Abstract

The invention of Computed Tomography (CT) undoubtedly started a revolution in diagnostic technology by obtaining a very clear anatomical image without violating the outer surface of the body, i.e. non-invasively. The formation of a CT image is a two stage process i.e. scanning and reconstruction. Due to the complexity of the Katsevich algorithm, an exact one for reconstruction in cone beam CT, has not been included in current CT machines till now. The reconstruction of the cone beam CT consists of two steps i.e. filtering and backprojection. The filtering is performed in CPU using MATLAB, and the backprojection is implemented in FPGA. The backprojection using Katsevich algorithm involves lots of trigonometric computations, multiplications and divisions. In the architecture, for trigonometric computations, CORDIC technique is used. Pipelined multipliers and Xilinx IP core based pipelined dividers have been included in the architecture for high speed performance. The required projection data is retrieved from external memory to the block RAM of the FPGA, and then backprojected into the currently computed subvolume. In order to hide memory access time, double buffering is employed. The circuit was synthesized, mapped, placed and routed using Xilinx 9.2i. The target device is Xilinx XC5VLX330T FPGA. At a speed of 253 MHz, a CT volume image of size 256^3 *can be reconstructed within 7s using this architecture.*

The Affine Transform (AT) is used for visualization of 2D and 3D images in different orientations from various angles and for image registration. The AT consists of four basic operations viz. rotation, scaling, shearing, and translation. By considering the replication and symmetric nature among the pixel locations two algorithms have been proposed. The architectures are mapped into the Xilinx XC2VP30-6FF676 FPGA. Total time required to perform any operation of the AT on a 256×256 image is 0.102 ms and 0.058 ms using ATPR and MATPR algorithm respectively. The architecture of 3D AT is implemented using MATPR algorithm and mapped into the Xilinx XC2VP100-6FF696 FPGA. A volume image of size 256^3 *can be transformed at a rate of 46 volumes per second and 55 volumes per second using the TLI technique and NNI technique respectively for real time applications.*

Keywords: VLSI architectures, Cone beam CT, Katsevich algorithm, Image reconstruction, Affine Transform, FPGA.