LOW COST RECORD OF A HISTORICAL BRAZILIAN CITY ENSEMBLE BY DIGITAL PROCEDURES

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ABSTRACT

This paper presents the recent advances in developing new methodologies to catalogue Brazilian heritage sites in colonial stile. The project is a partnership program between the IPF of the University of Karlsruhe (Germany) and the LFSG of the Federal University of Santa Catarina (Brazil). Our main goal is to document and model a large amount of monuments, using low-cost digital technology introducing colored mosaics. The connection of the 3D geometric and alphanumeric database will yield the necessary technical support for the urban planning process, taking into account the role of the historical heritage, restoration and preservation of the buildings.

ZUSAMMENFASSUNG

Dieser Beitrag präsentiert die Fortschritte in der Entwicklung neuer Methoden zur Dokumentierung von brasilianischen Denkmälern im Kolonialstil. Das Projekt ist ein Gemeinschaftsprogramm zwischen dem IPF der Universität Karlsruhe (Deutschland) und dem LFSG der Universidade Federal de Santa Catarina (Brasilien). Unser Hauptziel ist eine große Anzahl von Monumenten unter Nutzung von digitalen low-cost Technologien zu modellieren und zu dokumentieren. Die Verbindung einer 3D-Geometriedatenbank mit alphanumerischen Datenbanken gibt uns die nötige technische Unterstützung zur Stadtplanung, um die historischen Denkmäler, zur Restaurierung und Erhaltung der Gebäude, miteinzubeziehen.

1. INTRODUCTION

The documentation of the Brazilian national heritage is still an open question, aggravated by the absence of any plans at the IPHAN (National Institute for the Preservation of the Historical and Artistic Heritage) that include the adoption of photogrammetric techniques; lack of knowledge of architects and engineers about such techniques and their potential use and; the fact that the government has others priorities in its budget (infra-structure, education, health) which mostly are classified as urgent. Despite of this, special attention has been given by Brazilian cartographers and photogrammetrists (mostly in the past 5 years) to the adoption of photogrammetry for the documentation of a large amount of monuments.

Since 1995, a binational partnership between the Institute for Photogrammetry and Remote Sensing (IPF) of the University of Karlsruhe and the Laboratory for Photogrammetry, Remote Sensing and Geoprocessing (LFSG) of the Federal University of Santa Catarina, in the field of architectural photogrammetry has been established. It focus the challenges of protection of historical heritage, as legitim representants of the culture and epoch.

The project deals with the great task that architects, engineers, historians and archeologists face when documenting and recording a large heritage at a low cost and with the required quality to attempt future goals of restoration, reconstruction and visualization. In Brazil this represents and amount of more than 10 000 monuments (Gomes, 1995). The research aims at the structuration of

a methodology for documenting and modelling a large amount of monuments, using low-cost technology and introducing colored mosaics in this process. These objectives are supported by technological advances in the fields of digital image processing, digital photogrammetry, geographic information systems and multimedia.

In this work we also discuss the problems we confront when developing the database concepts, acquisition and processing for a historical heritage site of more than 500 monuments.

2. BACKGROUND

Laguna, the study area, is a small city in the south of Brazil, at the Atlantic shore, founded in 1676. In 1985 the city's commercial downtown colonial stile ensemble was recognized by the IPHAN as national heritage, therefore maintained since then under special Brazilian protection laws.

The ensemble comprises circa 500 buildings whose utilization is basically residential or commercial, showing generally a reasonable state of conservation. A great progress has been registered under the leadership of the local IPHAN office. It provides, along with the city administration, qualification of the historical site so that it presents the demanded infra-structure and urban equipment that allow the maintaince of the heritage and the development of its natural touristic potential. Therefore, local authorities look for alternatives to solve, in the short term, the most urgents problems of restoration. In the long term there are programs to improve the resident's understanding of the city by seminars and meetings, as well as by visual despollution of the commercial zone, by putting underground electricity cables, and by taxs reduction for those who keep their house in a good state of conservation.

Two different governmental agencies run separated information databases, in order to manage historical and urban planning issues:

a) Municipality of Laguna: its database comprises alphanumeric and geometric data that are still displayed and managed in analog format. It stores the data collected from field survey, which are: cadastral sheet; street map and existing public services for every parcel and; the geometric database comprising the blocks maps;
b) IPHAN: its database is currently being converted to digital media and comprises architectonic characteristics and state of conservation of the buildings, as well as a database of the proprietors and photos taken by non-metric cameras.

3. THE PROBLEM

First of all, one may notice that a great difficulty comes from the fact that the databases only exist in the analog format. Therefore, they are less suited for urban planing, scenarios prediction or simulations. This difficults the use of these databases in analysis, simulations or any other procedures that demand the management or manipulation of a large amount of data in a complex manner.

The fact that these databases are maintained separately leads to redundancy and inconsistencies. A fine comparison of the databases reveals that since the buildings are surveyed twice (by the IPHAN and the Municipality of Laguna), similar informations are collected and stored also twice. When checking the data that describe an unit many inconsistencies can be identified due to different criteria adopted by the surveyor team or even because the data collection was not satisfactorily supervised.

The insufficiency of the geographic basis was another problem. The lack of experience in cartography of IPHAN's staff and its limited resources made the Institute map the historical region by conventional means (manual tape measure). The results were not reliable geometrically despite the buildings' shape were correct. Any overlay analysis or even integration with other data sources (orthophotos, municipal cadaster, topographic maps) would be impossible due to its imprecision.

These above mentioned problems diminish efficiency and reliability of the generated information; higher the costs of surveying and managing the database and; restrict the possible uses of the data (once the non-existence of a common index number for the buildings makes it not possible to cross the data in different databases). Furthermore, the higher costs turn the databank updating cycle longer, resulting in the maintaince of an out of date base

4. THE SOLUTION

The general methodology for a joint Information System is displayed in Fig. 1. It shows the results from a study of the current situation and the predicted state-of-the-art of software and hardware industries, conjointly with our low-cost documentation and recording goals and the possible uses of 2D and 3D information systems in a geotechnical cadaster as a modern planning tool.

To make it easier to understand we will explain the construction of the 2D and 3D Information Systems for three different items: components of the RDBMS, components of the 2D-GIS and components of the 3D-GIS.

4.1. Components of the RDBMS

The first step in the development of the RDBMS was to define a primary key for each parcel, so that every unit of the database could be uniquely identified. This key was also designated to be the common access key, present in both IPHAN's and Municipality's database, integrating and interchanging their data. The key included four different numbers representing: the district, sector, block, parcel and real state unit.

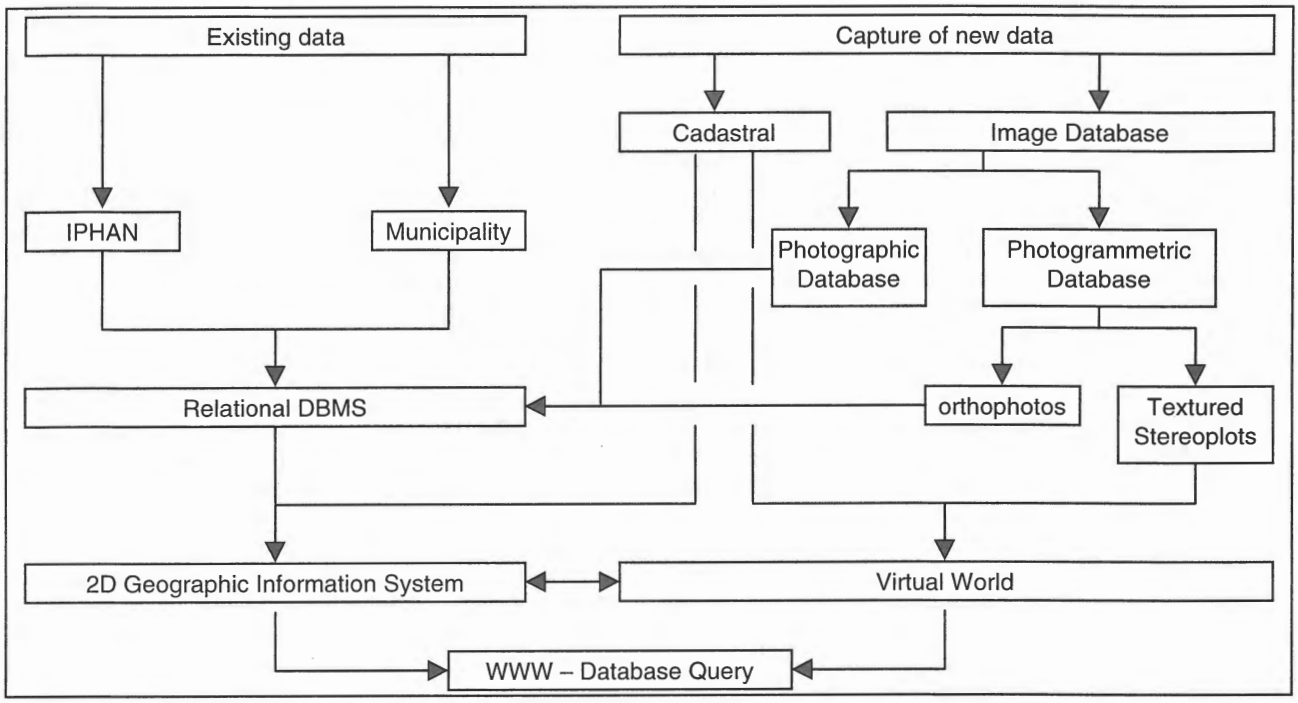

Figure 1 – Flowchart showing the construction of the 2D and 3D Information Systems.

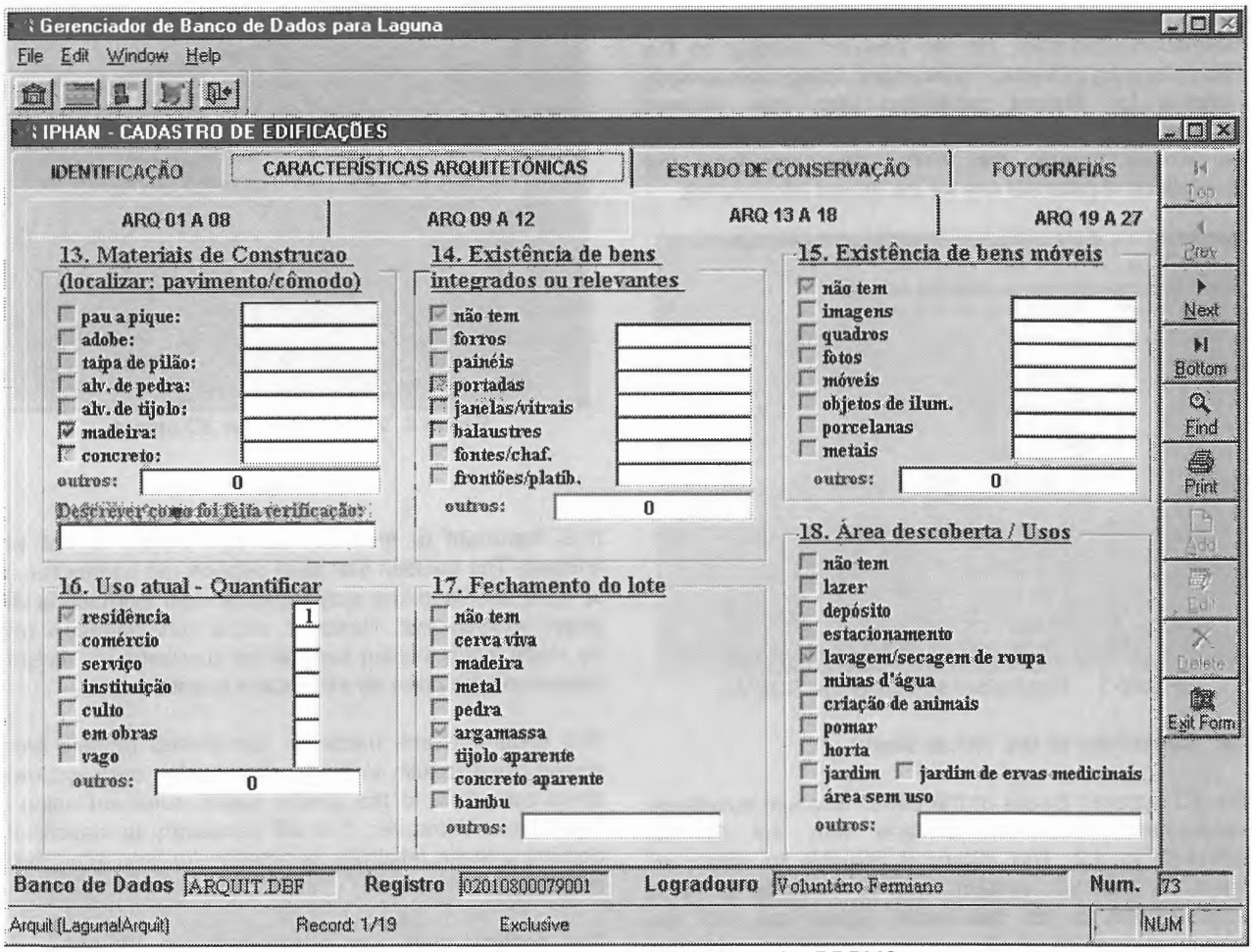

Figure 2 – IPHAN's database screen at the RDBMS

The database (prototype was developed in Visual FoxPro 5.0) consists of three main tables containing alphanumeric and geometric data, which comprises:

- Architectural Characteristics / State of Conservation / Orthophotos: description of every relevant architectural element present in the building as well as its state of conservation (Figure 2). Moreover, it is possible to visualize an orthophoto of the main façade together with some metadata (scale of source data, date of the rectification, executor, graphic scale);
- Property Cadaster: contains data maintained by the Municipality of Laguna describing the property in terms of name and address of the owner, measures, physical characteristics (soil, slope, etc);
- Street Cadaster: basically contains information about every road in the city (public services that are offered for every block in the city) and it is used in conjunction with the Real State Cadaster as a base for taxation. Moreover it also contains also the plant of every block, which can be edited directly in a CAD (Figure 3).

4.2. 2D Geographic Information System

The 2D-GIS is still under construction. Its configuration joins the RDBMS and the Cadastral Basemap, in order to make it possible to query, analyze and model the RDBMS through the this basemap. In this way the advantages of a GIS at a large scale (1:2 000) are added aiming the information production for the decision making on the urban planning process. Furthermore, using tools already available for internet publishing (Arc View Internet Explorer is, for instance, one of them) will give access to the 2D-GIS through the WWW, thus increasing the possibilities of potential use for the stored informations.

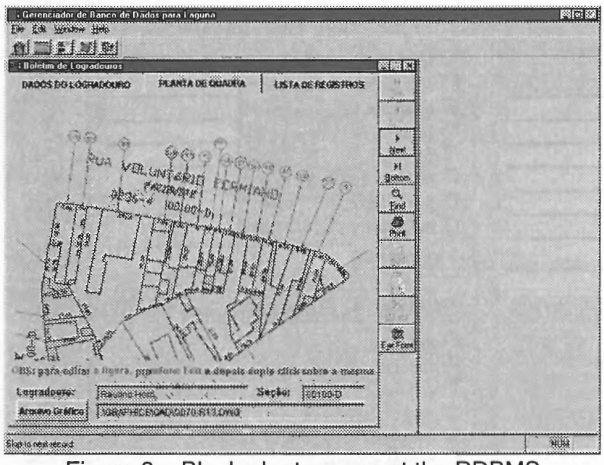

Figure 3 – Block plant screen at the RDBMS

4.3 Generation of the Virtual World

The 3D dynamic model of the city's historical downtown environment offers an interface with the 2D-GIS described in 4.2. This makes it possible to select an object in the 2D system and to observe it in a reconstruction of the real world, where not only the monument itself is feasible to be viewed but also the environment that surrounds it. Besides this, the selection of the object in the 3D scene and the visualization of its data in the 2D-GIS is possible.

The image acquisition is carried out in an A/D hybrid system. The analog photos are taken by a Pentax PAMS 645 camera and digitized by an image spatial resolution of 25.4 μm (diapositive) in a Microtek 45t film scanner. These images are then processed by the Photomodeler 3.0 software, where the spatial coordinates of the 3D model for every façade are computed. The resulting model is exported to a CAD for edition and returns to Photomodeler for the final production of the orthophotos and the 3D façade. The orthophotos are then stored in TIFF format to compose the RDBMS, while the 3D model already with its true UTM coordinates (necessary to design the different objects in a common coordinate system), is stored in VRML format.

Currently, the 3D model comprises the following objects: a DTM (retrieved from the Cadastral Basemap), the Mayor's Office, some houses and a baseplan, which contains the city block division. For the visualization the Cosmo Player 2.0 has been selected, one of the freely available Internet Browser's plugins for VRML rendering. A viewpoint of the model is displayed in Figure 4.


Figure 4. Viewpoint of the 3D model.

5. RESULTS

It is important to mention that this project is not yet finished. The solution that shall support the connection of all components in one single graphic user interface is still under development. However, some considerations can be made when looking back at the problems we already solved and the ones we still expect to encounter.

The measurements made on the plotted models have shown good results in terms of precision and accuracy when compared to the control points surveyed using a total station. However, it is still necessary to statistically determine these reliability parameters for both orthophoto and 3D plot.

The analysis and comparison between IPHAN's and Municipality's database proved the problems we pointed

out at item 3. A lot of redundancies and inconsistencies were detected when checking and inputting the data into the RDBMS. The consequence was a lot of time applied to alphanumeric data acquisition and field surveys.

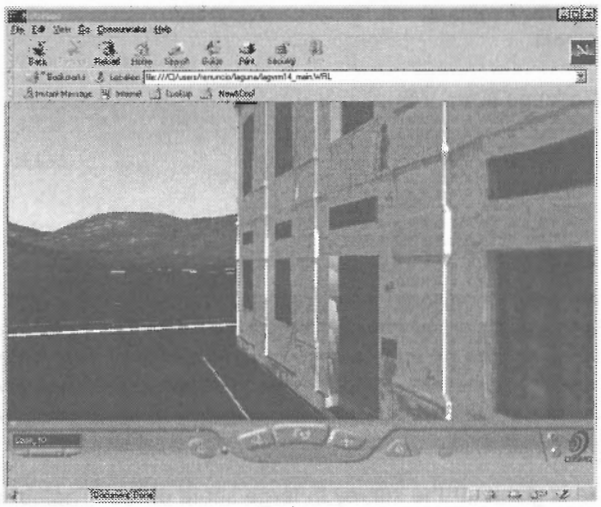

Figure 5 – Through columns, doors and windows in the image it is possible to notice details not only in the façade plan, but also in the depth direction.

When more than one photo in the orthophoto or 3D model is required then a problem remains. For example, the display of seamlines still requires the development of an algorithm that can adjust intensity, hue and saturation in such a way that the photos - acquired under different geometric and illumination conditions - look the same in terms of their brightness and contrast.

6. CONCLUSIONS AND PERSPECTIVES

The use of internet publishing tools and well-known exchange formats (VRML, DXF, HTML, ODBC, JAVA) enables the query of the databases not only from those government organizations in charge of keeping and managing them. Inhabitants of Laguna and all over the world, with the most different interests can consult the data:

- Tourists can visualize a virtual model of the city. They can appreciate monuments, and also determine which would be the best hotels in function of their surrounds and get additional information or even book them;
- Citizens can check their situation in the municipality's database and keep the IPHAN's database update, simply e-mailing the Institute if any change in the house needs to be made (repair, repaint, ...);
- A scenario prediction or simulation can be performed by any architect or engineer who acquires the city's 3D-model, so that it is possible to insert his new project in the context of its real location, verifying issues as, for instance, shadows and maintaince/conflict with the existing stile. The insertion of new buildings and the restoration of old façades is a critical issue in historical sites.

The system concept was recently presented to the IPHAN and Municipality that agreed to collaborate with the project. It is in our future plans to install the system in the Municipality's Administrative building, so that the database and interface development will also consider the feedback of the user.

During the realization of the common work, the interchange of researchers from both countries has been promoted focusing education, training, development of doctor studies and professional renovation. In course of the visits of the German scientist to Brazil, not only the Brazilian team at the LFSG, but also the students of the master's course in Civil Engineering had the opportunity to attend courses about Architectural Photogrammetry, Coordinate Systems in Photogrammetry, Data Acquisition using Photogrammetry Approaches and Introduction to PhotoModeler. The visit of the Brazilian partners to Germany offers them the opportunity for professional update and the chance to take part in the international congresses in the fields of Photogrammetry and Remote Sensing that were happening in Europe (ISPRS/96, *Geodaten-Management*/97). Brazilian students are doing their doctor studies (sandwich grants) in Germany too, which gives them the possibility to apply European experience in a Brazilian environment. These activities improved the global effectiveness and efficiency of the program.

7. REFERENCES

Ackermann, F., 1996. Digital Photogrammetry: challenge and potential. Photogrammetric Engineering & Remote Sensing. (62) 6, p. 679.

Carbonell, M., 1989. Architectural Photogrammetry. In: Non-Topographic Photogrammetry. 2nd ed., pp. 321-346.

Gomes, C. J. M. et alii., 1995. Anteprojeto do Cadastro Fotogrametrico de Monumentos Historicos do Brasil. In: XVII Congresso Brasileiro de Cartografia. Salvador, pp. 245-257.

Heinz, D., 1995. Untersuchungen zum Herstellen von farbigen Photoplänen auf digitalem Wege. Diplomarbeit. Institute for Photogrammetry and Remote Sensing, University of Karlsruhe, 86p.

Landes, S, Bähr, H. P. & Ringle, K., 1996. Architectural Photogrammetry and Picture Processing for Acquisition and Documentation of a Brazilian Town Ensemble. International Archives of Photogrammetry and Remote Sensing, Vien, Vol. XVIII, Part B5.

Mcglone, C. *et alli.*, 1989. Analytic Data-Reductin Schemes in Non-Topographic Photogrammetry. In: Non-Topographic Photogrammetry. 2nd ed., pp. 37-55.

Mcglone, C., 1996. Sensor Modeling in Image Registration. In: Digital Photogrammetry: na addendum to the Manual of Photogrammetry. Edited by Cliff Greeve, pp. 115-129.

Waldhäusl, P., 1992. Defining the Future of Architectural Photogrammetry - In: International Archives for Photogrammetry and Remote Sensing. Washington, Vol. XVII Part B5, pp. 767-770.