

CLIPMAP

Sujal Bista
CMSC 828V / Fall 2009

Outline

- Introduction
- Clipmap System
- Vertex Clipmaps
- Advantages/Disadvantages
- Conclusion

Introduction

- Also known as virtual mipmaps
- Very efficient texture LOD
- Used in real-time visualization of massive texture
- First presented by SGI in 1998

Clipmap

□ How does hardware save texture?

- Mipmaps
 - Used for filtering
 - Fast

Image from [Tanner et al. 98]

Clipmap

- How about massive textures ?
 - Image DC metro compressed with jpeg2000 ~5 Gig compressed
- Can it take advantage of mipmaps?

Image from [Tanner et al. 98]

Clipmap

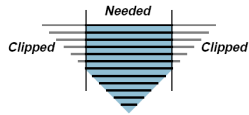
□ Which texture level is accessed ?

- Need high detail for close by objects
- Low detail for objects far from viewers

Image from [Tanner et al. 98]

Clipmap

- How much texture in each level would be enough ?



- Each mipmap level only saves small part of the texture that surrounds the viewer
- $(n - 1)$ mipmap level covers twice the area covered by mipmap level n but has roughly half the detail

Image from [Tanner et al. 98]

Clipmap

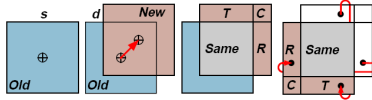
- Different texture resolution



Image from [Tanner et al. 98]

Clipmap

- How do we update a texture level ?



- Invalidate old region
- Update new region (disk access)
- Invalidate/validate levels if required

Image from [Tanner et al. 98]

Clipmap

Some hardware support required

- Sub-region update of textures
 - Repeat wrap texture mode required
 - Shaders
 - Level of Detail control `min_load/max_load`
- For fast implementation
- Texture Arrays
 - Multi-threading graphics API (DirectX 11)

Geometry Clipmaps

- Similar concept

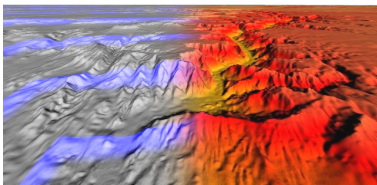


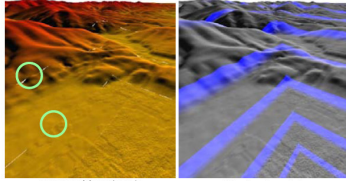
Image from [Losasso et al. 04]

Geometry Clipmaps

- Height map lookup from textures
- Tessellation can be done in CPU vs direct texture lookup in vertex shaders

Geometry Clipmaps

Additional problems



Can use fractals for realism

Image from [Losasso et al. 04]

Advantages/Disadvantages

Advantages

- Visualize massive images
- Smaller memory requirement
- Real-time
- Very less artifact
- Loading and displaying are parallel

Advantages/Disadvantages

Disadvantages

- Difficult to program
- Slower than regular texturing
- Filtering issues
- Transition areas artifacts
- For Earth mapping, less efficient in poles
- Optimized for single camera

Conclusion

- Clipmap allows real-time visualization of massive textures in regular hardware
- Very efficient LOD for textures

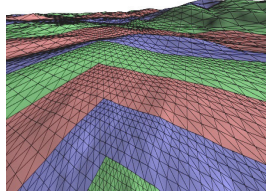
References

- Christopher C. Tanner , Christopher J. Migdal , Michael T. Jones, The clipmap: a virtual mipmap, Proceedings of the 25th annual conference on Computer graphics and interactive techniques, p.151-158, July 1998
- Frank Losasso , Hugues Hoppe, Geometry clipmaps: terrain rendering using nested regular grids, ACM SIGGRAPH 2004 Papers, August 08-12, 2004, Los Angeles, California

Additional Resources

- http://http.download.nvidia.com/developer/GPU_Gems_2/CD/Content/02.zip
- <http://developer.download.nvidia.com/SDK/10.5/Samples/Clipmaps.zip>

Questions ? ?



Images from [NASA visible earth] and [Losasso et al. 04]