Accelerating Medical Imaging on Multi-core Platforms

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1. Abstract

In this invited talk, we will address different software and hardware issues related to the design and implementation of medical imaging systems using reconfigurable computing and multicore platforms. A range of algorithms, including discrete wavelet transform (DWT), Ridgelet and Curvelet transforms will be presented for imaging applications such as medical image denoising, segmentation and compression. The implementation process of these algorithms on reconfigurable platforms will be described. In addition, we will review the latest reconfigurable hardware technologies and development methods for real-time embedded and high performance computing systems, and will conclude with comprehensive case studies demonstrating the deployment of low power reconfigurable architectures for algorithms acceleration and performance evaluation methods for reconfigurable medical imaging systems.

2. Proposed System Applications

Positron emission tomography (PET) imaging is an emerging medical imaging modality. In figure 1, we propose an automated system for the segmentation of oncological PET data is developed. A field programmable gate array (FPGA) based co-processing solution is proposed to offload the most complex computations onto hardware, in order to achieve high performance. Initially, the Bayesian information criterion (BIC) is utilised for optimal segmentation level selection. Expectation maximisation (EM) based mixture modelling is then performed, using a k-means clustering procedure which varies voxel order for initialisation. A multiscale Markov model is then used to refine this segmentation by modelling spatial correlations between neighbouring image voxels [1].

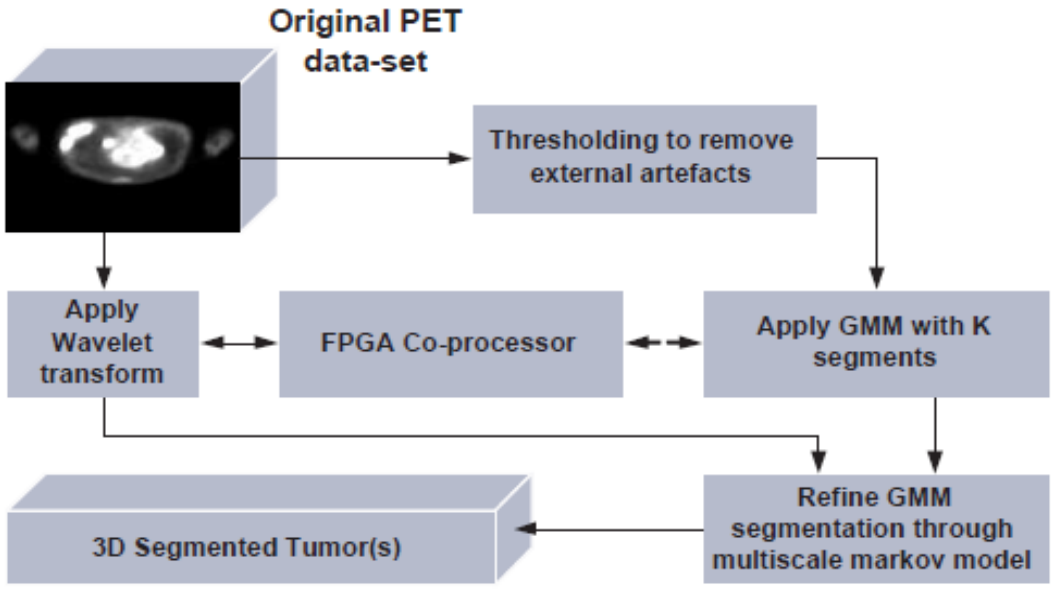

Figure 1 *Proposed statistical multiresolution segmentation co-processor*

The second applications is concerned with cerebral aneurysm which is a weakness in a blood vessel that may enlarge and bleed into the surrounding area. The early and accurate diagnosis of aneurysm is highly required to help doctors to decide the right treatment (clipping, coiling..etc). Figure 2 presents the implementation of a real-time automated segmentation technique for cerebral aneurysm on the Zynq system-on-chip (SoC), and virtualize the results on a 3D plane, utilizing virtual reality (VR) facilities, such as Oculus Rift, to create an interactive environment for training purposes. The segmentation algorithm is designed based on hard thresholding and Haar wavelet transformation. The system is tested on six subjects, for each consists 512×512 DICOM slices, of 16 bits 3D rotational angiography. Results have shown that real-time segmentation can be conducted on SoC platforms achieving promising results [2].

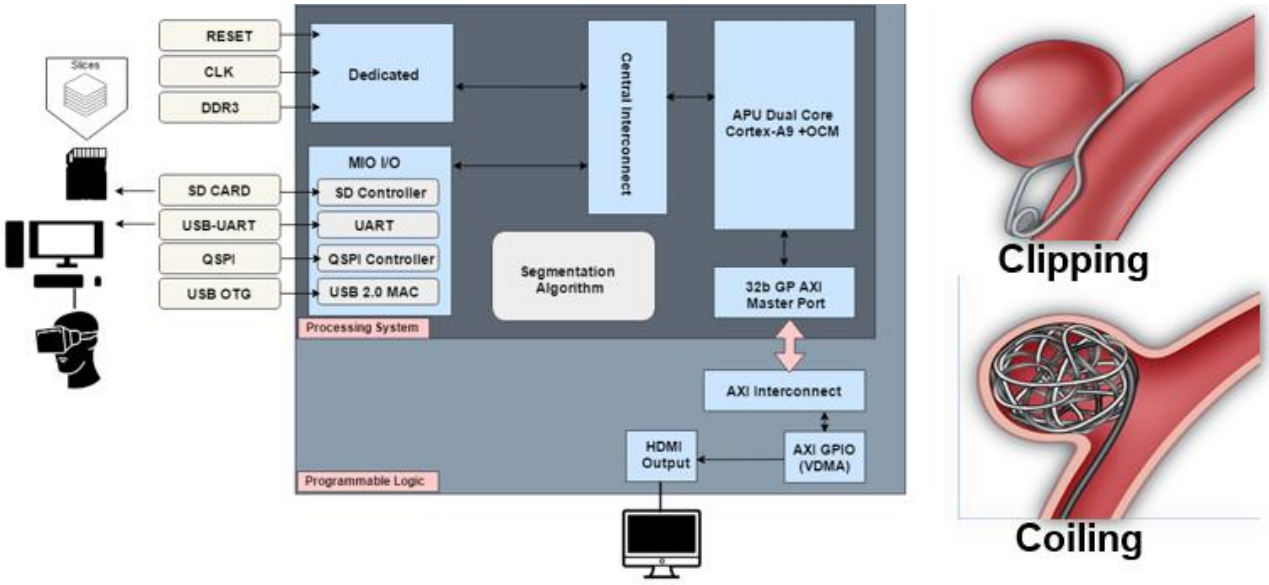

Figure 2 *Proposed Zynq SoC based Environment for Anyurism Segmentation*

3. References

[1] A Amira, S Chandrasekaran, DWG Montgomery, IS Uzun "A segmentation concept for positron emission tomography imaging using multiresolution analysis" Neurocomputing 71 (10-12), 1954-1965.

[2] X. Zhai, M. Eslamib, E. Husseinb, M. Filali, S. Shalaby, A. Amira, F. Bensaali, S. Dakua, J. Abi-Nahed, A. Al-Ansari and A. Z. Ahmed, "Real-Time Automated Segmentation Technique for Cerebral Aneurysm on Reconfigurable System on Chip", Journal of Computational Science, Elsevier, vol. 27, pp. 35-45, July 2018.