topic 0: Healthcare ICT infrastructure
topic 1: Genomic Analysis
topic 2: Numerical simulation of blood flow and cardiology
topic 3: Drug Discovery
topic 4: Deep learning medical image analysis
topic 5: Medical imaging registration & reconstruction
topic 6: Surgery visualization and rendering
topic 7: Epidemic research
topic 8: Neuroscience and brain activity analysis
topic 9: Radiation Therapy Planning
topic 10: Elderly patient surgical risk and outcome
topic 3['drug' 'docking' 'ligand' 'compounds' 'binding' 'ligands']
topic 10['patients' 'age' 'risk' 'year' 'total' 'increased']
topic 2['fluid' 'stokes' 'navier' 'flow' 'equations' 'finite']
topic 7['epidemic' 'influenza' 'spread' 'virus' 'pandemic' 'agent']
topic 9['carlo' 'dose' 'monte' 'mc' 'radiation' 'radiothera
topic 6['rendering' 'display' 'interactive' 'visualization' 'remote' 'workstation']
topic 0['healthcare' 'big' 'health' 'electronic' 'government' 'services']
topic 1['genome' 'sequencing' 'sequence' 'alignments' 'genomes' 'reads']
topic 5['reconstruction' 'gpu' 'cuda' 'projection' 'registration' 'tomog
topic 4['convolutional' 'neural' 'cnn' 'classification' 'deep' 'diagnosis']
topic 8['brain' 'neuroimaging' 'fmri' 'eeg' 'neuroscience' 'connectivity']
topic:5
Paper_ID:2131
Title:High performance computing for deformable image registration: Towards a new paradigm in adaptive radiotherapy
publish_year:2008/01
citation_count:101
Abstract:The advent of readily available temporal imaging or time series volumetric (4D) imaging has become a
n indispensable component of treatment planning and adaptive radiotherapy (ART) at many radiotherapy
centers. Deformable image registration (DIR) is also used in other areas of medical imaging, includ
ing motion corrected image reconstruction. Due to long computation time, clinical applications of DI
R in radiation therapy and elsewhere have been limited and consequently relegated to offline analysi
s. With the recent advances in hardware and software, graphics processing unit (GPU) based computing
is an emerging technology for general purpose computation, including DIR, and is suitable for highl
y parallelized computing. However, traditional general purpose computation on the GPU is limited bec
ause the constraints of the available programming platforms. As well, compared to CPU programming, t
he GPU currently has reduced dedicated processor memory, which can limit the useful working data set
for parallelized processing. We present an implementation of the demons algorithm using the NVIDIA
8800 GTX GPU and the new CUDA programming language. The GPU performance will be compared with single
threading and multithreading CPU implementations on an Intel dual core 2.4 GHz CPU using the C prog
ramming language. CUDA provides a C-like language programming interface, and allows for direct acces
s to the highly parallel compute units in the GPU. Comparisons for volumetric clinical lung images a
cquired using 4DCT were carried out. Computation time for 100 iterations in the range of 1.8-13.5 s
was observed for the GPU with image size ranging from 2.0× 106 to 14.2× 106 pixels. The GPU registra
tion was 55-61 times faster than the CPU for the single threading implementation, and 34-39 times fa
ster for the multithreading implementation. For CPU based computing, the computational time generall
y has a linear dependence on image size for medical imaging data. Computational efficiency is charac
terized in terms of time per megapixels per iteration (TPMI) with units of seconds per megapixels pe
r iteration (or spmi). For the demons algorithm, our CPU implementation yielded largely invariant va
lues of TPMI. The mean TPMIs were 0.527 spmi and 0.335 spmi for the single threading and multithread
ing cases, respectively, with <2% variation over the considered image data range. For GPU computing,
we achieved TPMI=0.00916 spmi with 3.7% variation, indicating optimized memory handling under CUDA.
The paradigm of GPU based real-time DIR opens up a host of clinical applications for medical imagin
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