Annotated Bibliography

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Abstract

This paper presents the annotated bibliography *(first version)*. About Doctoral thesis project "Algorithms to reconstruct 3D biomedical images in real time". This Project will be developed at Universidad Nacional de Colombia to obtain PhD in Engineering area Automation.

1 Use of Programmable Hardware in Mathematics, Digital signal Proccessing video and images applications

1.1 Papers reporting used of GPUs (Graphics Processing Units)

Adams, Samuel; Payne Jason; Boppana Rajendra; **Finite Difference Time Domain (FDTD) Simulations Using Graphics Processors**[1]: This paper presents use of a GPU for solving Maxwell's equations using Finite Difference Time Domain (FDTD). The principal result was perfomance obtained with GPUs versus using CPUs. They found GPUs were always faster and . They used GeForce 8800GTX, GeForce 7800GS, GeForce Go 7400 GPus and Core 2 Duo T7600, Optetron 890, Optetron 270 CPUs. Comparing Optetron 270 with the others the GPUs were between 12.40 and 429.20 times faster, and CPUs where between 2.16 and 2.20 times fater. The conditions were similar and the differences was for the GPUs architecture.

Kehoe, Peter; Smeaton, Alan F.; **Using Graphics Processor Units (GPUs) for Automatic Video Structing**[13]: This paper used again GPU versus CPU in this case to automatically struring Video. They describe GPUs architecture and the programming model, wich is different from CPUs programming model. They also report limitations in the readback of results from GPU to the CPU due to the relative narrow bus between the CPU and GPU.[13]. Again the result was GPUs faster than CPUs.

Shen, Guobin; Li, Shipeng;Shum ,Heung-Yeung; Zhang,Ya-Qin; **Accelerating video decoding using a GPU** [19]: In this paper the used a Intel Pentiun III CPU and a nVidia GeForce3 Ti200 GPU. The application was the concatenation of several standar MPEG test sequences in CIF Format (352x288. The result again show using GPU in some floating point applications in better than CPUs.

Trancoso, Pedro; Charamlambous, Maria; **Exploring Graphics Processor Perfomance for General Purpose Applications**[21]: The the paper's purpose was explore GPUs in General Purpose computation on Graphics Processing or GPGPU [21]. To achieve high speedup with GPU it is necessary to: (1) Format the vectors into two dimensional arrays; (2) process large data arrays; and (3) perform a considerable amount of simple operations per data element. They present GPU's model Programming known as *Vector processing model* or from Flynn's taxonomy[21] as *Single Instruction, Multiple Data* or SIMD. They purposed use GPUs to extend computer's life but I think is for a specials cases especially complex computation.

Owens John D, Luebke David, Green Simon, Stone John E., Philips James C.; **GPU computing** [16]: This paper shows the GPU computing and its advantages over moderns CPUs. The principal contibution is state of art in tools and techniques for programming GPUs also use GPUs in game physics and computational biophysics.

Tita, Ralf; Wolfgang Holler; Huth, Sven; Lueth, Tim C.; **Near Real Time Tomographic 3D Reconstruction with the use of the PC Graphics Accelerator**[**?**]: This paper shows a 3D reconstruction system for x-ray tomography. The goal was to provide a surgeon 3D x-ray tomography images on line during an operation. Due to mechanical limitations of the x-ray system the Algebraic reconstruction algorithm SART was used. Using convetional SART the reconstruction time is about 3 minutes, and with paper's algorithm it takes near 10 secons. The quality is similar. To reconstruct a 3D image they need data 30 to 100 x-ray images depending on the anatomical region and the needed information.

1.2 Papers using Field Programmable Gate Arrays (FPGAs)

Dandekar O., Plishker W., Bhattacharyya S., and Shekhar R., *Multiobjective Optimization of FPGA-Based Medical Image Registration*[3]:In this paper the authors explaind how to use restricte hardware in images processing especially in medical domain. The applications was image registration, which is the process

of aligning two images that represent the same anatomy at different times, from different viewing angles, or using different imaging modalities. They compare several search methodes and demostrate the applicability of an evolutionary algorithm-based search. They had to convert floating point implementations to fixed-point versions for perfomance reasons. This process is an inherently multidimensional problem, as several conflicting objectives, such as area and error, have to be simultaneously minimized.The principal contribution is a framework for they goal and how they resolved inherents problems with programmable hardware.

Draper, Bruce; Najjar, Walid; Böhm, Wim; Hammes, Jeff; Rinker, Bob; Ross, Charlie; Chawathe, Monica; Bins, **José; Compiling and Optimizing Image Processing Algorithms for FPGA's** [5]: They developed a high-level lenguage for expressing image processing algorithms and a compiler that tagets FPGAs. The lenguaje was called SA-C. They translate the SA-C algorithms in VHDL anh then put it in a FPGA. They compare their results with a tool know as Annapolis Microsystems WildForce board with Xilinx 4036XL FPGA. The authors goal was developed a easy use tool to be used by C programmers in image processing using FPGA. In the paper they describ SA-C lenguage and some perfomance measurement without comparison with a CPU or GPU, but there isn´t their goal.

Etiemble D.,Bouaziz S., and Lionel L., **"Customizing 16-bit floating point instructions on a NIOS II processor for FPGA image and media processing"**[6]: Altera's NIOS embedded processor was used to customizing floating point instructions to improve image processing. The instructions were developed using SIMD model, they obtain speed-up ranging from 1.5 to more than 2 is obtained versus the integer implementation. The paper is clear to develop an applications in NIOS II processor programm must be in Assembler, maybe a difficult and using processor maybe another problem.

Gorgon,M. **"Universal Reprogrammable Architecture for implementation dedicated image processor based on FPGA"** [8]: Author's proposition is a new image processor's architecture. The idea is use dedicated processors for differents applications improving speed and flexibility of software processing. This paper is old but its importance is its Procesor design .

Gribbnon K., D. Bailey, and C. Johnston, **"Using Design Patterns to Overcome Image Processing Contraints on FPGAs"** [9]: They describe two methodologies to image processing using FPGAs, high-level mapping and Design patterns to overcome the constraints in image procesings. Using an exampled they showed advantage of design using patters, it facilitates the mapping process and cal help overcome the impose con straints. This approach can be

used algorithm development. But need to be compre with others metodologies.

Johnston C.T. and Bailey D.G., **"FPGA implementation of a Single Pass Connected Components Algorithm"** [12]: This paper describes using one pass algorithm ideally for building applications for processing streamed images on a FPGA or other embedded system with limited memory. They showed how developed algorithms and emphasising the modifications made to the algorithm to enable it to satisfy timing constraints. They used Haldel C as the hardware description lenguage. Maybe this algorithms can be improve speed to image processing, they said this non-trivial task. The mmaping of this algorithm onto the FPGA is also non-trivial with architecture design. Advantage is components analysis can be implemented on a FPGA without the need for a frame Buffer.

Saegusa, Takika; Maruyama, Tsutomu and Yamaguchi, Yoshiki; **How Fast is an FPGA in image processing?** [17]:This paper describes embedded processors in images processing Two-dimensional filters, stereo-vision and k-means clustering. They used SIMD operations. As results they compare with Intel Core 2 Extreme QX6850 (3GHz, 8 MB L2 cache) with 4GB main memory, and compiled them using Intel C++ compiler 10.0, and Xilinx XC4VLX160 (66MHz). They found the perfomance of the processor with quad cores is fast enough for real-time processing (more than 30 fps) when the image size is small. All hardware resources of the processor have to be used to satisfy the real-time requeriment, and no resources are left for other works. The perfomance gain by FPGAs are limited, but large amount of hardware resources are still avaible on a large FPGA, and we can execute more sophisticated works wich take over the task on the FPGA. The article in no so definitive becuse they talk about thats results are preliminary and they no take care about power consumption and cost.

Havel, Vladimir; Vlcek, Karel; **Feasibility of image Compresion in FPGA based Neural Networks**[11]: This paper examines the feasibility of using neural network based image compression in the implementation on Single FPGA based plataforms. They used Auto-associative multilayer perceptron(AMLP) as supervised learning representative and self-organization feature map (SOFM) as unsupervised learning or self-organization representative. As conclusion they showed that SOFM in not efficient for single FPGA implementation, because it needs too much neurons and connections. Both AMLP topologies had very close SNR values. Thus, the topology with less number of neurons and connections (AMLP with compress ratio 4:1) can be implemented on single FPGA.This was another application using FPGAs in image processing.

Fahmy, Suhaib A.;**Generalised Parallel Bilinear Interpolation Archi-**

tecture for Vision Systems [7]: In this paper is showed how used Bilinear Interpolation in coputer vision for extracting pixel values and an architecture for its implementation in an FPGA based vision systems. This architecture was implemented in VHDL, with Xilinx CoreGen memory cores to provide maximun perfomance. The circuit was Synthetised, mapped, placed and routed using Xilinx ISE 10.1. The target Device was Xilinx Virtex 4. This application uses the FPGA capabilities for parallel processing and improve perfomance to artificial vision systems. They didn't implemente a complete vision system and only used MATLAB produced images.

2 Brain tumors detections

Wang, C.H.; and Tseng, S.S.; **A Brain tumor diagnostic system with automatic learning abilities** [24]: They used a expert system and a learning systems. The systems help to diagnosicians in judging the causes of brain tumors according to the computed tomography pictures, and use inductive learning mechanism. This paper only contribute about how to implement a learning mechanism.‘

Zhou, Yun; Huang Sung-Cheng; Bao, Shanglian; Wong, Dean F.;**Parametric Imaging and Statistical Mapping of Brain Tumor in Ga-68 EDTA Dynamic PET Studies** [25] :In this paper they show statistical mapping to found brain tumors, they used the LPISC Linear Parametric Imaging Algorithm for generating images of K_1, and DV of good image quality, especially for K_1 images in Ga-68 EDTA dynamic PET studies. The principal contribution is the use of statistical processing to locate brain tumors, and how they used this information to the project goal, they used no complex mathematics to do that.

Doraiswami, Ravi; Kalapurakal, John A; **Novel Biosensor Development for monitoring children´s Brain Tumor**[4] : This paper presented a biosensor to monitoring Childen's Brain tumor using RF cancer sensor for in vivo monitoring of the recurrence of brain tumor after treatment. They presents as the most common symptoms of brain tumor an increase in pressure in or around the brain. There in no spare space in the skull for anything except the tissues of the brain and its fluid. a Tumor causes increased intracranial pressure (ICP). They designe a low cost sensor to temperature, pressure and capacitance. However this sensor is only a purpouse and there isn't implemented yet.

Corso, JJ; Sharon , E; Dube, S; El-Saden, S; Shinha, U; Yullie, A; **Efficient Multilevel Brain Tumor Segmentation with Integrated Bayesian Model Classification** [2]: In this paper they presented a method for au-

tomatic segmentation of heterogeneous image data that takes a step towars bridging the gap between bottom-up affinity-based segmentation methods and top-down generative model based approaches. They used bayesian formulation for incorporating soft model assignments into calculation of affinites, wich are conventionally model free. The computionally efficient method runs orders of magnitude faster than the current state-of-art techniques giving comparable or improved results. They presented a table comparing their segmentation method with 14 others and only in a case they were under other method. They do segmentation in 7 min. Their contributions were The mathematical formulation for bridging graph-based affinities and generative model-based techniques. other contribution they extended SWA algorithm to integrate model-based terms into the affinities integrate classification without making premature hard, class assignments and Mathematical formulation for learning the parameters of model-specific affinity functions directly from training data. The paper is rigurous and there isn´t doubt about their contributions.

Machucho,Rubén; De la cruz Rodríguez, Sergio; Bayro-Corrochano, Eduardo; **Rendering of brain tumors using Endoneurosonography** [15]: In this paper they showed a method to render brain tumors from endoneurosonography. They track an ultrasound probe in successive endoscopic images without relying on an external optic or magnetic tracking system. The track was using two differnt methodes, the based Generalized Hough Transform and Particle Filters. With the stimation of pose of the ultrasound probe in several contigous images they used Conformal Geometric Algebra to compute the geometric transformations that yield the 3D podition of the tumor, wich was segmented in ultrasound image using morphological operators.

3 Algorithms to 3D images processing

Kidera, S.; Sakamoto, T.; Sato, T.;**A high-resolution 3-D imaging algorithm with linear array antennas for UWB pulse radar systems** [14]: They proposed a fast 3-D imaging algorithm called SEABED, based on a Reversible transfor BST (Boundary Scattering Transform) between the received signals and the target shape. The resolution is limited to the sampling number of the scanning. They recosntruct an image in 0.03 secs using at Xeon 3.2 GHz processor enough for this real-time operations. The paper is rigurous but the images are so simple comparing with biomedical images(It's my viewpoint).

Uschkerat, U.; **Application of 3D-SAR nearfield imaging algorithms to GPR data**[22]: In this paper they used a 3D-SAR imaging algorithm to reproduce 3D images in GPR systems. They reconstruct 3D images using 2D images, but its very complex developed, to use with FPGA, as propouse can

be used GPUs because the problem is compute large data in short time. The paper there isn't conclusion and Results.

Schuhr, W.; Kanngieser, E.; **3D-Visualization Techniques, Including Samples and Applications** [18]: Inthis paper show an approch to 3D visualization, it had only 8 references. However is an interesting paper compiling information as applications of stereoviews. There are alot of etc. maybe it's unconclude. The principal contribution is a list of Virtual Spatial Visualization Techniques (July 2006). and with it Can be developed a specific interes area.

Halcrow, Gavin; Mulgrew, Bernie; **SAR 3D Scene Reconstruction Using Fourier Imaging Techniques** [10]: In this paper describing how obtain a 3D images using convolution back-projection, however due to the extra dimension this is computionally intensive, They developed a method using FFT for image formation. They used MATLAB simulation to obtain results. And used Polar Format Algorithm using FFT, the data where resampled onto a uniform rectangular grid and in the 3D case they must be resample onto a uniform cube grid points. In the paper isn't showed the contrast results and resolution to apply in others applications. But is an interesting complex reduction using FFT.

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