Ripoll: the most precise facade ever seen

The technology of the MOVING group will allow us to look deep into the past through one of the Catalan Romanesque jewels. A polygon model of almost two hundred million polygons, one of the most complex ever built, reconstructs all the details and colours of the famous facade in the Monastery of Ripoll, an true Bible of stone. This model will be on display at MNAC next May and it will be one of the stars sharing its hiperrealism with other Romanic pieces from the museum.

Virtual fingers touch the fine grain of reality
By giving top priority to visual fidelity and extending quality to submilimetric precision, this model allows one to navigate all the details of the thousand years old stone bas-relief reaching places that cannot be seen by visitors who reach the actual monument in Ripoll, 70 miles north of Barcelona. Moreover, one can recover views of long forgotten or destroyed parts of the myriad figures that cover the whole portico.

This computational tour de force is the result of long years of research and application of geometric modelling , visualization and virtual reality techniques done by the Moving group, led by Pere Brunet. One can define this project as millions of triangles and a lot information on a single, ordinary PC at the service of hiperreality. It will be like reading an enormous library of details through navigation: jumping to any little piece of that library in tenths of a second. Close to magic!.

Although the MOVING group has long experience on this specific type of research, and on its application to Cultural Heritage projects, they also have done important contributions in other areas as well, such as medicine or industry.

Given the precision of this model and the well-thought interface with the user, the experience of visitors at MNAC will be like fondling the stone with their fingers and sensing the smallest detail.

You will be able to explore the Ripoll's facade at the Museu Nacional d'Art de Catalunya (MNAC) in Barcelona inside the "El Romànic i la Mediterrània. Catalunya, Toulouse i Pisa" exhibition from the 29th of February.

Step by step: from real to virtual stone.

The task of building the complex model behind Ripoll's facade starts with laser scanning. It is followed by the application of computational techniques in order to transform a cloud of points in space into a collection of connected polygons that represents the general structure and volume of the monument. Researchers of the Moving Group in cooperation with a group of colleagues from CNR in Pisa, Italy, created a grid of 2050 patches of each one of about 40x40 cm. This resulted in a first model that weight around 20 Gibabytes. On top of this colour and texture information were captured by photographic means and merged with the rest of information. But let's go one step at a time.

A puzzle of 2050 pieces

The researchers from CNR in Pisa were in charge of scanning the whole facade. That is, they treated it one square at a time with different resolution levels. Then, they had to align all scanned squares and made them fit together. The difficulty of this process lies in the fact that each point of information -the 3D coordinates of the point- was calculated with respect to the different successive location of the laser scanner. As such, a collection of data points tells little of the actual structure and appearance of the whole monument. It is necessary to build a structured representation, i.e., a grid of interconnected polygons.

The result of this step is ... an even bigger puzzle, that is, a model of almost two hundred million triangles of a side length of 1,4 millimeters. Again, this collection of tiny triangles has to be adjusted so that everything is connected. This is necessary to fit together the partial areas. Typical problems in this step are the need to treat possible "holes" of missing triangles given to the inaccessibility of the real, original volumes. The final grid of triangles, even if has an amazing volume of information, is now reduced to 5 Giga Bytes. From this, grid representations with multiple resolutions were calculated so that maximum visual quality from all viewpoints is guaranteed.

A final touch to ensure realistic navigation

Now another type of problems arises. Visitors to the exhibition will be using a simple, ordinary PC to navigate through the virtual facade. Their visual and interactive experience has to be very smooth. Processing and reprocessing such a huge model in order to create a realistic and smooth navigating experience using the power of a just single PC is a big challenge. It is necessary to know how to manage the correct fragment of the model where the user is heading to and anticipate its presentation. It is also necessary to be able to adapt the different resolutions to the timing of the navigation and interaction. All this boils down to being smart in managing the transfer of the the correct part of model from different levels of memory, from hard disk to the graphical board... giving that the whole model cannot be present in the fastest memory in full.

How to navigate in real time

So, how to solve this apparent dilemma? Well, using the representational and algorithmic methods developed by the MOVING group along the years. The key is to be able to create a hierarchy of spatial and geometrical representations. Information about the model is distributed, so to speak, in three different "floors" corresponding to the three different levels o memory, from lowest to fastest and from more external (hard disk) to the one in the graphical board. At the "first floor", the hard disk, the most precise representation of the model is stored. Then, at the "second floor", the computer memory, there is an intermediate precision model. Finally, on the graphical board is where the least precise model is, this is the one that has to be refreshed faster in order to keep the eye of the viewer in the illusion of continuity. One has to take into account that in order to load the complete model from hard disk to primary memory, almost 30 seconds could elapse. However, to keep an illusion of real navigation, similar to the one you have when viewing a film, the image that reaches the eye has to be refreshed 50 times a second. The use of clever methods of representation and anticipation

allows to solve this apparently unsurmountable difficulty. The final viewing experience will be, at times, similar to the one that one has while surfing the popular Google Earth website: there is always an image present and navigable if, initially, it is somewhat blurred. As one zooms in, more a more detail appears. The merit of MOVING work is to make this transition barely noticeable with such an enormous model.

Navigating through the past, the present and the future at the same time.

This hiper-precise reproduction will get the general public closer to one of he best pieces of Catalan Romanesque art. At the same time it will be a study tool for experts and a faithful archival information that will reflect the precise aspect of the facade on November 2007, which was the time of the year when all data was captured. It can be understood, also as a new storage technique for archaeologists that complements tratiditional ones: original documents, drawings, blueprints and photos.

The set up for navigating the model allows for different types of navigation. A touchscreen on the PC will allow simple, direct observation. A second mode pops up extensive information just by touching different "hotspots" that float in front of important components of the facade: one can learn more about a representation of Moses leading his people or to discover that a little stone carving represents the labours associated with a month of the year. In this second mode it is also possible to recover and project details that are no longer present in the actual facade, such as missing parts of sculpture that have been recreated from XIXth century photographs. It is also possible to recreate precise illumination conditions. For example it is possisible to see the aspect of the facade on the morning of a sunny 4th of July. Finally, with the "virtual flashlight" the viewer will send a spot of light to a precise place or detail. The use of the flashlight results in the appearance of sharp, very precise shadows with stone grain precision. This, in turn, helps in creating a more real sensation of volume and of the true aspect of the stone figures. The final effect is more an immersive visualization that enhances the realism of the user's experience.

Centuries of history
The arcade

The Benedictinian monastery of Ripoll was founded by count Guifré el Pilós in 879. The main work of art from the monastery, as well as the main Romanic sculpture from Catalunya, is the facade which dates back to the 12th century.
This arcade has been defined, by historians such as Josep Maria Pellicer Pagès or Catalan poets such as mossèn Cinto Verdager, as a "Stone Bible". It is a masterpiece of cultural, historical, social and scientific interest.

Ripoll being a bit apart from the typical touristy routes in and around Barcelona, virtual aids like the one developed by the MOVING group will help in making it known to a wider audience. This, together with the impovered condition of the stone was a strong motivation for computer scientists, museum curators and archaologist to go for a virtual ultra-precise model of this significant cultural heritage masterpiece.

The fine art of simulating fine art

MOVING has created a work of art form a work of art. It is the result of many research years and it will leave new material to be explored. Now, MOVING is considering the possibility to using their work to create pseudo-clonic models to reconstruct damaged parts. If geometric models and virtual scuplturing tools are combined with the knowledge from art historians and talented scupturs it will be possible to have several "reconstructive hypothesis" in place.

Getting closer...

If you want to feel this unique and revolutionary experience yourself you should walk into MNAC from the 29th of February to the 18th of May, 2008.

And to know some more you could check their web page:

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