EXACT™ CT Scanner

EXACT: The heart of an FAA-certified Explosives Detection Scanner

3-D Image
System Block Diagram

X-ray CT scanner

Helical Cone Beam Data

Image Reconstruction
1.5 GOp/s, 50 processors

Automatic Explosives Detection
4 processors

3D Image Display
Reconstruction Engine Requirements

Control and Status (RS232)

Dual-energy Helical Cone-beam data

6064 samples/view
1080 views/s

Nutting Slice Image Reconstruction
1.5 GOP/s

Images (SCSI)

450 3D bags/hr
... 90 2D slices/s

68x197 6064 samples/view
68x171 1080 views/s
554x203 450 3D bags/hr
554x177 ... 90 2D slices/s
Reconstruction Algorithm

• Nutating Slice Reconstruction

• Prerequisite: cone beam data corrected for detector imperfections
Nutating Slice Reconstruction

HELICAL CONE-BEAM

FAN BEAM
VIEW 1

PARALLEL (OUTPUT) SLICES

VIEW 2

PARALLEL BEAM
VIEW 1

NUTATING SLICES
SKYpack* Computer

- Application-specific repackaging of standard 6U VME product
  - originally developed for DARPA SAST program
- Dual use in commercial applications
  - explosives detection
  - medical CT image reconstruction

*SKY Computers, Chelmsford, MA
SKYpack Components

- 1 RISC processor for I/O control
- 12 RISC processors for compute processing
  - Labeled AP0-11 in diagram
- 6 SHARC processors
- 6 ASIC processors
- Shared Bus: SKYchannel
SKYpack Partitioning

- High and low energy images reconstructed on different SKYpacks
- Processes are data driven and asynchronous

[Diagram showing Processor and Memory]
SKYpack Partitioning cont’d
SKYpack Partitioning

- System processor distributes cone beam data to AP 0-7
- AP 0 does RS232 communication and controls other processors
- AP 0-7 correct and convert cone to hybrid data
- Each cone view contributes to 22 slices, every 12th view a new slice is created
SKYpack Partitioning

- AP 8-9 convert hybrid data to parallel
- SHARCs high pass filter parallel data using FFT
- ASICs backproject filtered data into tilted slices
- AP 10 untilts tilted slices into parallel
- AP 11 formats images and carries out SCSI communication
Verification and Validation

- Offline, single process software was implemented
- Simulations to verify offline software
- Intermediate results from offline software matched with online software
Automatic Detection Subsystem

- Consists of four processors
- Does image analysis, archiving and display
- Image data is propagated along two paths that search for two classes of explosives
- Each path uses detection and discrimination algorithms
References

