High Performance Processing with MONARCH – A Case Study in CT Reconstruction

Kenneth Prager
Raytheon Company
2000 E. El Segundo Blvd
El Segundo, CA 90245
keprager@raytheon.com

David Rohler
Multi-Dimensional Imaging
31300 Bainbridge Rd.
Solon, OH 44139
rohler@mdivac.com

Pat Marek
Raytheon Company
2000 E. El Segundo Blvd
El Segundo, CA 90245
psmarek@raytheon.com

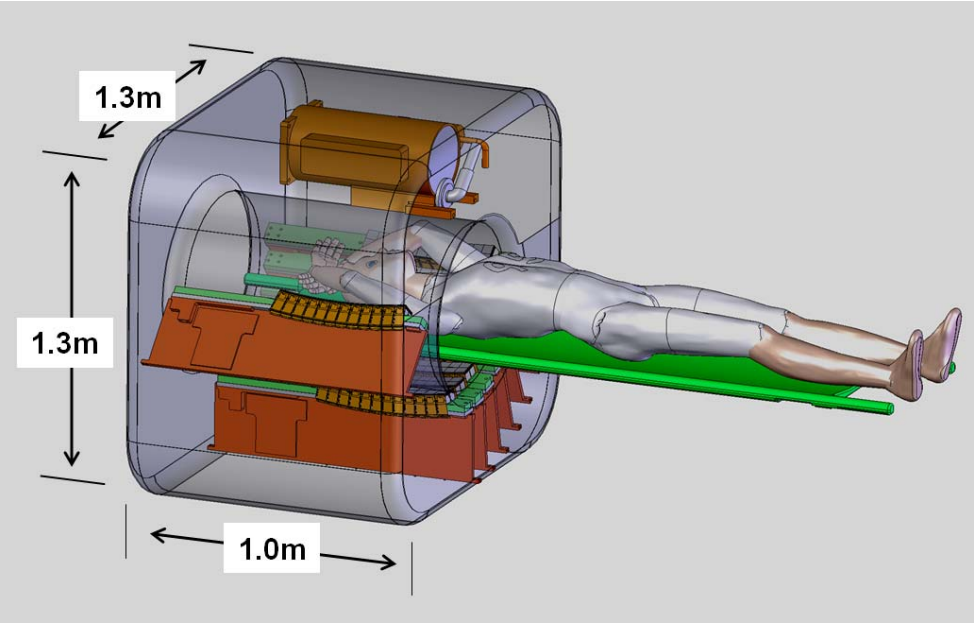
Arthur Dartt
Multi-Dimensional Imaging
31300 Bainbridge Rd.
Solon, OH 44139
dartt@mdivac.com

Lloyd Lewins
Raytheon Company
2000 E. El Segundo Blvd
El Segundo, CA 90245
llewins@raytheon.com

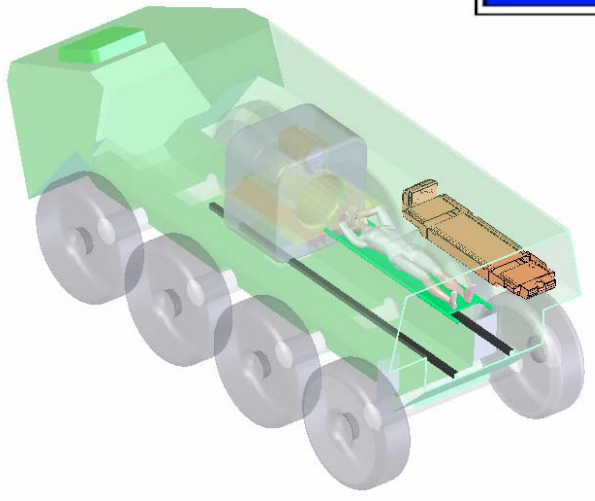
High Performance Embedded Computing (HPEC) Workshop

23−25 September 2008

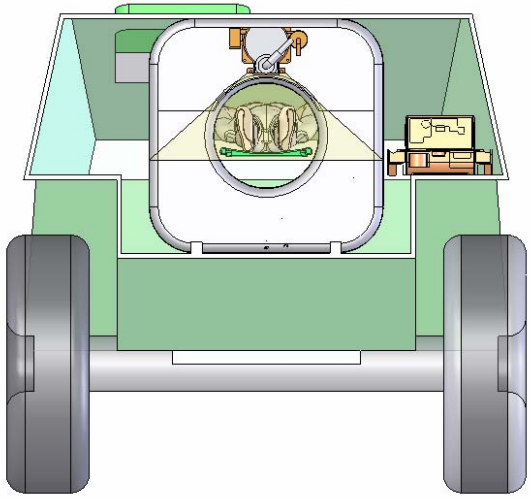
Compact VAC Overview



- Compact VAC (Volume AngioCT) is an advanced Computed Tomography (CT) system proposed for development by DARPA to allow combat casualty assessment in forward battlefield positions
- Size, weight and power enable mobility and portability suitable for use in multiple vehicles and enclosures for forward and rear military applications

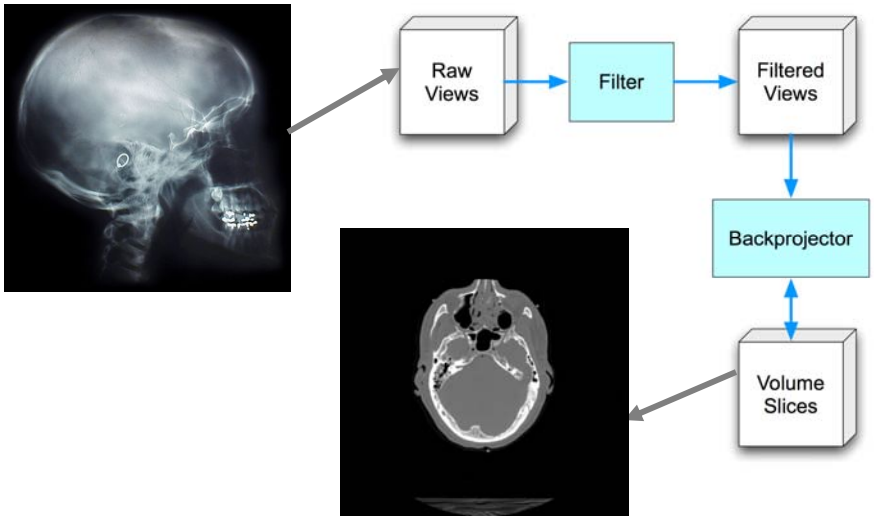


Example transport vehicle - Stryker



VAC Algorithm Overview

- CT cone-beam reconstruction is a computational algorithm that transforms a sequence of raw views into volume images.
- Volume images are typically organized as a “stack” of cross-sectional 2D slice images.
- Reconstruction consists of two components:
  - cone-beam filter process
    - Each view is independently filtered
    - No storage required
    - Low latency
  - cone-beam backprojection process
    - each reconstruction slice has contributions from a large range of views
    - each view impacts a large number of slices.
    - The range of slices and/or views is too large to fit into cache or local memory
    - Algorithms must be designed so that slice data and/or view data constantly flow in and out of local memory



Problem Summary

- Problem Statement
  - Develop an embedded system for mobile, real-time reconstruction of cone beam CT imagery
  - System must provide 1 – 2 TFLOP/S of processing throughput while only consuming around a kilowatt of power
  - Spiral cone beam reconstruction requirements:
    - 1.125 TFLOP/S of throughput
    - 100 GB/S Read/modify/write bulk memory access
- Predicted Result
  - Analysis predicts that MONARCH-based system satisifes the above requirments
    - System efficiency of ~1 GFLOP/S per Watt versus <0.1 for GP-GPU-based system