ERCIM "Alain Bensoussan"
Fellowship Scientific Report

Fellow: Georgios Evangelidis
Scientific Coordinator: Prof. Christian Bauckhage
Visited Location: Fraunhofer IAIS, St. Augustin, Germany
Duration of Visit: September 15, 2009 – September 14, 2010

I - Scientific activity

During my ERCIM fellowship I was being a member of the research team of Prof. Christian Bauckhage in the Visual and Social Media group in Fraunhofer Institute for Artificial Intelligence Systems (IAIS). My staying in Fraunhofer IAIS and my involvement into this research team allowed me to make myself familiar to state-of-art approaches used in Pattern Recognition and Machine Learning fields. As a consequence, I had the opportunity to adopt such approaches and formulations for computer vision problems and especially for the problem of Video Registration I mainly dealt with.

Towards the solution of this problem, we developed a novel approach by adopting an efficient pattern recognition approach. The main goal in our research project was to detect changes between two (or more) unsynchronized video sequences, captured independently by moving cameras, by aligning them in both space and time. We treated the problem in question as sequence of two separate problems; an approximate video synchronization and a space-time alignment of roughly synchronized sequences, with the solution of the first being the initialization of the second one. Regarding video synchronization problem we introduced an Image Retrieval approach for its solution. In more detail, we considered the frames of the first sequence as an image database while the frames of the second sequence were considered as successive query images. This approach permits us to exploit the meantime between the records (usually they concern quite different times) by indexing the database appropriately and envisage an online and real-time solution of the problem, i.e. detect changes by recording the second sequence. To this end we adopted an efficient indexing scheme which was recently proposed in astrometry field (Google astrometry). This scheme permits us to define short-length image descriptors (quad descriptors) and to use them as the key of finding similar patterns between the sequences. This descriptor is based on quadruples of interest points provided by an image detector (i.e. Harris) and results in the geometry hashing of them. Despite the low discriminability of such a descriptor, we succeed through a voting scheme in efficiently solving the video synchronization problem and provided us with two roughly synchronized sequences.

In order to accurately detect changes between videos, we developed a spatio-temporal alignment scheme which enables the refinement of synchronization and the spatial registration of synchronized frames as well. This scheme is based on the space-time extension of a recently proposed image alignment scheme, which is called Enhanced Correlation Coefficient. The output of this framework is a spatio-temporal model which aligns with subpixel and subframe accuracy the query frame with the reference sequence. This procedure is repeated for all query frames.

In addition, we developed a multiscale descriptor to achieve better synchronization results. More specifically, we developed a multiscale framework by considering scale-space analysis

and worked at each scale separately. This multi-querying scheme provide us with a scale-variant vote-space and, by combining the votes of different scales, we achieve more accurate synchronization. The performance of this approach is based on the facts that, first, in a real scene different objects are described better at different scales and second, different frames are synchro-outliers after querying the database at different scales. Furthermore, we developed a multiscale dynamic programming method based on a vote-volume. This can be viewed as global (non-causal) solution, which can be used in offline applications (video copy detection, super-resolution video, high dynamic range video etc). This global scheme also allows us to assess the loss in performance by enabling a causal solution, i.e. when we decide for the corresponding frame based only of the query frame. The multiscale framework is combined with a modification of the space-time alignment scheme which seems to be quite robust to outliers (i.e. different moving object in two sequences).

II- Publication(s) during your fellowship

There were no published papers during my fellowship period. However, the results of my research in Fraunhofer IAIS have been already summarized in two papers. The first one concerning primary results of the uniscale approach will be submitted to IEEE Int. Conf. on Computer Vision and Pattern Recognition (CVPR 2011). The second paper that reflects the extended work including the mutliscale framework and the modification of the space-time alignment scheme will be submitted to IEEE Transactions on Pattern Analysis and Machine Intelligence. A third paper, as well, concerning my research in CWI is under preparation.

III -Attended Seminars, Workshops, and Conferences

* Bonn Vision Workshop 2009, October 8th, 2009, BIT-Bonn

I also regularly attended the weekly seminars of the research group, where the progress of the group members (MSc students, PhD students, postdocs) was being presented. I presented my research work in one of them during my first days in IAIS.

IV – Research Exchange Programme (12 month scheme)

First Exchange Institute: Centrum Wiskunde & Informatica (CWI), Amsterdam, The Net herlands
Exchange dates: June 14-18, 2010
Research contact: Prof. Eric Pauwels

During my stay at CWI I visited the research group "Images and Signals" headed by Prof. Eric Pauwels. I had the opportunity to have fruitful discussions with Prof. Eric Pauwels and Dr. Paul de Zeeuw. My expertise fitted their needs and preferences in the context of a project concerning a photo-identification system for animal images. Specifically I have got involved in this project by enabling a sophisticated alignment method of images representing pineal spots of leatherback turtles. Our collaboration is still active and a joint paper is under preparation.

Second Exchange Institute: Artificial Intelligence Research Institute (IIIA), Barcelona, Spain
Exchange dates: August 23-27,2010
Research contact: Dr. Josep Puyol-Gruart

During my staying in IIIA I had the chance to discuss with Dr. Josep Puyol-Gruart about our common interests in Artificial Intelligence filed. Furthermore, Dr. Josep Puyol Gruart introduced me to some of his colleagues whose expertise was related to Computer Vision field. I had profitable discussions with them about Image Processing and Computer Vision Problems.

We also investigated the intersection of our research directions in order to set up a joint project in the future.

Acknowledgments