ERCIM "Alain Bensoussan" Fellowship Scientific Report

Fellow:	Özgür TAMER
Visited Location :	NTNU Trondheim / Norway
Scientific Coordinator:	Prof. Leif Arne Rønningen
Duration of Visit:	1 Year (24.2.2011 – 23.2.2011)

I - Scientific activity

I have been a member of the Distributed Multimedia Plays project during my research period at the Telematics Department. The project is managed by Prof. Leif Arne Ronnigen who is also my ERCIM scientific advisor. The Distributed Multimedia Plays (DMP) Systems Architecture provides three-dimensional multiview video and sound collaboration between performers over packet networks. To guarantee an end-to-end time delay under 20 ms., and to obtain high network resource utilization, the perceived quality of audio-visual content is allowed to vary with the traffic in the network. Typical applications are creating virtual collaborations for jazz sessions, music lessons and distributed opera. Research at the Norwegian University of Science and Technology is building on the concept of DMP, which was first proposed in 1996 as an extension to Multimedia Home Platform.

The research I have been involved was focused on the proposal and implementation of various image and video processing algorithms using parallel processing techniques. We can divide the research I have worked on in to three:

1) **System Architecture:**
   Different System Architectures for 10, 12 and 16 camera cluster arrays (CCA) have been proposed. The camera clusters are connected to FPGA based special acquisition boards. Each camera cluster has 9 cameras and each FPGA board can handle 3 cameras; each CCA will be connected to 3 acquisition boards. The acquisition boards will also be responsible of pre-processing the acquired image and transfer only the necessary data to the main FPGA board via an 4X external PCI-express interface. Xilinx ML605 boards are used as the main FPGA boards. Each board can handle 4 4X PCI-express connections. So we will be able to connect 4 CCA's to 3 ML605 boards. For a 16 CCA configuration we will need 12 ML605 boards. The ML605 boards will be responsible for converting the pre processed image data to image objects and sub-objects which are well defined under the AppTraNet protocol. The AppTraNet protocol is the main transmission protocol for the whole DMP system.
2) **Systolic Array based Real Time Edge Detection:**
   To prevent image and Video processing algorithms spend the precious time for the DMP system; they will run on parallel architectures. As a starting point, edge detection is selected as a basic tool for image processing applications. Hardware based edge detection algorithms generally work on a pixel wide basis; they acquire a single pixel at a single clock cycle, and produces a single pixel at single clock cycle, which can be very time consuming for processing large scale image (For a 1080p HD image a hardware working at 250 MHz can detect edges at 12.5 ms). We proposed a row wide edge detection algorithm based on a three dimensional systolic array structure. The row wide approach improves the performance of the algorithm when compared with the pixel wide algorithms presented in previous works. The presented results show significant

improvement in processing time and satisfactory detection of the edges on reference images. The proposed structure can detect the edges of a 1080p HD image in 8.2 µs.

3) **SIMD based architecture for the Kriging Algorithm:**
Sub-object dropping and reconstruction of objects from the remaining sub-objects is one of the main ideas proposed in the DMP system structure. Kriging algorithm which is mostly preferred by geophysicists is proposed for reconstruction of the objects. I have worked for a parallel SIMD architecture for the Kriging algorithm which is also row based like the systolic array structure for the edge detection. The performance of the SIMD structure heavily depends on the number of the sub objects transmitted. The more the number of sub objects, the more time it takes to reconstruct the object. However decreasing the number of sub-objects also decreases the quality of the reconstructed image. We are still working on solving this dilemma and making the structure adaptive for the number of sub-objects transmitted.

II- Publication(s) during your fellowship

[1]Tamer Ö., Ronnigen L.A., Panggabean M. "Real time edge detection using three dimensional systolic array" The IASTED International Conferences on Informatics 2010 Parallel and Distributed Computing and Systems Marina Del Rey / USA November 2010

Abstract:
Real time video processing is gaining importance, while the size of the video sequences are also getting larger with the improvement of new multimedia applications. Eventhough software based video and image processing systems have significant advantages like flexibility and cost effectivity, they are lacking performance, which makes hardware based systems more preferable for real time high definition applications. This paper presents a row wide edge detection algorithm based on a three dimensional systolic array structure. The row wide approach improves the performance of the algorithm when compared with the pixel wide algorithms presented in previous works. The presented results show significant improvement in processing time.

[2] Panggabean M. , Ronnigen L.A., Tamer Ö. "Toward Futuristic Near-Natural Collaborations on Distributed Multimedia Plays Architecture" 10th IEEE International Symposium on Signal Processing and Information Technology (ISSPIT) 2010, Luxor, Egypt, December 2010

Abstract:
This paper presents a vision of how people can collaborate in real-time in the future from different places on the continents with near-natural quality of experience. To achieve that very high quality, the requirements are also very high and challenging. The ultimate challenge for its implementation is to guarantee end-to-end delay less than 10-20ms with graceful quality variability to enable live musical collaborations. The Distributed Multimedia Plays architecture with the AppTraNet protocol and the design of the collaboration spaces is our proposal for the realization of the vision, since existing Internet standards are unable to provide such guarantee. The relation of this novel proposal to the existing and future standards is also discussed. It is expected that significant milestones on this research avenue will be attainable in the next 5-10 years.

[3] Panggabean M., Tamer Ö., Ronnigen L.A. "Parallel Image Transmission and Compression Using Windowed Kriging Interpolation " 10th IEEE International Symposium on Signal Processing and Information Technology (ISSPIT) 2010, Luxor, Egypt, December 2010

Abstract:

We propose the use of windowed kriging to enable ordinary kriging to interpolate sampled natural images of much higher resolution. Due to its high computational cost, applying ordinary kriging on a whole image can interpolate samples from only 5% of a 64x64 image, while windowed kriging can process images with resolutions higher than 512x512 pixels. Our proposal is motivated by our vision of real-time near-natural collaboration from distributed places based on Distributed Multimedia Plays (DMP) architecture that is realizable in another decade. Windowed kriging allows parallel transmission and compression of sampled natural images to facilitate controlled packets dropping by network nodes for graceful video quality degradation with guaranteed maximum end-to-end delay. Our simple window scheme makes parallel interpolation at the receiver side possible, for which a design of parallel hardware implementation is presented. Typical artifacts due to applying the technique can easily be eliminated completely to produce images of decent quality.

III -Attended Seminars, Workshops, and Conferences

Session Chair:
The IASTED International Conferences on Informatics 2010 Parallel and Distributed Computing and Systems Marina Del Rey / USA November 2010

Presentation:
The IASTED International Conferences on Informatics 2010 Parallel and Distributed Computing and Systems Marina Del Rey / USA November 2010

Training:
The MATLAB Technology Tour 2010, Trondheim/Norway, 29 April 2010

IV – Research Exchange Programme (12 month scheme)

1. **Dr. Roberto Scopigno ISTI CNR Pisa / Italy (30.11.2010 - 4.12.2010)**
   During my visit to CNR institute at Pisa I introduced the DMP system to the researchers at the institute and presented our progress on the system.
   I also had chance to talk to many researchers at Dr. Scopigno's team about their research areas and made some minor contributions on some of them.
   I was also introduced to the MeshLab which is an open source, portable, and extensible system for the processing and editing of unstructured 3D triangular meshes. The system is aimed to help the processing of the typical not-so-small unstructured models arising in 3D scanning, providing a set of tools for editing, cleaning, healing, inspecting, rendering and converting this kind of meshes.
   Most of the team members are working on 3D modelling of objects using the VCG library. The VCG library is a portable C++ templated library for manipulation, processing and displaying with OpenGL polygon meshes.

2. **Prof. Dr. Panagiotis Tsakalides ICS FORTH Crete / Greece (24.1.2011 – 28.1.2011)**
   The dates of my one week visit to FORTH institute at Crete overlapped with the Hipeac Conference which was held at the same location. So I had the opportunity to attend a few sessions of the conference.
   I also made a presentation at FORTH institute about he DMP structure and recent progresses we have achieved during my working period.
   Prof. Tsakalides and Prof. Mouchtaris also introduced their researches which was very similar to the DMP system. The work they have introduced was a real time audio

collaboration over Internet. They also stated that they would gladly collaborate with Prof. Rønningen, on future projects.