MURAL PAINTING DIGITAL SURVEYS

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ABSTRACT

The method presented in this paper answers the following question related to the documentation of mural painting conservation: how can information technology be applied in order to achieve ease of symbolizing and updating, better accuracy, flexible presentation, ease of integration and cross-link with other data? Furthermore, another important issue: are all these possible at a low cost?

1. GRAPHIC DOCUMENTATION IN MURAL PAINTING CONSERVATION

Often, during the wall painting conservation process, the mural painting conservator acts just like a geographer or, at least as a surveyor. The conservator has to know in detail how the original wall painting was achieved and what kinds of treatments were applied in the past, if any. Also, she/he must determine the current state of conservation as accurate as possible, including all types of deterioration encountered, and, at the same time, make all possible correlation with other information: chemical analyses, humidity measurements, operational tests and so on. All these data must be mapped "on the wall" (e.g. exfoliated regions, humidity maps, salted areas) in order to ensure the best conservation decision and, of course, to facilitate conservation works in the future, over the years.

Therefore, "where the restoration of a mural painting is concerned, the purpose of documentation is to provide a detailed report of the results of examination, the methods used and the conservation treatment. This must be prepared as clearly and completely as possible for the benefit of interested specialists." (Mora et. al., 1984, p.25)

Generally, the mural painting documentation includes historical research, preliminary inspection and diagnosis, documentary survey. The latter consists of graphic documentation, photographic and video recording, written report (Cavezzali, 1994).

Graphic documentation plays an important role in mural painting documentation because it represents the best way of providing a clear and systematic overview of the mural painting conservation works. It includes metric-dimensional survey of the structure, metric-dimensional survey of the painting, graphic base, thematic diagrams, symbology and glossary (Cavezzali, 1994).

It is worth mentioning that, in most cases, geometric accuracy is not a critical problem. Usually, centimetric accuracy is satisfactory. This is because both the deteriorated areas and the conservation treatments are usually localized and reported relatively to the graphic features of the mural painting (graphic basis). The reporting of the deteriorated areas is based on conservator's examination and interpretation. Of course, this process is subjective and the conservator's responsibility is high. Hopefully, the future technological progress might offer appropriate sensors which will provide relevant data for assisting the conservator in this type of work. Actually, "non-destructive testing" (e.g. IR and UV based techniques) is a current research topic in the conservation of the works of art. Anyway, the use of the image processing techniques, which are currently used for remotely sensed data interpretation and classification, would be valuable.

Nevertheless, there are cases when geometric accuracy is very important. In this context, photogrammetric techniques are required: "The application of this technique (i.e. photogrammetry) to mural paintings will prove to be valuable whenever a highly accurate record is required, for instance, to verify the possible movements in a building, or to determine the precise state to be re-established after the transfer of a painting" (Mora et. al., 1984, p.28)

2. INITIAL GOALS

From the beginning, the main operational purpose of the proposed method was to reduce the conservator's effort dedicated to the mural painting graphic documentation.

In the following, the most important issues the authors took initially into account and the reasons behind them are presented.

First, ease of symbolizing and symbol manipulation were required. The conservators perform a lot of work in symbolizing the deterioration and the treatments. This is especially true for areas that have to be reported with raster symbols (e.g. dots, hachures). Moreover, in traditional hand-made surveys, once a specified pattern symbol has been chosen, it is very difficult to change it because this practically means to make a new survey. The same is true when corrections are needed for larger areas which are raster symbolized.

Second, avoiding the subjectiveness of traditional hand-made "graphic basis", which consists of a line drawing interpretation, was another important issue. The authors' purpose was to create a graphic reference basis which must stand also for an objective support for thematic recording (deterioration and treatments) ensuring, at the same time, a better accuracy of the survey. Such a graphic reference basis will also be used within future conservation works, enabling ease of change detection and considerable reduction of the conservator's effort.

Third: better accuracy in locating and describing the deterioration and conservation treatments. This issue is one of the most important in graphic documentation of mural paintings and would be extremely valuable for conservation works over

the years to come: better accuracy in thematic recording will ensure better conservation decisions.

Fourth: graphic documentation display at various (convenient) scales was required. Additionally, the specific symbols the conservator chooses to use must be scaled altogether with the graphic reference basis and all the other thematic records.

Fifth issue consists in the need for flexible overlay capabilities between the graphic reference basis and various – ideally, any - combinations of thematic components. The overlay process must not imply additional effort in re-creating the graphic reference basis as it does in the traditional approach.

Sixth: the method must be used easily by a conservator and should not imply any special computer professional skills. In other words, the conservator must be allowed to focus on the specific conservation activities and not on sophisticated computerized tools.

Last but not least, the cost issue: the method must induce a cost comparable to the traditional approach. Ideally, off the shelf software and hardware have to be used.

3. MURAL PAINTING DIGITAL SURVEYS

The proposed method, called mural painting digital surveys, consists mainly in applying the GIS (Geographical Information Systems) technology to the specific problems of mural painting documentation. GIS technology was chosen because it naturally offers heterogeneous spatial data processing. Indeed, the main three types of software functionality required by the authors' initial goals (i.e. image rectification, digitizing and descriptive data processing) are currently implemented in various commercially available GIS software. At the same time, this technology ensures ease of integration with other classes of software, which are relevant and useful in cultural heritage: digital photogrammetric systems, image processing, computer aided design (CAD), desktop publishing, relational database management systems (RDBMS).

Mural painting digital surveys consist of three components: graphic reference basis, thematic component and descriptive component. In the following, these components and the way they are achieved are presented.

The graphic reference basis is a rectified digital image. The input digital images may be scanned photograps or digital images captured with a digital camera. Although the "3-3 - Rules" (Waldhaeusl and Ogleby, 1994) referred originally to the reconstruction of 3-D objects and scenes, their application is useful and strongly recommended, taking into account, at the same time, the specific conditions and requirements of the mural painting conservation problems. The rectification is carried out using digital techniques, by means of specific software functionality. The image is geometrically rectified in the wall-based coordinate system. In this way, the conservator is enabled to make reports and measurements at the scale 1:1. Whenever possible and appropriate, several subsequent operations may be applied to the rectified image such as: edge detection, contrast stretching, thematic classification. Image acquisition, image conversion in digital format and digital image rectification may be also performed by specialized personnel under the coordination of the mural painting conservator. Creation of graphic reference basis does not exclude the use of more accurate photogrammetric techniques whenever required.

The thematic component consists of point, line and polygon features reporting the deterioration areas and the conservation treatments. These elements may be introduced interactively through on screen digitizing over the rectified image as background – a common GIS function. Usually, the creation of this component is the conservator's task. The use of automated techniques for assisting the conservator during this process is recommended, whenever possible and appropriate.

The descriptive component includes mainly specific attribute (tabular) data relevant to the mural painting conservation but may also include any other type of digital information, which naturally refer the mural painting conservation process. For instance, specific attributes attached to polygonal zones may be: area, type of deterioration, type of conservation treatment, and so on. In the case of linear thematic components, for example fissures, one can include length and type of fissure as attributes. For point components, such as injection points, the type of substance injected and the corresponding injected quantities may stand for attributes. It is important to remark that the method does not impose restrictions either to the number of attributes or to their type. Thus, various kinds of photographic and video data, for example general views of the monument and macro-photographs, may be also considered as attribute data. Moreover, relevant documents converted in digital format (e.g. scanned documents), text files (e.g. written reports, historical studies, conservation methodology, technique of execution, treatment information, state of conservation, description of conservation problems, previous investigations), meteorological and soil information, laboratory tests may be attached as attribute data too.

Therefore, the method results in a spatial database that integrates image, thematic (graphic) and descriptive information. It is important to note that integration of these heterogeneous data is naturally ensured by the use of GIS technology.

Originally, the method was designed for solving the graphic documentation problems but its application into practice revealed another important characteristic: the created spatial database structures systematically all the information related to the conservation process. Thus, the method can be naturally extended in order to include the entire mural painting documentation.

4. APPLICATION: MONASTERY OF BISTRITA (BOLNITA)

The Monastery of Bistrita (Bolnita) is one of the most important mural painting monument in te southern part of Romania. The mural painting was achieved in Byzantine "afresco" style and dates back to 16th century (altar, narthex) and 18th century (exonarthex). This unique jewel represents the only mural painting monument completely preserved in its original form in this part of the country over the centuries. The conservation problems are generated by the severe deterioration (exfoliation, salts) and, in many areas, by the imminent danger of loosing the pictorial layer. An emergency conservation project was required. Therefore, a limited amount of time was available. The conservator adopted a scene-oriented acquisition approach, whenever possible.

The emergency mural painting conservation project for the Monastery of Bistrita (Bolnita) was approved by the National Commission of Historic Monuments within the Ministry of Culture of Romania.

4.1. Graphic reference basis

Within the image acquisition phase, some control information was prepared in order to ensure the subsequent rectification. In this respect, two scale-bars were used and several distance measurements were performed between identifiable locations of the mural painting. The shots were taken using approximately the same distance and homogeneous illumination. A CANON SFTb camera was used.

The graphic reference basis (Figure 1) was created having scanned photographs as input. The scanning resolution was fixed at 400 dpi, according to the required centimetric accuracy.

For rectification purpose, the coordinate system was chosen such that mosaics and collages should be possible. Thus, for each chamber an appropriate coordinate system was established. Therefore, the entire church was naturally decomposed in altar, narthex, exonarthex and exterior.

Due to the emergency character of the project, the conservator decided that image rectification should be performed exclusively for those areas where typical deterioration phenomena are encountered. For all the other areas, a general outline of the walls was digitized.

Figure 1. Scanned photograph (left) and geometrically rectified image (right)

4.2. Thematic component

The thematic component (Figure 2) was introduced via on screen digitizing having rectified images or general outline of the walls as background. This component describes the geometry of the conservation status, each theme corresponding to a mural painting deterioration phenomenon. The thematic component was carried out by the conservator exclusively.

4.3. Descriptive component

Descriptive (tabular) attribute data were attached to several themes presenting the conservation status. This will be further completed during the work-site conservation activity and final documentation phases. The attribute data were useful whenever thematic data were displayed because they provided a simple and natural way of categorizing and symbolizing.

It is important to note that both area and perimeter of polygonal regions and length of line features were automatically computed and stored as attributes.

Also, several scanned images were incorporated as detailed descriptive information attached to particular mural painting areas.

A 3-D simulation related to the mural painting from the vault of exonartex was performed and its results were attached as descriptive information too.

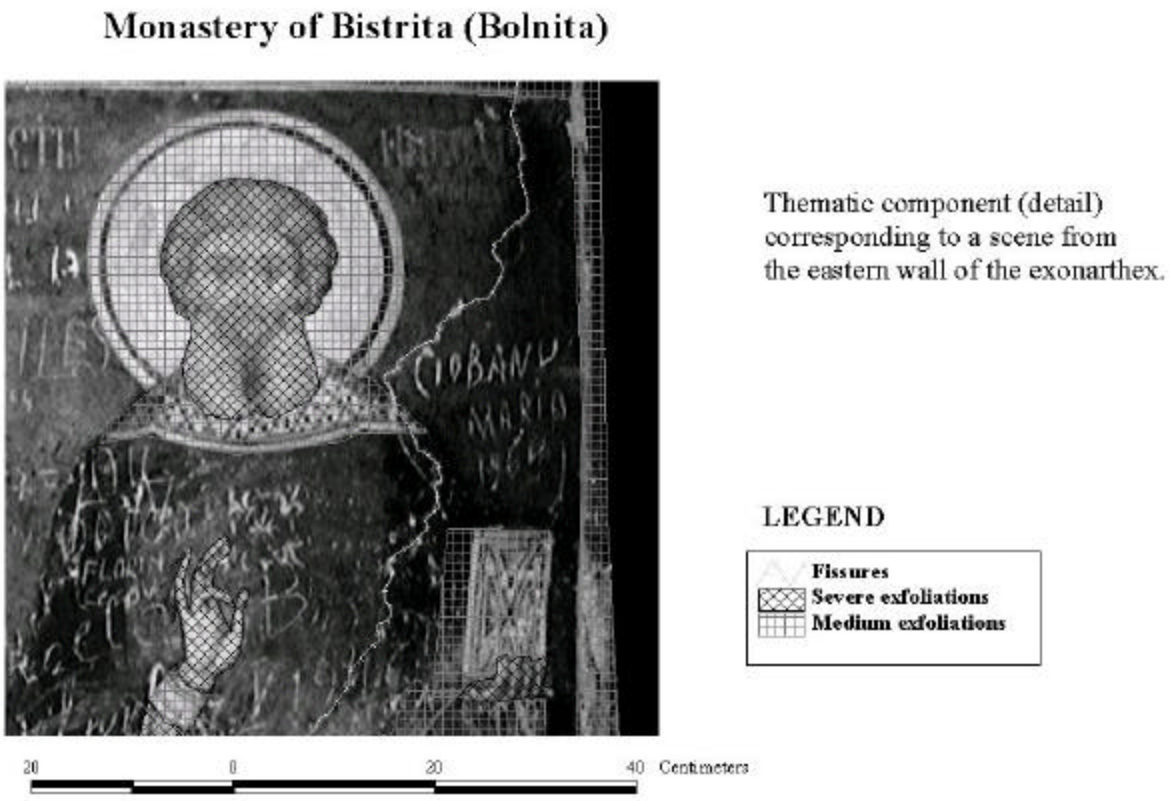

Figure 2. Thematic component overlayed to the graphic reference basis (detail)

4.4. Hardware and software

A common PC computer platform was used: Pentium II 366 MHz, 64 MB RAM, 6 GB HDD, Windows NT 4.0. Scanning was performed using an EPSON GT-6500 scanner. Additionally, a HP DeskJet 870 Cxi printer was used.

The GIS software used consisted of ESRI's ArcView GIS 3.1 for Windows, one of the most popular desktop GIS platforms world-wide, along with two of its extensions ArcView Image Analysis and ArcView 3-D Analyst.

ArcView Image Analysis functionality was needed for image rectification and other specific image processing techniques. Additionally, ArcView 3-D analyst was required in order to achieve a 3-D simulation of the vault of exonarthex. All the other tasks were carried out using the core ArcView GIS 3.1 exclusively.

5. CONCLUSIONS

The method proposed in this paper is applicable in most cases of mural painting conservation and it proved that low cost GIS software systems can also provide appropriate functionality in order to achieve mural painting graphic documentation. Thus, mural painting digital surveys can become a common and practical tool for the conservators because the equipment and software related costs are not prohibitive. The method might be appropriate also within conservation of other types of artworks (e.g. mosaics, paintings, carpets, tapestry).

Nevertheless, it is up to the conservator to finally decide the adequacy of applying the method, taking into account the complexity of the mural painting conservation tasks. It is very important to note that the use of information technology in mural painting conservation represents nothing but a possible useful tool and should not induce considerable additional efforts.

By applying the proposed method, the graphic documentation becomes a spatial database, which can be naturally extended to the entire mural painting documentation. In this way, better cultural heritage information management is enabled.

The method has several advantages over the traditional ones. For example: objective nature of the graphic basis, ease of updating and symbolizing, more accurate area and length measurements, unlimited overlay and display possibilities, ease of manipulation, ease of cross-links with other data, relatively simple 3-D simulations.

Possible drawbacks are those generally inherent for any operational implementation of a new information technology. Maybe the most important is generated by the difficulties in creating a dedicated infrastructure (personnel, equipment, software). This is true both for the conservation team level and for the cultural heritage institutional level. Furthermore, difficulties in integration with existing traditional documentation and archiving systems, difficulties in creating an appropriate system for training and education must be mentioned too.

It is worth mentioning that GIS technology was already taken into account and applied for very similar purposes in cultural heritage information systems. In this respect, an exquisite and complex example is the work of the team conducted by

professor Carlo Monti referring the Basilica “San Marco” in Venice, Italy (Monti et al., 1998).

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