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A fast, cache-aware algorithm for the calculation of radiological paths exploiting subword parallelism

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Abstract

The calculation of radiological paths is the most important part in statistical positron emission tomography image reconstruction algorithms. We present a new, faster algorithm which replaces Siddon's. Further code transformations on this algorithm prove to be beneficial in a Maximum Likelihood–Expectation Maximization reconstruction algorithm and the result is perfectly suitable for an implementation that exploits the VISual instruction set from Sun or other modern architectural extensions providing subword parallelism. The final speed-up achieved with this new algorithm and its subword parallel implementation is 13. Though smaller data formats are used in subword parallelism, the resulting images are as good as the original ones. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Radiological path; Subword parallelism; Positron emission tomography

1. Introduction

The reconstruction of an image from the data obtained from a tomographic scan using statistical algorithms requires a measure of the contribution of the various parts of the body to the radiation received by a sensor pair of the PET-scanner (Positron Emission Tomography). This measure is obtained by calculating the radiological path: the line-integral of the local intensity of radiation in the body along the ray connecting the sensors. During a full image reconstruction, radiological paths are calculated for millions of rays corresponding to different sensors of the scanner, positioned at different angles. This calculation is the most time-consuming part of image reconstruction algorithms and Maximum Likelihood–Expectation Maximization (ML–EM) [1] in particular. ML–EM is not the fastest reconstruction

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