A Lumigraph Camera for Image Based Rendering

Jason C. Yang
Prof. Leonard McMillan
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Overview

- Image Based Rendering
- Video Demo
- System Design
- Obstacles
Image Based Rendering

• Motivation
  - Geometry is hard.
  - Textures are easy.

• Light Field Rendering:
  Generate novel views using a database of “rays” from a 2D array of images.
State-of-the-art in CG

Model

Model + Shading

Model + Shading + Textures

At what point do things start looking real?
Rendering Process

new viewpoint

‘closest’ camera

‘closest’ ray

desired ray

camera surface

reference images

Rendering Process
Demo System
Goals

- Real Time Camera System
- Off the shelf components
- Desired frame rate:
  30 frames per second
  640 x 480 resolution
Overall Design

Interface Solution (PCI or Cardbus)

FIFO

Address

Data

Sensor Pod - A

B

A

B

C

D

C

D

A

B

A

B

C

D

C

D

Motherboard
Sensor Pod

Aramis Random Access CMOS Sensor
(on board A/D)

Address

CLK

CL Data

FPGA Logic

VRAM
(for FPN)
Major Hurdle

- Ideal frame rate is not achievable
  - Best Frame rate: 7fps
- Bottlenecks:
  - PCI bus
  - Turnaround time for one pixel
- Potential Solution:
  - Interleaving
  - FIFOs
Actual Frame Rate

- To reach desired 30fps we need: 37MBs
- Maximum Random Access on PCI: 33MBs

- Turn around time (time to access pixel from camera) is not one clock cycle!
Virtual vs. Physical Pixels

When the host requests a pixel it is actually a virtual pixel as indicated by the circles.

The actual pixels requested are the color photocells on the imager.

Each virtual pixel request will return a four byte group of color values.
Time to Access a Pixel

CLK

Address

Y0  X0  X1  Y1  X2  X3

A/D

A/D  A/D  A/D  A/D

Data

(Y0,X0)  (Y0,X1)  (Y1,X2)  (Y1,X3)

30ns  480ns

4 byte Pixel ready
**Actual Transfer Rate**

\[<\text{Address}> + <\text{Access}> + <\text{Data}> + <\text{Wait}>\]

\[30\text{ns} + 450\text{ns} + 30\text{ns} + 30\text{ns} = 540\text{ns}\]

\[540\text{ns/pixel} \Rightarrow 7\text{fps @ 640x480}\]
Optimizations

Motherboard - Interleaving
Use PCI Burst Mode

- PCI burst mode can achieve 133MBs

![Diagram of PCI burst mode with CLK, Address/Data, Address/Turn Around, Data, Data, Data, and 30 ns time marker]

- Idea: Use FIFOs to store Addresses and Data
Conclusion

• Tradeoffs
• Technological Needs
  - Random Access CMOS imagers
  - Faster imagers
  - Faster bus protocols