THE GIGAPXL PROJECT

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Angel’s Window on trail to Cape Royal
9” x 18” format, 200mm lens
1-stop grad filter, center filter, f/22, ¼ sec

CULTURAL ARCHIVES

Newspaper Rock State Historical Park

- Real-world dimensions ~ 8m x 4m
- Normal viewing distance ~ 4.5 m
- Close-up zoom ratio ~ 15:1

CULTURAL ARCHIVES

- Close-up viewing distance ~ 0.3 m
- Required pixel count at rock face (20/20 vision equivalent) ~ 11.5 mm⁻¹
- Full image pixel count ~ 4.2 gigapixel
WHY USE FILM IN THE DIGITAL AGE?

- Pixels per frame: $4 \times 10^9$
- Capture time: $1/125$ sec
- Data per pixel: 36 bits
- Information capture rate: $1.8 \times 10^{13}$ bits/sec

IMAGE TRANSFER

- Scene → Atmosphere → Lens → Film → Scanner → DVD

MODULATION TRANSFER FUNCTION (MTF)

- Sinusoidal Test Chart
- Exposed Negative
- Densitometer Trace

FILM RESPONSE

- Spatial frequency of 30 cycles/mm corresponds to 100 pixels/mm (2540 pixels/in)
- Equates to 6.45 megapixels per square inch

CHOICE OF FORMAT

- 1000 megapixels at 6.45 megapixels/sq in. requires a film area of 155 square inches (twice the area of an 8" x 10"

- 14" x 14" plate (196 sq in)
- 9" x 18" roll (162 sq in)

ATMOSPHERIC MTF

- 5.5 km path in mid-summer
DISTANT LANDSCAPE LENSES
- Uses six glass types
- Accommodates 6.6" filter
- Each lens is unique

MTF OF CCD ARRAY
- Normalized for 100 pixels/mm

PUTTING IT ALL TOGETHER
Contributions due to atmosphere, lens, film, and scanner are balanced at 30 c/μm (1.045 megapixels on 9" x 18" format)

ULTRA-WIDE CAMERA DESIGN
- 60-shot magazine
- Rapid manual advance
- Vacuum film hold down
- Dial indicator focus/tilt
- Interchangeable magazines
- Exposure counter
- Wheel sockets

PERFORMANCE OF "NORMAL" CAMERA
- Mormon Temple, San Diego CA
SCANNING & PROCESSING
- Scanner: Leica Geosystems DSW700 (2000-4000 ppi)
- Processing Hardware:
  - Two custom PCs (AMD Athlon 64 & PIV 3Ghz) each with:
    - Two 120Gb drives (one each exclusively for Photoshop files and scratch space)
    - Two dual DVD burners
    - RAM: 3Gb. (2Gb dedicated to PS)
    - NVidia Quadro4 980 XGL graphics board
- Printer: Epson Stylus Pro 9600
  - 7-color Ultrachrome inks
  - Epson Enhanced Matte paper
- Storage media: DVDs & external hard drives (Lacie, terabyte)
- Software:
  - Adobe Photoshop CS2
  - ColorByte ImagePrint RIP

PORTRAIT OF AMERICA
STATUS
- > 1,100 photographs
- 502 locations
- 46 states & provinces
- 28 national parks
- 39 state/regional parks & monuments
- 91 cities

PORTRAIT OF THE WORLD
Focus on UNESCO World Heritage Sites
- Multicultural significance
- Sites presently at risk
- 788 locations worldwide
- Vastly greater task
  - Teams
  - Cameras
  - Logistics

Red – sites photographed
Blue – sites to be photographed summer/fall 2005
San Diego from Coronado Island
9" x 18" format, 480mm lens
1-stop grad filter, f/16, 4 minutes

10X

100X

San Diego CA from Coronado Island

10X
**BUILDING RESTORATION**
Example of deteriorating building
At 5.5X chisel marks visible
Ultra-high resolution provides large-scale prints for use as restoration guides

Museum of Art
Balboa Park
San Diego CA

**REVELATIONS IN THE DIGITAL DARKROOM**
Just one more benefit of ultra-high resolution

Parasailers at Torrey Pines, San Diego CA
NOISE REDUCTION

- Structured noise addressed via straightforward FFT routine
- Random noise (grain related)
  - Favorable ratio of smallest image feature to grain density
  - Wavelet-based image decomposition and reconstruction
- Superior to standard Photoshop™ plug-ins
- Less effective than elaborate movie industry techniques (CINESITE, etc.)
- Well suited to images in the 1-4 billion pixel regime

THE GIHANDLE PROJECT

Near-term objectives (1-2 years)
- Maximize the information content of photographic images
- Generate an ultra-high-resolution portrait of North America
- Disseminate images for use and enjoyment by others

Long-term objectives (3-6 years)
- Expand to world-wide coverage
- Provide future generations with an archive of sites which cannot be physically preserved
WHO NEEDS SUCH RESOLUTION?

- Virtual reality
- Cultural archives
- Preservation/restoration

VIRTUAL REALITY

- 20/20 vision (~1 arcminute resolution)
- Hemispherical coverage
- ~75 megapixels
- ~7.5 gigapixels at 10X zoom
CHOICE OF FOCAL LENGTH

- Focal length too short, film resolution dominates
- Focal length too long, atmospheric blurring dominates
- Distant landscapes (5-20 km)
  - Matched focal length 200-300 mm
  - Ultra-wide angle for 9” x 18”
- Typical cityscapes (0.1-1.5 km)
  - Matched focal length 400-600 mm
  - “Normal” lens for 9” x 18” format