ERCIM "Alain Bensoussan"
Fellowship Scientific Report

Fellow: Carles Bosch
Visited Location: INRIA Sophia Antipolis
Duration of Visit: 12 months

I - Scientific activity
(1 page at maximum)

During my stay at the REVES group of INRIA Sophia Antipolis, my research has been centred on two main topics: the simulation of weathering phenomena and the procedural representation of surface details. In Computer Graphics, simulating weathering effects such as stains, corrosion, or fractures, has been typically done by means of physically-based simulation techniques or data-driven methods. However, these two approaches have significant limitations. While simulation techniques produce very realistic results, they tend to rely on parameters that are difficult to know beforehand. Data-driven methods, on the other hand, offer the possibility to acquire weathering information from images and easily transfer it to new objects, but then are restricted by the information available in the images or not able to realistically reproduce complex phenomena, such as stains produced by water flow.

In collaboration with Prof. Holly Rushmeier and Julie Dorsey from Yale University, we have developed a new method that combines simulation techniques with data-driven methods for the first time. The idea behind this method is to use images of weathering effects to guide the corresponding simulation techniques, so that similar effects can be easily reproduced onto new scenes. In order to do that, we have proposed different contributions, such as the extraction of simulation parameters from photographs by an optimization method, the colour transfer of the weathering effect from the original background to new materials, and the extraction of high frequency details for its combination with the simulation results. The results of this work have been recently accepted for publication in ACM Transactions on Graphics, and will be presented at SIGGRAPH 2011 this summer; both considered the best journal and conference in Computer Graphics, respectively. Furthermore, this work has opened new interesting research directions that we are currently exploring, such as the extension of this method for simulating phenomena affecting the geometry of the objects (fractures, erosion, etc.), or the development of a comprehensive weathering solution for city models.

The second topic that we have explored during my stay is the procedural representation of geometric surface details. This kind of details is usually separated from the main geometry model of the objects due to their small scale nature and repetitiveness. Instead, they are usually encoded using regular texture maps (or height field maps) that are later mapped onto the objects to simulate the surface variations. Texture maps, however, have several limitations due to their discrete nature and the fact that they are precomputed, thus dynamic changes are not well suited. In collaboration with Ares Lagae from K.U. Leuven, we have been working on a new method based on a procedural noise model for the simulation of stochastic details. Such a method will allow real-time changes of the parameters of the detail (scale, frequency,

orientation, etc.), but will also be very efficient and accurate compared to texture maps. To achieve this goal, there are different problems that need to be solved first, such as the correct filtering of the detail in the distance, or the simulation of shadows and occlusions effects onto them. During these last months, we have considerably advanced in the solution of these problems, and we will continue working on these after the stay. We believe that solving these problems will open the door to a new representation of surface details that will offer many advantages over existing methods, so a good publication is envisaged. We also believe that this representation may bring up interesting applications, such as the interactive modelling of surface details or the efficient representation of geometric details on large scale scenes.

To conclude, I believe that my stay in INRIA Sophia Antipolis has been very positive and fruitful for my career, and will help in consolidating my future as a researcher.

II- Publication(s) during your fellowship

Please insert the title(s), author(s) and abstract(s) of the published paper(s). You may also mention the paper(s) which were prepared during your fellowship period and are under reviewing.

Image-Guided Weathering: A New Approach Applied to Flow Phenomena.
C. Bosch, P.-Y. Laffont, H. Rushmeier, J. Dorsey and G. Drettakis
ACM Transactions on Graphics, 2011 (Accepted) (To be presented at SIGGRAPH 2011)

Abstract:

"The simulation of weathered appearance is essential in the realistic modelling of urban environments. A representative and particularly difficult effect to produce on a large scale is the effect of fluid flow. Changes in appearance due to flow are the result of both the global effect of large-scale shape, and local effects, such as the detailed roughness of a surface. With digital photography and Internet image collections, visual examples of flow effects are readily available. These images, however, mix the appearance of flows with the specific local context. We present a methodology to extract parameters and detail maps from existing imagery in a form that allows new target-specific flow effects to be produced, with natural variations in the effects as they are applied in different locations in a new scene. In this paper, we focus on producing a library of parameters and detail maps for generating flow patterns – and this methodology can be used to extend the library with additional image exemplars. To illustrate our methodology, we show a rich collection of patterns applied to urban models."

III -Attended Seminars, Workshops, and Conferences

Please identify the name(s), date(s) and place(s) of the events in which you participated during your fellowship period.

IV – Research Exchange Programme (12 month scheme)

Please identify the name(s), date(s) and place(s) of your Research Exchanges during your fellowship period and detail them.

First Research Exchange:

- Centre: Visual Computing Lab, ISTI-CNR, Pisa, Italy.
- Dates: 10/10/2010 - 16/10/2010
- Contact Name: Roberto Scopigno (roberto.scopigno@isti.cnr.it)

For the first exchange programme I visited the Visual Computing Lab in Pisa, which is especially known for their contributions on geometry and colour acquisition as well as its cultural heritage applications. Since the simulation of weathering and surface details is closely related to this area, this visit provided me a good opportunity to exchange common interests that may be useful for a future collaboration.

Second Research Exchange:

- Centre: Computer Graphics Laboratory, ETH Zurich, Switzerland.
- Dates: 14/03/2011 - 19/03/2011
- Contact Name: Markus Gross (grossm@inf.ethz.ch)

The Computer Graphics Laboratory at ETH Zurich is one of the most renowned groups of Computer Graphics in Europe. In this visit, I had the opportunity to present my work to this group and to learn from very close their current projects in this field.