Statistical Algorithms and VLSI for 3D Imaging Applications – Medical Imaging and More

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3D – Fertile Fields of Study

- Image Capture Devices (Light to Electrons)
- Image Processing (Algorithmic VLSI)
- Image Display Devices (Processing, Interfacing, Electrons to Light)

VLSI is needed in several areas where the computation time is a barrier when executing on standard computing platforms.
3D Imaging

3D Imaging is inspiring research with results in interesting places:

3D TV European-funded: [http://www.3dtv-research.org/index.php](http://www.3dtv-research.org/index.php)


Demonstration of Philips’ 3D display available in SL197
3D Image Display

- Autostereoscopic
  - Depth Based Image Rendering
  - Lenticular Lens (multiple views)

Philips Display

Figure 1. Overview of 3D frame in the 2D-plus-Depth format.

Figure 10. Overview of 3D image processing in the display.
Key Concepts:
- Bayesian neighborhood system
- Probability optimization – Markov Random Field

Uses of Statistical Methods:
- Isolate tissue types in medical images, performs well in noise
- To calculate depth map for image capture using blur estimate
- Requires computational power:
  - Therefore we need VLSI designs!
3D Ultrasound Breast Data from Karmanos Cancer Institute, Detroit, MI
Application: 3D Brain PET Segmentation
Segmented Contrast Kidney MR

Image Data from Dr. Karmazyn at Riley Children’s Hospital
Dental 3D rendering

Cone beam CT Data from Dr. Jie Chen, Mechanical Engineering and the IU Dental School (this is a dental Phantom)
Chest CT Scan, color segmentation

Data from University Hospital, Dr. Shawn Teague
Bone / Heart

Lauren Christopher, PhD
3D Image Capture

- **2D plus Depth Imagers:**
  - CMOS depth sensing using phase (Photonic Charge Pump) Nicola Massari in SPIE online 2006
  - IR, Radar, Sonar Illumination & Detection
  - Multiple Camera Data Fusion
  - NEW AREA: Depth from Defocus

- **Integral Photography**
  - Imagers with Microlens Arrays
    - Manuel Martinez-Corral, in SPIE online 2006

- **Medical Radiology:**
  - 3D CMUTs (Capacitive Micromachined Ultrasonic Transducers) T. Khuri Yakub in SPIE online 2006
  - CT and MRI are 3D media
3D Image Display

- Autostereoscopic Display Demo
  - Available in SL197 after this program

- Multiple view, 3D, glasses-free experience
  - Visualization of Medical Images
  - Other applications?

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*Figure 10. Overview of 3D image processing in the display.*