Photogrammetric stone-by-stone survey and archeological knowledge: an application on the Romanesque Priory Church Notre-Dame d'Aleyrac (Provence, France)

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PHOTOGRAMMETRIC STONE-BY-STONE SURVEY AND ARCHAEOLOGICAL KNOWLEDGE

An Application on the Romanesque Priory Church Notre-Dame d'Aleyrac (Provence, France)

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This paper focuses on a new approach of stone-by-stone surveying in which formalised architectural knowledge is used as a prerequisite to the photogrammetric measurement process. One of the major aspects of our approach regards the photogrammetric survey of historical architecture built from stone or brick, aiming at the three-dimensional and database treatment of the individual stones or bricks as elements composing structural units, such as arches, pillars, windows and vaults. The chosen object are the remains of the romanesque priory church of Aleyrac, in northern Provence (France), the semi-ruinous state of which gives a clear insight into the constructional details of its fine ashlar masonry. In addition to the morphological definition, the structural point of view is implemented in the model in order to consider some architectural elements as containing a set of ashlar blocks. In our approach of stone-by-stone surveying, which has been conceived for the study of historical ashlar masonry but can be applied to other types of investigation, archaeological or else, the measures are taken directly on each individual stone in its built context. A previous analysis of the building, conducted by an archaeologist, is necessary to define the characteristics of the construction, its relative chronology, and the properties of all the measured architectural entities.
Retrieving architectural information (for example the intrados radius of an arch) is the approach we have developed in architectural surveying. We are currently working on this issue in the stone-by-stone surveying process on which this paper focuses.
The photogrammetric approach is developed with ARPENTEUR, a web application for digital photogrammetry mainly dedicated to architecture (Architectural PhotogrammEtry Network Tool for EdUcation and Research) available at http://www.arpenteur.net. ARPENTEUR has been developed by two complementary research teams: the "Photogrammetry and Geomatics" group of ENSAIS-LERGEC's laboratory (Strasbourg, France) and the Gamsau-MAP CNRS laboratory located in the school of Architecture of Marseilles (France).
The survey process is made by a non-photogrammetrist operator using the I-MAGE method (Image processing and Measure Assisted by GEometrical primitive) which allows the operator to achieve the main part of the 3D survey considering one single picture.

1. PRESENTATION

1.1 ARPENTEUR

ARPENTEUR (for ARchitectural PhotogrammEtry Network Tool for EdUcation and Research) is a set of software tools available on the web and dedicated to architectural survey. It has the benefit of the two partner laboratories' expertise in the field of close range photogrammetry and architectural knowledge representation in a survey process. This collaboration is enriching for both researchers and students working on the project. (DRAP and GRUSSENMEYER, 1998)
Some samples can be seen on our web server
http://www.arpenteur.net

1.1.1 ARPENTEUR: a presentation

The main **axis** of the project are:

- As a software dedicated to education and research the JAVA development language provides tool and technology which allow different teams located in different sites to work easily together, sharing processes and data.
- As a tool dedicated to architecture and archaeology, ARPENTEUR has the benefit of the two partner laboratories' expertise in the field of close range photogrammetry and architectural knowledge representation in a survey process.
- As a photogrammetrical tool, ARPENTEUR is a simple photogrammetric software. By simple we means the facility of use and an access to non-specialist in the field of photogrammetry. On an other hand, ARPENTEUR does not require any elaborate hardware, a simple computer equipped with a standard web browser are sufficient.

The integration of these tools and aims in a same set is guided by certain conceptual and technical choices.
The first choice is the digital aspect of the software. The use of digital images through Internet allows to develop tools which enable to automatise traditional steps in photogrammetry which usually need a human operator. Finally, digital images make possible a complete integration of the production line from the taking of the picture to its three-dimensional visualization with CAD tools.

This integration of digital images in the photogrammetric process is part of another choice, this conceptual one. We aim at a photogrammetric process monitored by a formalization of architectural and geometrical knowledge.
During the survey we wish to optimize the plotting phase by using archeological knowledge in order to reduce the operator's task.
The architectural corpus must be first identified and structured: a phase intricately linked to the archaeological study of the edifice. The architectural knowledge of the building is then used to guide and control the measuring process. This implies that the morphology of the measured object is already known. This knowledge is provided by previous analysis of the measured structure, e.g. by the archaeological survey of an historical building. Building elements are described as "entities" (elementary item) providing that they meet two requirements:

- An entity is an architectural unit, or unique "object" identified by a specific element of the architectural vocabulary, such as those defined here above.
- An entity has an obvious and permanent role in the physical structure of the building: e.g. a buttress, a pillar, an arch, or a vault.

The object-oriented programming approach enables to gather generic entities into hierarchies of elements sharing properties or common behaviors or attributes, each property added giving birth to a new, more specialized (lower in the hierarchy), generic element. This concept permits to introduce the individual block as part of an entity, and to define this entity as being composed of a certain number of blocks that are assembled according to a more or less precise concept, such as cuneiform voussoirs in a round arch, or the headers and stretchers of an angle.
In other words: by adding architectural entities, the system is able to manipulate other concepts present in the corpus of architectural knowledge used to describe the building, as ashlar blocks or topological relationship between architectural elements.

1.1.2 A photogrammetric survey through Internet

The ARPENTEUR photogrammetric approach is based on well known routines (KRAUS, 1997). The standard steps are developed: internal, relative and absolute orientation and since the version 1.4.2 a bundle bloc adjustment is available. ARPENTEUR is developed in JAVA, using actually JDK 1.3 and the image library JAI 1.02; it is operational on any hardware platform supporting a web browser using this level of Java. Presently the software tested with Netscape ™ has been Communicator 4.7 on PC platforms and SUN workstations.
The ARPENTEUR software is client-server oriented and provides a way to transfer architectural measured objects on the server witch is able to generate report files and 3D CAD model survey interpretation. These generated files are available on the server throught a FTP transfer.

1.1.3 The I-MAGE process

ARPENTEUR is a web tool for architectural photogrammetry. We plan to offer a convenient photogrammetric tool which can be used by archaeologists and architects. (DRAP and GRUSSENMEYER 2000).
If we consider that the photogrammetric orientation phase is still in charge of the photogrammetrist who validates at least the final results, the most problematic phase is the homologous point determination. Normally, with ARPENTEUR, we use a correlation process to help the operator in this task: a precise measure is made on one photograph and a strictly homologous point is computed after an approximate measure on the other photograph.
I-MAGE (Image processing and Measure Assisted by GEometrical primitive) is a new measuring method of digitizing 3D points which is based on the coupling of image correlation and geometric primitives as planes, cylinders, cone and sphere shapes of the object.
We have developed the I-MAGE process as a device to assist the plotting phase: this method allows the operator to make stereo measurements using only one photograph. The homologous point is determined by the system using both image orientation and a geometrical primitive computed on a set of already measured 3D points this means that for a computed primitive, it is possible to compute and measure by correlation its homologous in other images from one measure on one image.
In most cases monitoring the survey by underlying geometrical models stemming from architectural knowledge is very appropriate. The formalisation of architectural knowledge includes a morphological aspect which uses geometrical primitives for description (planes, cylinders and spheres).

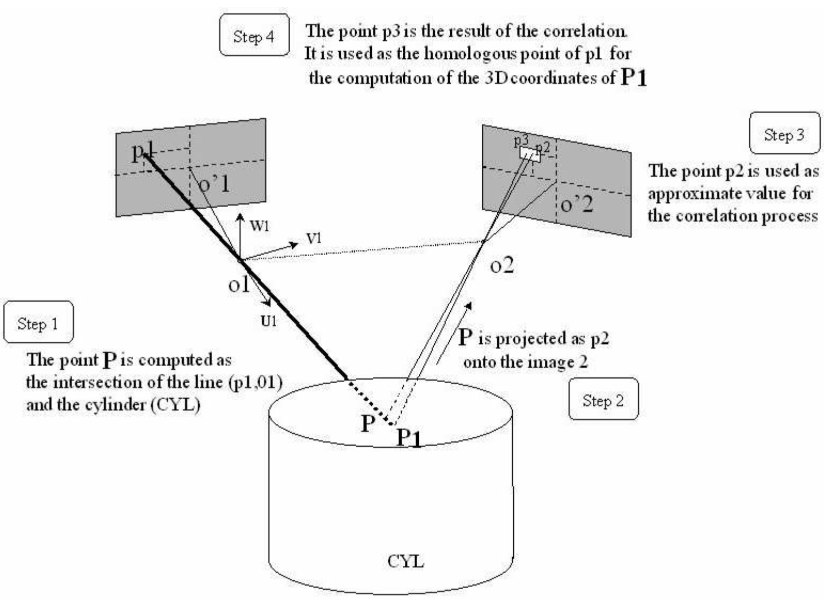

Figure 1. *Steps of the I-MAGE process in ARPENTEUR.*

We consider four steps (Figure 1) in the I-MAGE method, considering that a geometric primitive has been measured from a set of 3D points visible on a couple of images:

- A point P can be computed from one image by the intersection of an image ray (p_1, o_1) and the geometric primitive (the cylinder in figure 1 is defined by 7 parameters in an earlier process from a set of 3D points);
- P is projected as p_2 onto the second image;
- The point p_2 is used as approximate position to initiate the area based correlation process;
- The point p_3 is the result of the correlation; p_1 and its homologous p_3 are used for the computation of the 3D co-ordinates of p_1.

The final co-ordinates of p_1 can be

compared with P (computed in step 1 depending on the parameters of the primitive) and to the definition of the primitive. The example presented in figures 2 and 3 is applied to the round arch opening on the north side of the nave approximated by a cylinder:

- the cylinder is defined by its seven parameters from a set of 3D points;
- digit: a digitised point is defined by its co-ordinates given in pixels (in one image, left or right one);
- results: the 3D point (step 1), the pixel co-ordinates of p_2 in the other image (image computed) and p_3 (correlation)
- residuals: discrepancy distance between p_1 and P on the one hand, p_1 and the primitive on the other hand.

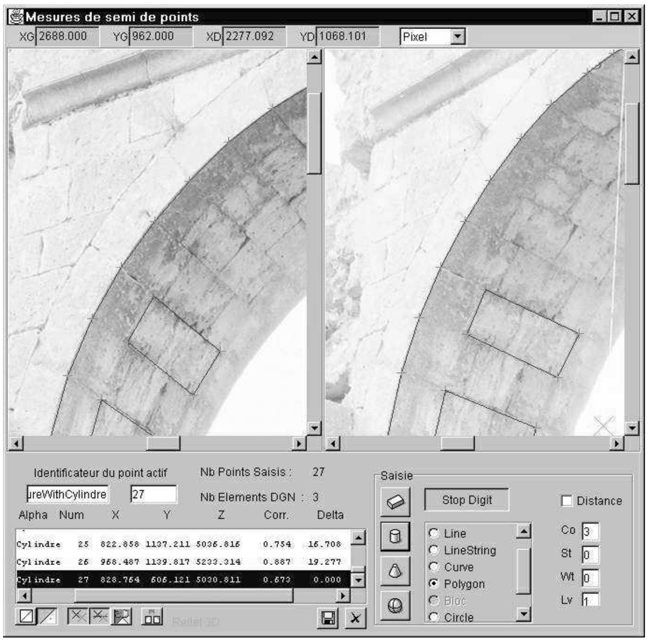

Figure 2. *I-MAGE process applied to a cylinder shape.*

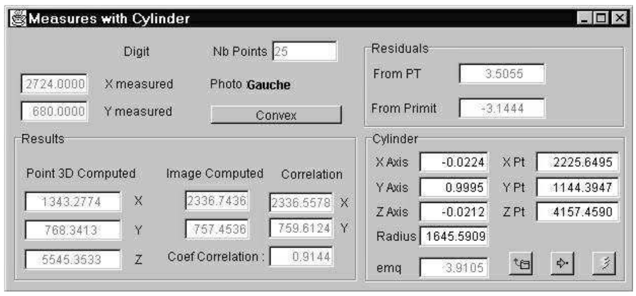

Figure 3. *User interface of the processing module related to the Semi-automated Primitive Measurement Method.*

The I-MAGE method is a useful tool for fast object-modeling. The method is interactive since the operator follows and analyses the result of the adjustment directly on the images. More geometric primitives could be added in the process and applied to other applications as industrial ones. The restitution of Notre-Dame d'Aleyrac was done by a student in archaeology during a stage in the MAP-GAMSAU laboratory.

1.2 THE SURVEY OF NOTRE-DAME D'ALEYRAC

Aleyrac, erected about the last third of the 12th century, is a typical case of the type of edifice and construction which can be analysed through the ARPENTEUR process. Its two-shell-masonry has an excellent ashlar facing assembled practically without any joint. As large parts of the exterior facing have been removed, the infilling is stripped bare on two sides of the church, and can thus be analyzed. Instead of the usual rubble infilling the inner part of the walls consists of more or less irregular blocks of the same size and the same height as the cut stones of the facing, and assembled with the same courses (HARTMANN-VIRNICH 1996). The form and size of the hidden part of the ashlar blocs can thus be analyzed as well as the relationship with the interior structure of the wall or the vaults. The process results in the definition of an approximate depth for each type of stone, according to the archaeological evidence. It is thus possible to restrict the survey to the block's visible part alone, the only aspect of a masonry that can normally be measured and studied. An extrusion vector is computed in order to inform missing geometrical description of the individual stone.

Once the instanced block is measured a polyhedron representation of its morphology is generated. The instance is also added to a data structure in which it is positioned according to topological or geometrical order. The result is therefore an organised group of blocks, which implies, for instance, for each block data on its neighbours (adjacent blocks). The definition of such groups relies upon the architectural and archaeological analysis of the edifice and its structural components: pillars, buttresses, walls between these vertical elements, jambs, arches, blind arches, vaults, transverse arches, and more. The morphology of the building is interpreted as an arborized hierarchy of major and minor architectural, structural and functional units, which are themselves composed of their individual entities, the ashlar blocks (header, strecher, impost, voussoir, keystone, mouldings…). Naturally, these categories must correspond as exactly as possible to the structural concept of the edifice. In later Romanesque Provençal church building, this concept is particularly obvious, especially in the extremely sober and austere forms inspired by the Cistercian style, as in the case of the priory church of Aleyrac. At Aleyrac, this clear architectural concept implies also the choice of distinctive types of stone material.

When completed, the tool will create a direct link between the architectural object and the database, enabling to locate and thus identify the properties of each block registered in the database. The possibilities of this new type of approach to architecture extend from archaeology to restoration and maintenance to any type of structure treated by photogrammetrical survey.

1.3 TWO DIFFERENT POINT OF VIEW

> *Marco Polo describes a bridge, stone by stone.*
> *"But which is the stone that supports the bridge?" Kublai Khan asks.*
> *"The bridge is not supported by one stone or another," Marco answers, "but by the line of the arch that they form."*
> *Kublai Khan remains silent, reflecting. Then he adds:*
> *"Why do you speak to me of the stones? It is only the arch that matters to me."*
> *Polo answers: "Without stones there is no arch."*
>
> Italo Calvino (CALVINO 1993)

Our approach uses two different points of view on the architectural element to be measured: we consider an architectural entity (for example a wall or an arch) as a structural element with its own function in the building and also as a set of different ashlar blocks. The goal is to obtain a complete geometrical description of both the architectural entity and the set of ashlar blocks using a partial measurement of the stone and the information, for each stone, of the architectural entity owner.

The morphology of each ashlar block is here considered as a polyhedron with two parallel sides, or faces. In most of the cases only one side is visible, sometimes two, rarely three. The survey process can inform about the dimensions of one face, then the entire polyhedron is computed according to the architectural entity's morphology (extrude vector) and the data provided by the archaeologist (depth, shape …).

Computing an extrude vector can be easy in the case where the architectural entity morphology is obvious; during a wall survey for example an extrude vector can be computed by a minor square adjustment of a plane around the survey zone. In this case where the entity geometrical properties are simple, the extrude vector is calculated before the survey phase and the block is extruded directly from the measured points. In the case of a round arch the extrude action should be radial and needs the geometrical features of the entity (intrados, radius, axis).

Computing the extrude vector: the archaeological approach

In this case a post process computation is necessary to elaborate the main architectural entity features from the ashlar block's measures. In order to achieve to obtain the morphology of the whole block it is often necessary to compute the architectural entity's features. This can be done by specifying for each type of entity the relevant mathematical operation and the way to extract relevant points from the measured ashlar blocks. This process requires a relevant theoretical concept of the entity's hidden parts, as defined through archaeological evidence or, if an analysis of these parts is impossible, through a typology based on comparison with relevant examples. In the case of the ashlar facing, computing the entire block requires knowledge about the way the blocks penetrate into the rubble and mortar infilling. In the more complex case of major entities formed by a group of blocks, an architectural analysis is required to relate the actual form to its theoretical concept used by the builder: e.g. a round arch is defined or not as a hemicycle; the curve begins either directly at impost level, or it is separated from the impost by an intermediate springer. In certain cases, an arch may seem strongly deformed because its original shape differed from the perfect round arch: segmented, stilted, pointed, horseshoe..., or the joints of the voussoirs are not radial, or do not converge towards the same centerpoint. Thus, a thorough archaeological and comparative analysis is necessary to define the possible architectural forms that can be admitted for a specific type of building in a specific region at a specific period.

2. THE CASE STUDY: "LA PRIORALE NOTRE-DAME D'ALEYRAC"

Our case study dedicated to the Romanesque priory church Notre-Dame d'Aleyrac is based on a recent study of the co-author of this paper (HARTMANN-VIRNICH 1996). As we specified above, the semi-ruinous state of the edifice gives an insight into the internal structure of the extremely refined two-shell ashlar masonry, a feature characteristic of the late 12th century in southern France, and offers an excellent opportunity for the development of relevant extrude vectors for an ARPENTEUR survey. The Romanesque builders of Aleyrac had obviously a good empirical knowledge of the mechanical properties of their building material, as they used deliberately different types of stone for different functional entities, such as cornerstones, arches and windows, or vaults. The vault of the polygonal main apse alone is made of three different sorts of limestone: two slightly different types of the usual molasse for the opening arch and the lower third of the vault, against tufa for the two upper thirds, reinforced at the angles by limestone voussoirs which extend beyond the extrados of the tufa shell into the rubble filling under the stone roofing. This constructional feature tends to prove that the criteria defining different types of ashlar material as ordinary blocks, cornerstones, voussoirs, are relevant, and can be used consistently for an ARPENTEUR survey.

The stone-by-stone analysis of a medieval building implies a great number of interesting aspects, essential for the knowledge of the building process and chronology, the technical standards and skills of the builders, the mechanical properties of the edifice (deformations) as well as the economy and the history of its development. The dimensions, the finish of the stones (e.g. the precision of angles and sides, tool marks, mason marks etc.), the geological properties of the distinctive materials, the continuity or discontinuity of the courses, are irreplaceable clues (HARTMANN-VIRNICH 1998, 1999). A virtual stone-by stone survey is of great interest, especially if it allows to visualize relevant information for each constructional unit.

The selected part of the building is the north transept. The study focused on the round arch opening on the north side of the nave. The sample is of particular interest as it can be easily defined as a coherent unit composed by similar elements, the voussoirs, which share the same properties: each voussoir course is assembled with three or four blocks, two of which have visible front sides. Ideally, they all share the same intrados and extrados, i.e. the curved inner and outer sides, and their joints converge towards one same central axe parallel to the intrados and extrados. On the other hand, their thickness and depth vary. Thus the structure offers several types of relevant parameters, variable and invariable, for a test of ARPENTEUR's capacities.

Our research project originated from the dialogue between specialists of different disciplines who rarely collaborate to create new tools. The interdisciplinary exchange is at a beginning but will generate further exchange and, we hope, far-reaching results. Although ARPENTEUR is presently being developed to serve in the architectural field, its possibilities might go far beyond, the tool being adaptable to the photogrammetric survey of any type of structure composed of characterized units.

3. THE PHOTOGRAMMETRIC SURVEY

3.1 THE PHOTOGRAMMETRIC CAMPAIGN

The photogrammetric campaign was achieved in August, 1999 in Aleyrac, Drôme, France. (DRAP, GAILLARD, GRUSSENMEYER, and HARTMANN-VIRNICH, 2000). The pictures were taken with a P32 Wild camera using Agfapan 25 roll film. No control point was taken, we used plumb lines and distances to create a local reference system. Three stereo pairs have been used. The film was scanned by Kodak and the result file is 4860 x 3575 pixel in GIF format.

3.2 DEFINITION OF BLOCKS

The survey first step is a building rigorous analysis to isolate the architectural entity and the ashlar blocks types to be measured. For each entity, arch, wall, gable wall, we have to determine which type of stone has been used and how to

Figure 4. *Example of pictures used for the survey.*

measure it. We can isolate two generic cases of measurement:

- The geometry of the entity is easy to model (a wall offers the opportunity of determining a plane to extrude)
- The geometry is not obvious and the extrude method needs to be informed about any indirect results from the measurement (intrados radius and axis of an arch).

In each architectural entity there is a block manager object in charge of managing blocks. It is possible to obtain a lot of data from each single block:

- Owner: the architectural entity.
- Model: the photogrammetric model used for survey.
- Plane: the plane used to extrude (including measured points to compute the plane).
- Measured points.
- Computed points (after the extrude phase).
- Extrude depth: measured or defined by the archaeologist.
- Access to the polyhedron of morphology representation.

All these data are available from each ashlar block or from a Block-Manager object in charge of managing all the entity blocks, or also from a general Block-Manager. The Block-Manager is also in charge of ranking blocks (finding adjacent or neighbouring objects according to special criteria) and calculating statistics (on volume and dimensions).

3.3 MEASURING THE BLOCS

As often as possible we try to compute the complete geometry of a block during the survey process. The measurement can be done, and has in fact been done, by an archaeologist, the most important point at this step being not a high competence in photogrammetry (the I-MAGE process helps a photogrammetrist neophyte to determine the homologous points) (DRAP and GRUSSENMEYER 1998), but the integration of architectural knowledge into the model.

During the survey process the operator informs the system on which kind of ashlar block he is measuring, its third dimension, the architectural entity it belongs to; he chooses the points used to compute the extrude plane and decides or to use not the ‘on the fly’ extrude facilities.

The depth can be determined in two ways:

If, as generally, only one face is visible, the depth is evaluated by the archaeologist according to properties known from the monument itself. At Aleyrac, the dismantled walls give an insight into the inner structure of the masonry and the dimensions of ashlar blocks of the facing. These actually differ from course to course and from block to block, in order to create a firmer link with the stones and mortar filling the space between the two facings. In the specific case of certain cornerstones or voussoirs the third dimension can be deduced from the other apparent face or faces.

4. CALCULATION OF INTRINSIC PARAMETERS: THE CASE OF AN ARCH

In the present case the aim is to determine the geometric definition parameters of each architectural entity using both the measured blocks and the architectural knowledge (the geometrical definition of the entity morphology, structural and building knowledge).

For each architectural entity it is possible to isolate a set of relevant blocks giving some information on the geometric parameters. This approach requires three steps:

- The determination of the object bounding box and of its own reference system.
- The isolation, according to geometrical and topological data, of several sets of blocks for each geometrical parameter to be computed.
- Finally isolating points (held by the blocks) and computing by least square adjustment the geometric parameters of the entity.

As specified above, we present here the case of the north transept arch.

4.1 DETERMINATION OF THE BOUNDING BOX

A relevant bounding box corresponds approximately to the minimal volume of the object. We are working on a generic method to compute such a bounding box.

For all convex objects with a dominating direction it is possible to use an analysis of the main components, which can be used without any consideration of the object. The first problem is to determine the transformation going from the original reference system to a local reference system where one of the axis is equipollent to the object main axis. This is equivalent to looking for a maximum variance through this axis. In this new reference system it is possible to compute a bounding box by sorting coordinates which results in a good approximation of the smaller bounding box.

Unfortunately, this method does not function well if the points are inside the volume, or if the architectural volume is concave. This means that we have to get first the convex envelope before using the covariance method to obtain the bounding box. Actually we use a hybrid method, as we already have a set of relevant informations on the architectural object. These informations are collected during the survey phase by the operator according to the architectural model used.

4.2 CALCULATION OF INTRINSIC PARAMETERS

In the case of an arch we have five parameters to compute: the cylinder axis, the intrados radius, the extrados radius and the two circle centers (who should be on each top of the

cylinder axis); After the determination of the blocks, the points are easily located by geometric criteria.
Here we need to develop the architectural model: by construction, the intrados and extrados centers have to be at the same location.

4.3 EXTRUDE OF BLOCS MEASURED IN THE INTRADOS

Once we computed all the geometric arch parameters we can extrude the bloc, which has measured only by the face visible in the intrados. (internal part of the arch). This extrude is radial from the main axis of the intrados axis cylinder. Each point has its own extrude vector defined by the projection of the point onto the main axis and the point itself. Each computed stone of the arch is represented as an arc of a rectangular torus centered on the intrados main axis.

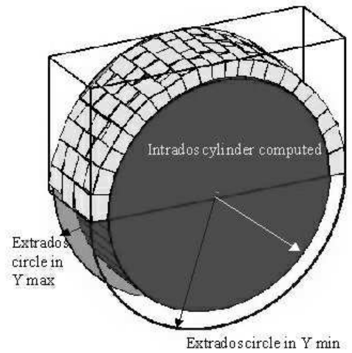

Figure 5. *Arc intrinsic parameters scheme.*

5 RESULTS: A NEW INTERPRETATION OF THE BUILDING

5.1 GEOMETRIC PRIMITIVE LEAST SQUARE OPTIMIZATION

We made two kinds of least square optimization in order to make the numerical results explicit. We present in figure 6 (on the right), the two sets of points measured on the intrados and extrados front stones. On the figure, all points at the angle are on the same stone. figure 6, on the left, shows an intrados representation of the developed cylinder. The cylinder is the least square cylinder from all the indrados measured points. On the *X* axis we have the curvilinear abscissa of each point, the *Y* component remains unchanged and *Z* is the residual distance from the optimized cylinder.
This type of approach permits to verify the exactitude of the stone cutting and the deformations undergone by the built structure. According to the architectural properties of the arch, as defined by the comparison with other arches of the building itself and other contemporary examples of the same technical quality, the arch should ideally be a precise hemicycle. The magnified irregularities (20× anamorphosis of residuals) tend to demonstrate a partly close approximation of the intrados to this theoretical curve, and confirm the high standard of the workmanship of the edifice. The comparatively slight deformations in the lower parts and at the top might be due to movements subsequent to the settling down of the masonry after the removal of the sustaining auxiliary wooden structure, and the increase of the weight of the surrounding masonry, the arch being - according to comparative archaeological evidence - normally built before.
Least square optimization can thus be helpful for the approach or the identification of an ideal form, i.e. the theoretical concept of this form. In the case of a gothic pointed arch, for instance, relevant geometrical proportions can thus be determined and compared. Applied to more complex structures, the process can help to characterize and to comprehend deformations as being related either to the more or less exact or inexact realization of a project, or to statics.

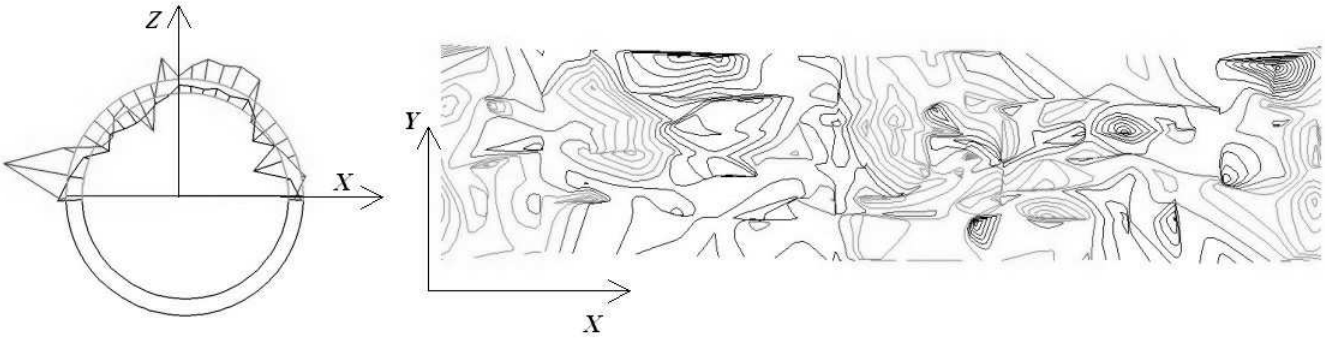

Figure 6. *Left: intrados and extrados circle least square optimization with 20x anamorphosis of residuals. Right: intrados cylinder least square optimization with 20x anamorphosis of residuals.: iso-deformation curve (each 5 cm) from the computed Cylinder. In green, outside the cylinder, in black, inside the cylinder.*

5.2 3D CAD OUTPUTS

The resulting architectural model, entities computed and measured ashlar blocs have a set a 3D writing method able to generate ASCII VRML file and binary design file for MicroStation cad software made by Bentley. We choose to generate binary design file for MicroStation instead of the widely used DXF file format because we can easily introduce non graphical data linked to the architectural element representation. It is now easy to establish a link between the architectural element and its MicroStation representation.

6. CONCLUSIONS

As regards architectural and archaeological analysis, two essential issues of ARPENTEUR have to be pointed out: the use of the tool for the direct measuring of structural elements, and the link to be established between the image and a database. This second feature is of particular interest, as it combines a representation of the architecture itself to the database serving as a tool for the analysis of its units. It

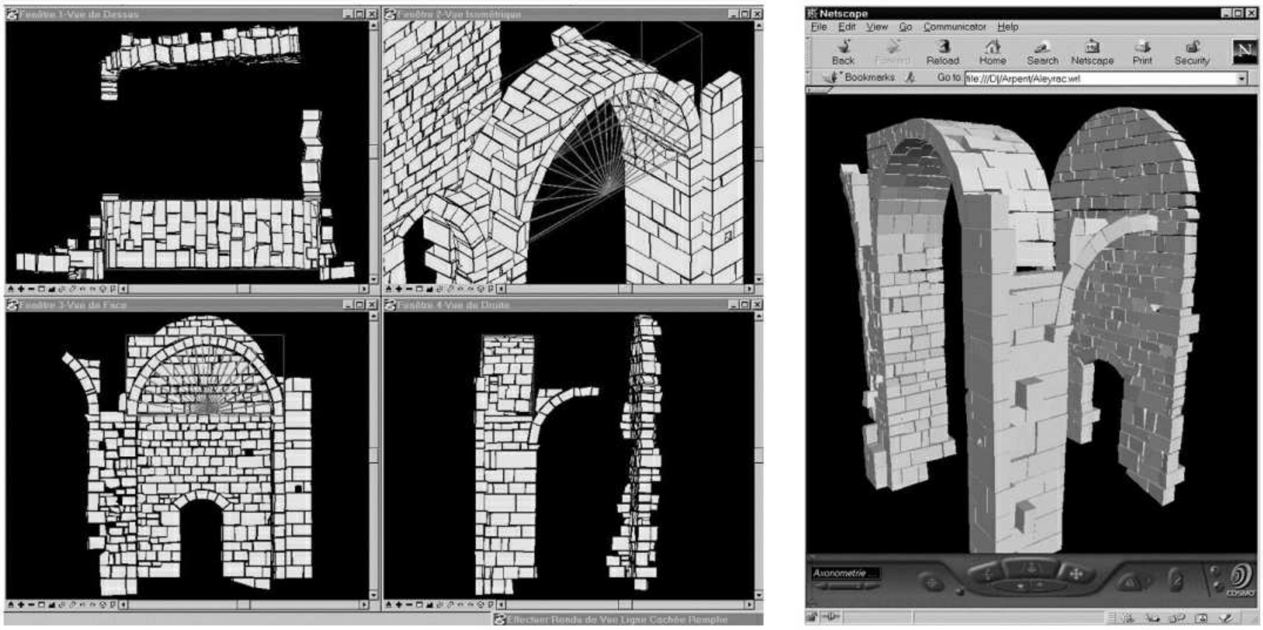

Figure 7. *Results outputs for Microstation, Bentley and* VRML *2.0.*

will in fact be most useful to locate in or through the virtual image all the blocks of one same category, as defined and registered in the database files, such as: type of block (voussoir, cornerstone, column, capital,…) or architectural unit (window, buttress, vault, bay…), type of stone, state of preservation, details of surface (mason marks…). Spotting these categories in their architectural context offers the advantage of a clear perception of relevant groups. It is easy to imagine the wide range of possible applications, far beyond the domain of architecture and restoration.

Mechanical simulation

Beyond the work presented here this approach of the link between photogrammetric survey and architectural knowledge is the first step to another project dealing with a new approach for the mechanical modeling of historical monuments built with blocks. (ACARY and *all*., 1999). The computational method, Non Smooth Contact Dynamics (NSCD), is used to simulate masonry as a large collection of bodies under unilateral constraints and frictional contact. The computational method, NSCD, within an architectural and archeological model are merged in a single tool providing a interdisciplinary approach of historical buildings where the presented work, a photogrammetrical survey monitored by an architectural and archeological knowledge, gives the building morphology and initial deformations.

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