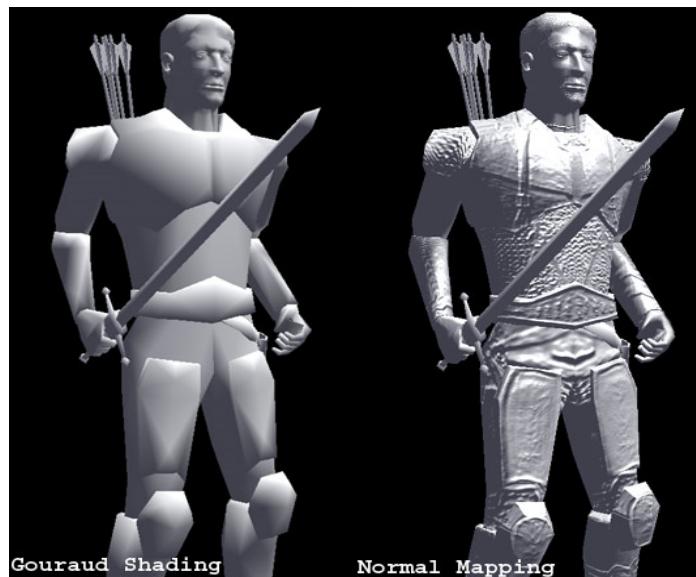
Bump Mapping

- Perturbação da normal pode ser armazenada como uma textura que representa:
 - um vetor deslocamento aplicado a normal



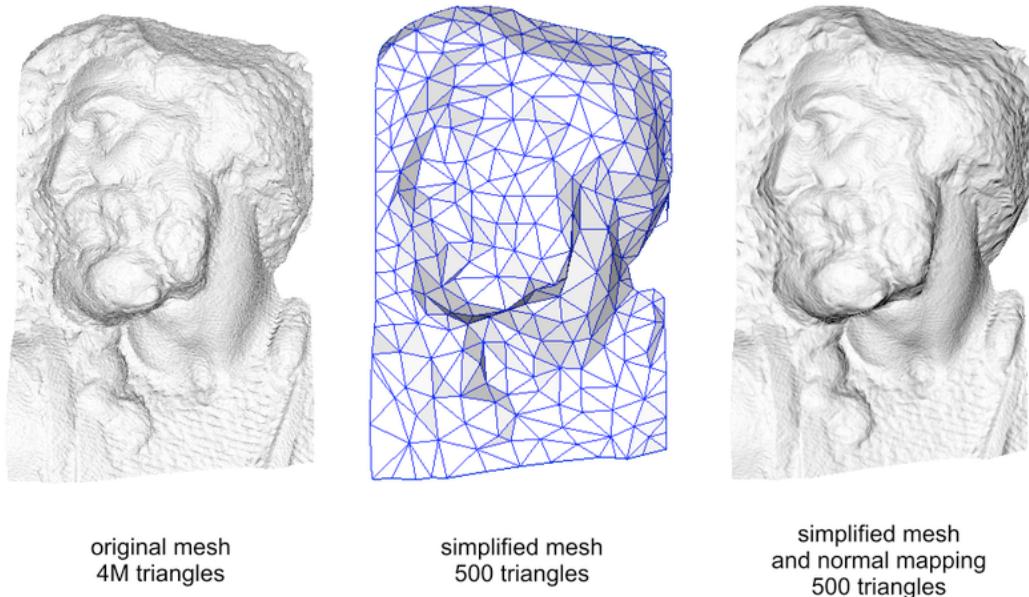
Normal Mapping

- Mapa de normais
 - Permite armazenar as normais de um modelo em uma imagem.



Normal Mapping

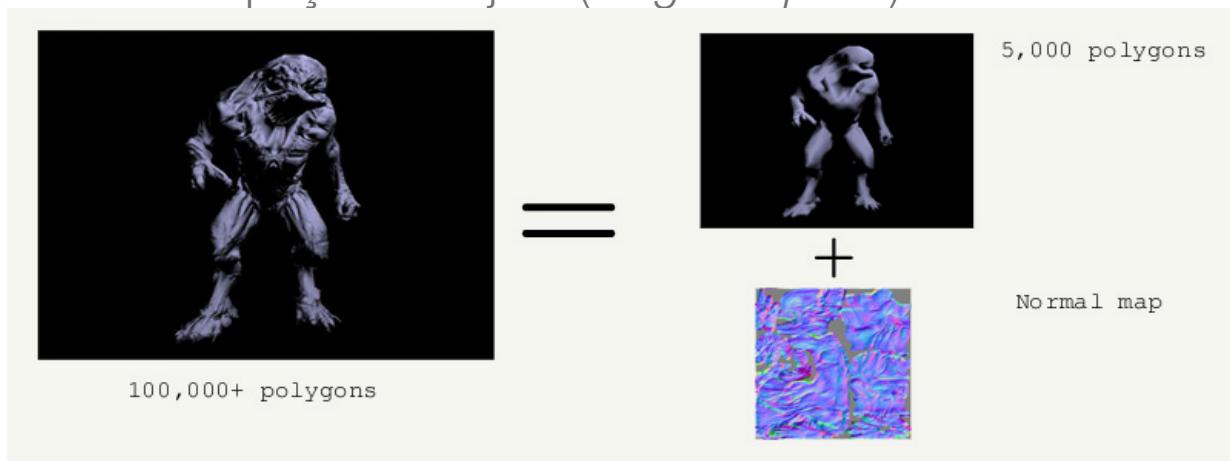
- Mapa de normais extraído a partir de um modelo originalmente muito denso



Cohen, Jonathan, Marc Olano, and Dinesh Manocha. "Appearance-preserving simplification." *Proceedings of the 25th annual conference on Computer graphics and interactive techniques*. ACM, 1998.

Normal Mapping

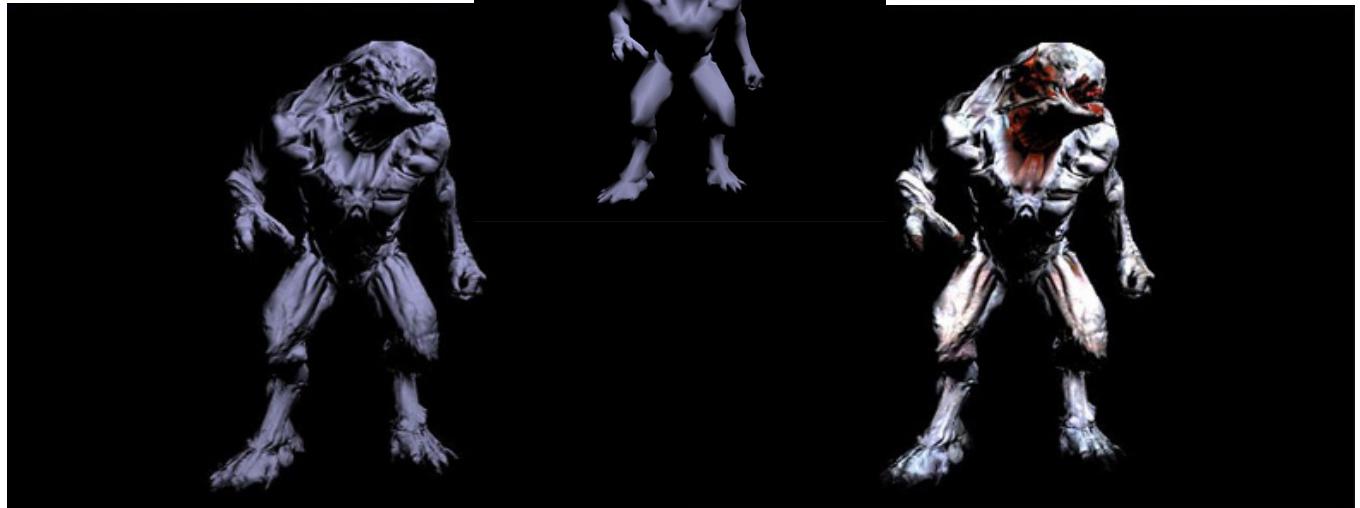
- Mapa de normais
 - Aplicação similar a uma textura
 - Os canais RGB armazenam a direção da normal
 - No espaço do objeto (*tangent space*)



Kilgard, Mark J. "A practical and robust bump-mapping technique for today's GPUs." *Game Developers Conference 2000*. 2000.

Normal Mapping + Mapeamento de Textura

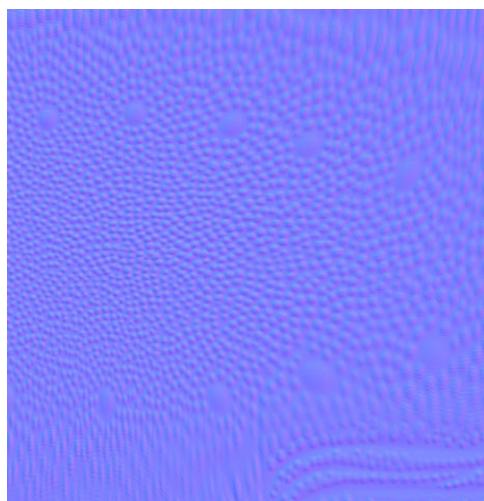
- Técnica que associa uma função que perturba o comportamento suave da normal nas superfícies poligonais



Kilgard, Mark J. "A practical and robust bump-mapping technique for today's GPUs." Game Developers Conference 2000. 2000.

Normal Mapping + Mapeamento de Textura

- Técnica que associa uma função que perturba o comportamento suave da normal nas superfícies poligonais



Kilgard, Mark J. "A practical and robust bump-mapping technique for today's GPUs." Game Developers Conference 2000. 2000.

Displacement Mapping

- Similar ao *bump mapping*, porém modifica a geometria do objeto
 - Adiciona detalhe a superfície

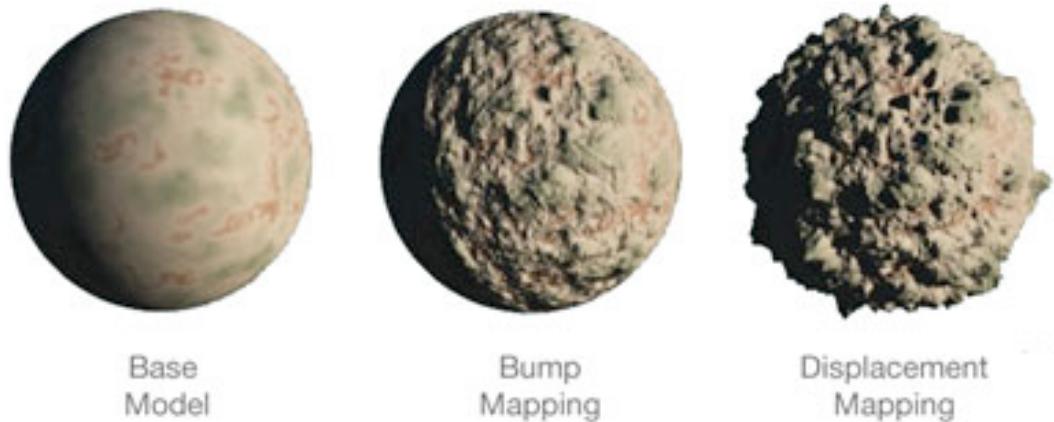
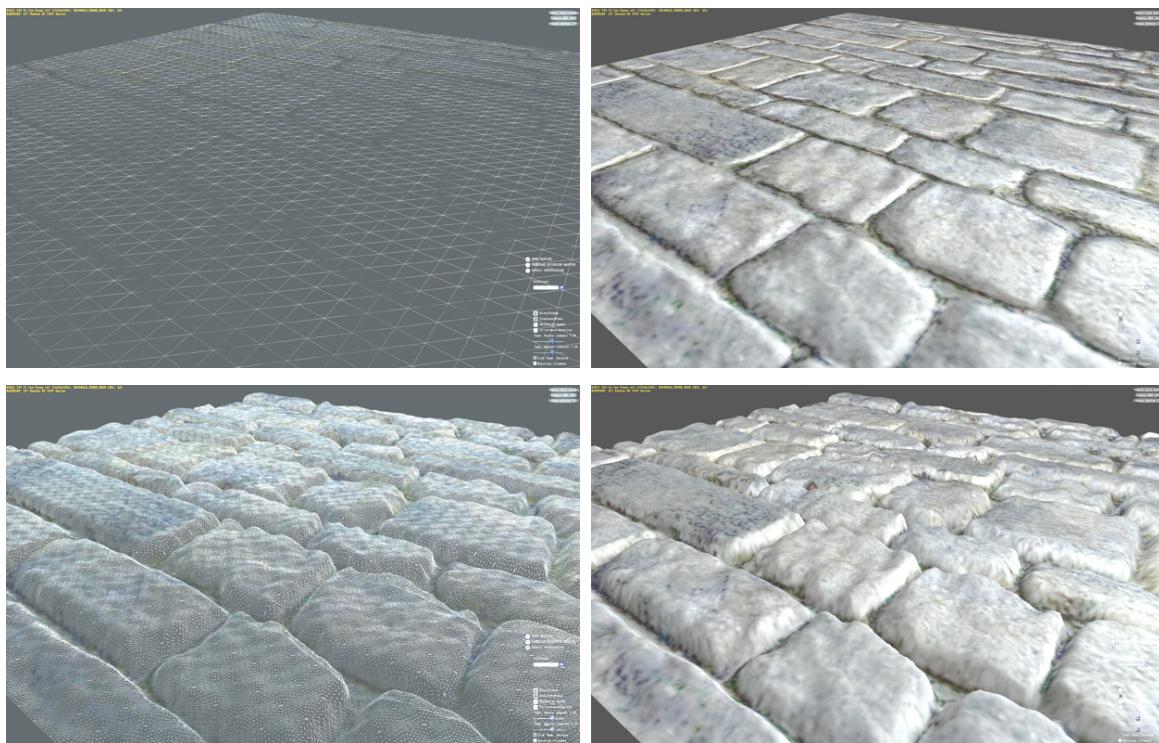


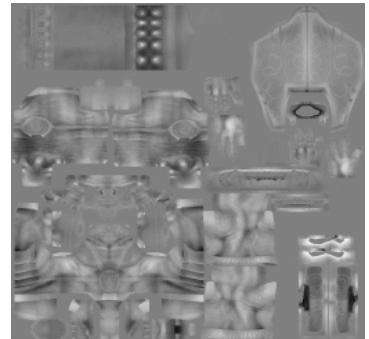
Image courtesy of www.chromesphere.com

Displacement Mapping



Displacement Mapping

- “Textura” define o *displacement* a ser aplicado



Displacement Mapping

- “Textura” define o *displacement* a ser aplicado



Outras técnicas baseadas em mapeamento

- *Parallax Mapping*
- *Relief Mapping*

凹凸映射
縫・微調移動

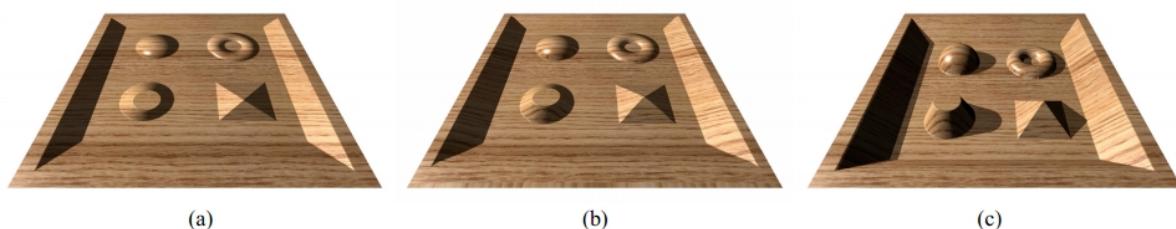
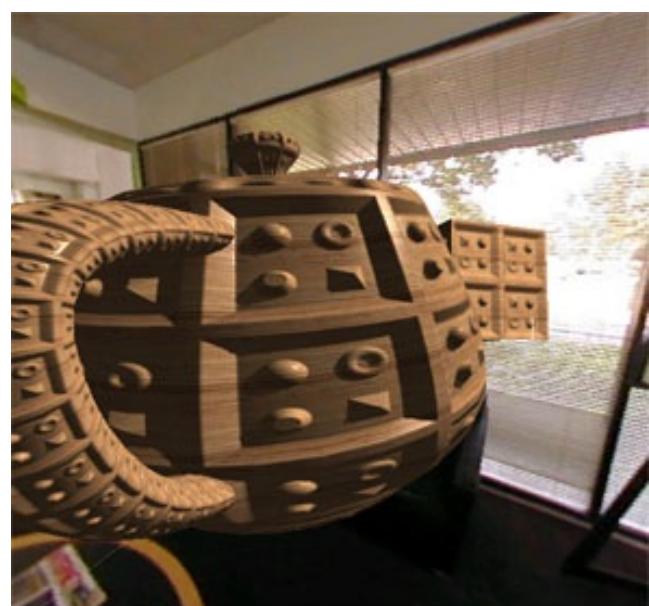


Figure 19: One polygon rendered from the same viewpoint using three different techniques: (a) Bump mapping, (b) Parallax mapping and (c) Relief mapping with self-shadowing. A 2D wooden texture was mapped to the surface.

Relief texture mapping

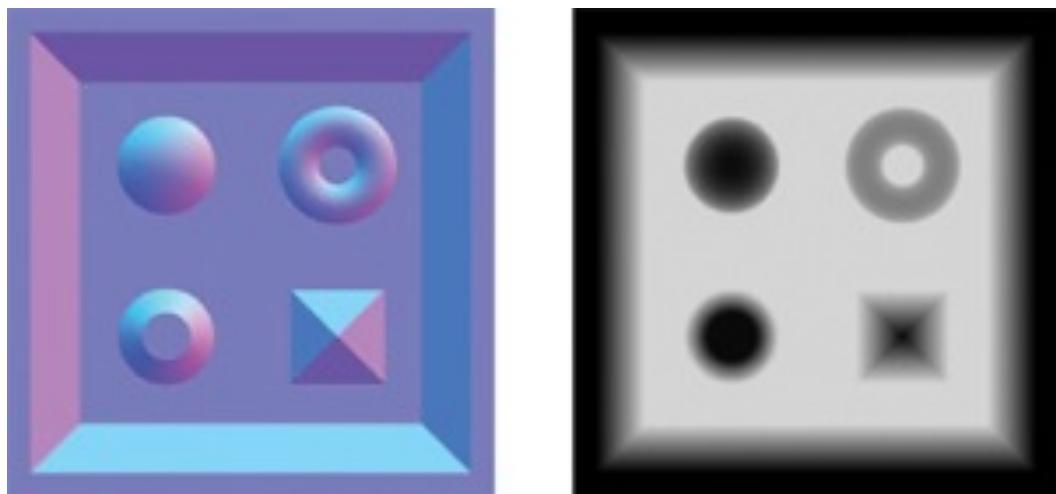
- Procura resolver os problemas das técnicas baseadas em perturbação da normal
 - *self-occlusion*,
 - *self-shadowing*,
 - *view-motion parallax*,
 - *silhouettes*.



Oliveira, Manuel M., Gary Bishop, and David McAllister. "Relief texture mapping." Proceedings of the 27th annual conference on Computer graphics and interactive techniques. ACM Press/Addison-Wesley Publishing Co., 2000.

Relief texture mapping

- Mapa de alturas representado no canal alfa do mapa de normais



Oliveira, Manuel M., Gary Bishop, and David McAllister. "Relief texture mapping." Proceedings of the 27th annual conference on Computer graphics and interactive techniques. ACM Press/Addison-Wesley Publishing Co., 2000.

Relief Mapping



Oliveira, Manuel M., Gary Bishop, and David McAllister. "Relief texture mapping." Proceedings of the 27th annual conference on Computer graphics and interactive techniques. ACM Press/Addison-Wesley Publishing Co., 2000.

Relief Mapping

- Controle da silhueta

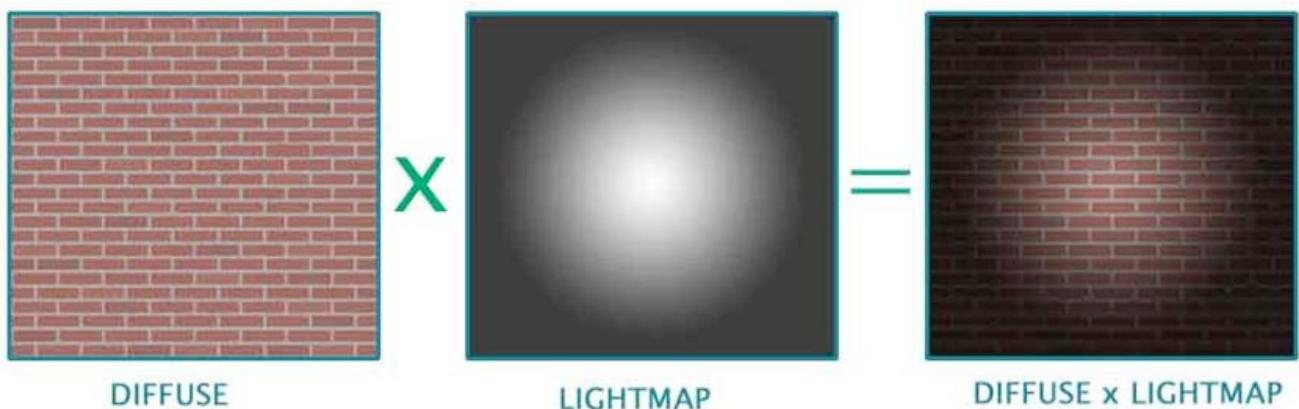


Oliveira, Manuel M., Gary Bishop, and David McAllister. "**Relief texture mapping**." Proceedings of the 27th annual conference on Computer graphics and interactive techniques. ACM Press/Addison-Wesley Publishing Co., 2000.

Luz e Sombra

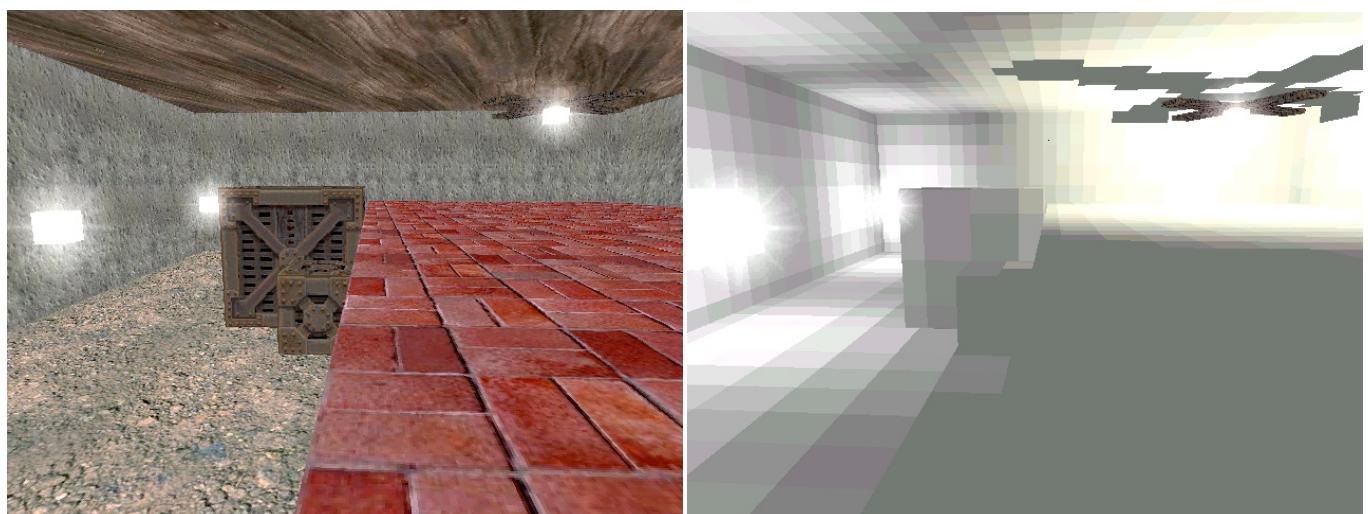
Light Mapping

- Utilizar o princípio de mapeamento de textura para simular efeitos de iluminação
 - Reproduzir modelos de iluminação mais complexos
- Necessita que se possa compor mais de uma textura (*multi-texturing*)



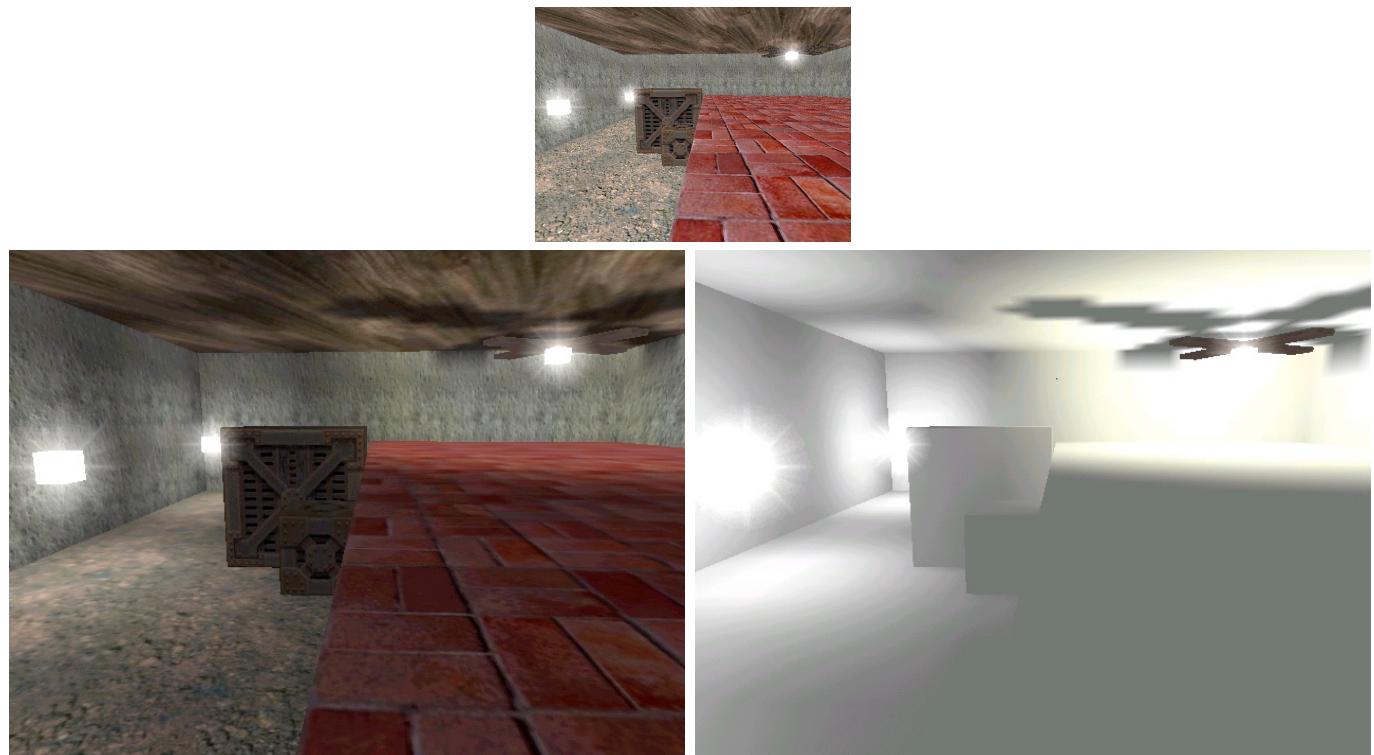
Blow, Jonathan. "Implementing a Texture Caching System." *Game Developers Magazine* (1998).

Light Mapping



Blow, Jonathan. "Implementing a Texture Caching System." *Game Developers Magazine* (1998).

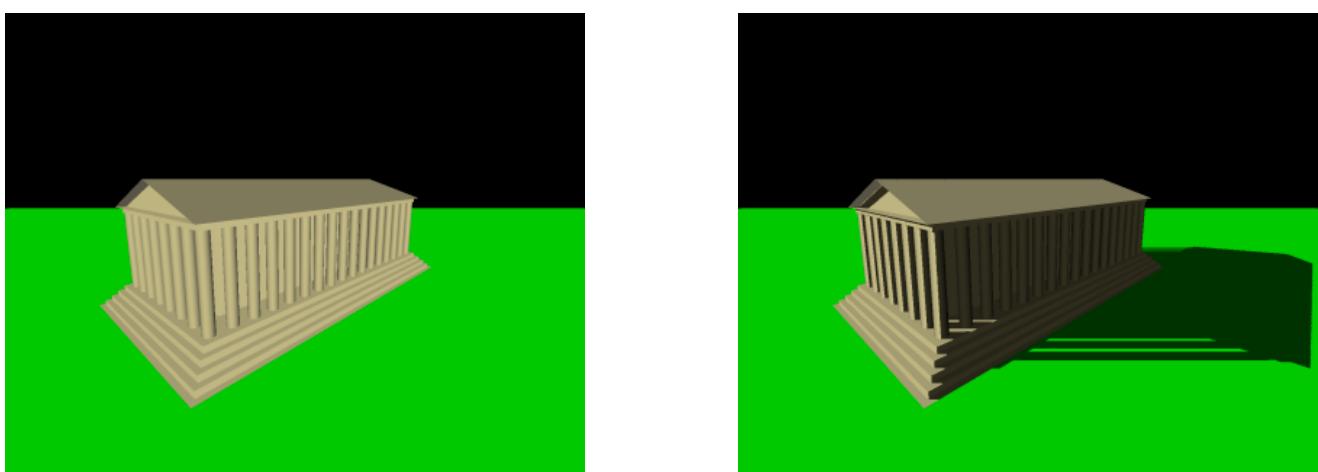
Light Mapping



Blow, Jonathan. "Implementing a Texture Caching System." *Game Developers Magazine* (1998).

Shadow Mapping

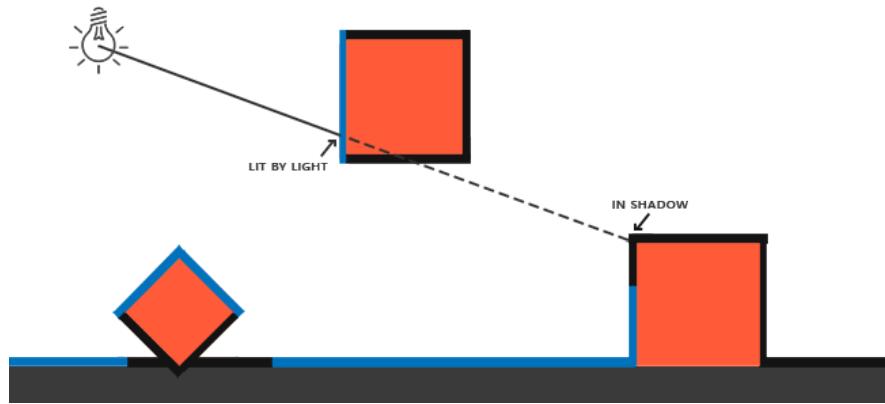
- Utilizar o princípio de mapeamento de textura para simular efeitos de sombras
 - Reproduzir a sombra de outros objetos



Williams, Lance. "Casting curved shadows on curved surfaces." *ACM Siggraph Computer Graphics*. Vol. 12. No. 3. ACM, 1978.

Shadow Mapping

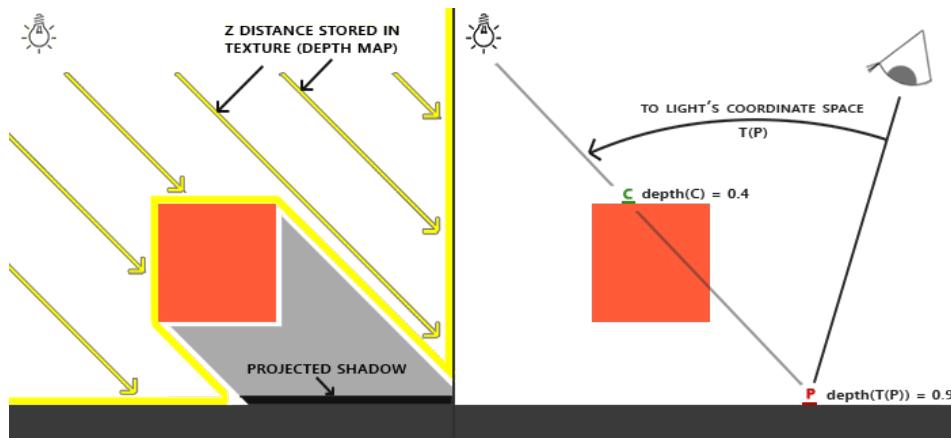
- Calcular a visibilidade do ponto de vista da fonte de luz



Williams, Lance. "Casting curved shadows on curved surfaces." ACM Siggraph Computer Graphics. Vol. 12. No. 3. ACM, 1978.

Shadow Mapping

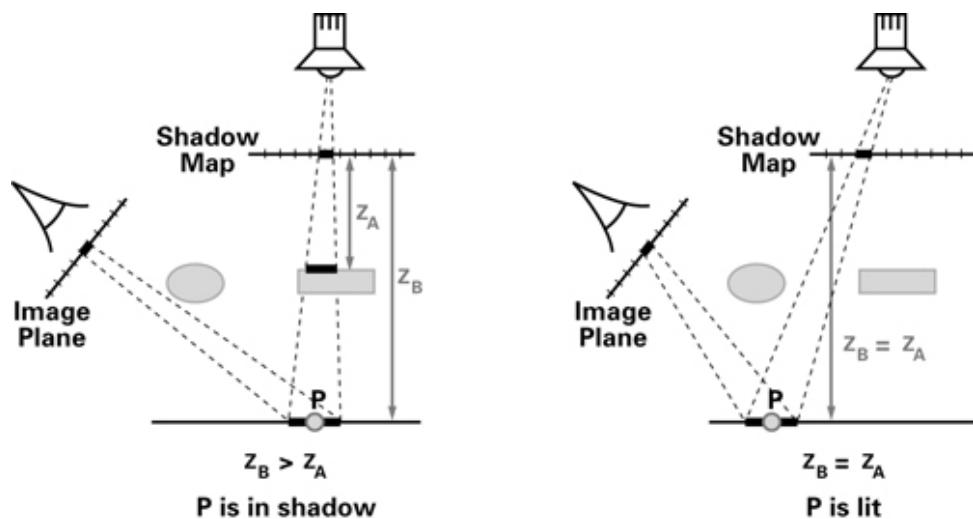
- Cada ponto visível pelo observador verificar se é visível pela fonte de luz
 - Caso não, em sombra



Williams, Lance. "Casting curved shadows on curved surfaces." ACM Siggraph Computer Graphics. Vol. 12. No. 3. ACM, 1978.

Shadow Mapping

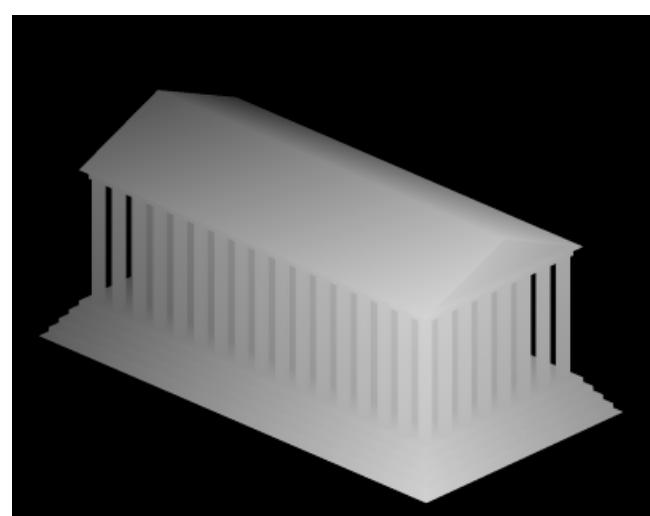
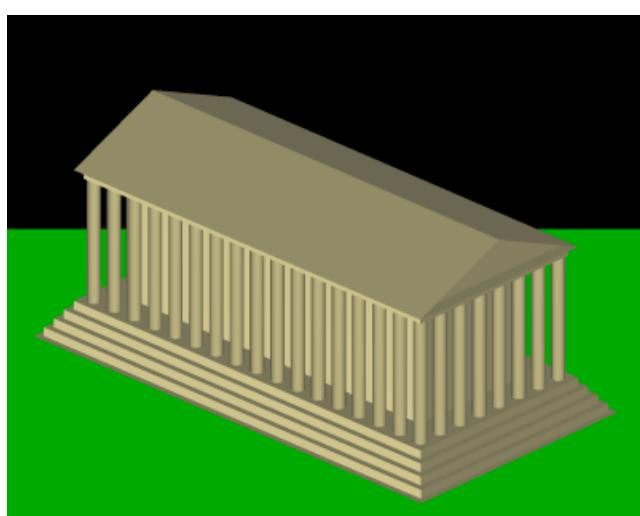
- Comparar a distancia do ponto fragmento visível pela camera no espaço da camera com o *shadow mapping*



Williams, Lance. "Casting curved shadows on curved surfaces." ACM Siggraph Computer Graphics. Vol. 12. No. 3. ACM, 1978.

Shadow Mapping

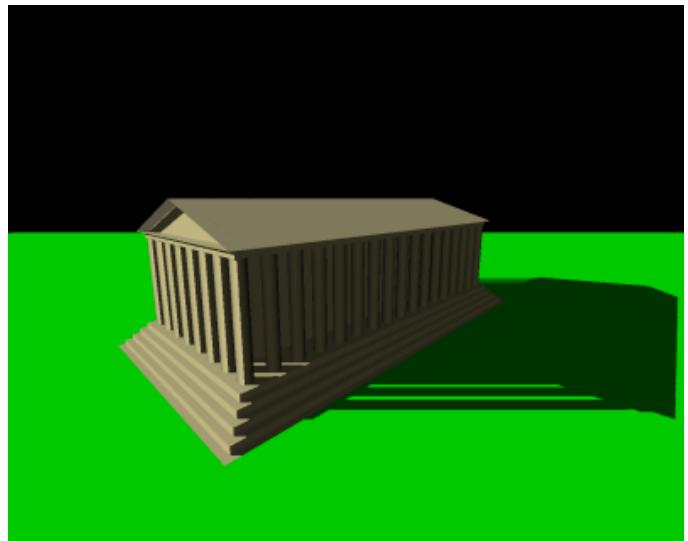
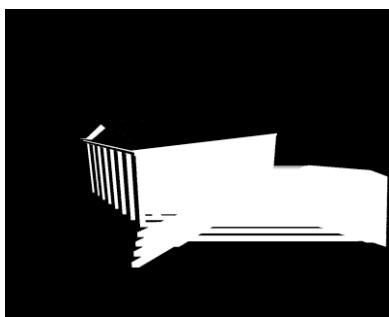
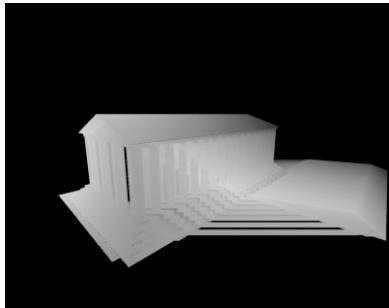
- Ponto de vista da fonte de luz



Williams, Lance. "Casting curved shadows on curved surfaces." ACM Siggraph Computer Graphics. Vol. 12. No. 3. ACM, 1978.

Shadow Mapping

- Classificando os pixels pelo *shadow map*



Williams, Lance. "Casting curved shadows on curved surfaces." *ACM Siggraph Computer Graphics*. Vol. 12. No. 3. ACM, 1978.

A Seguir...

Algoritmos de Iluminação Global