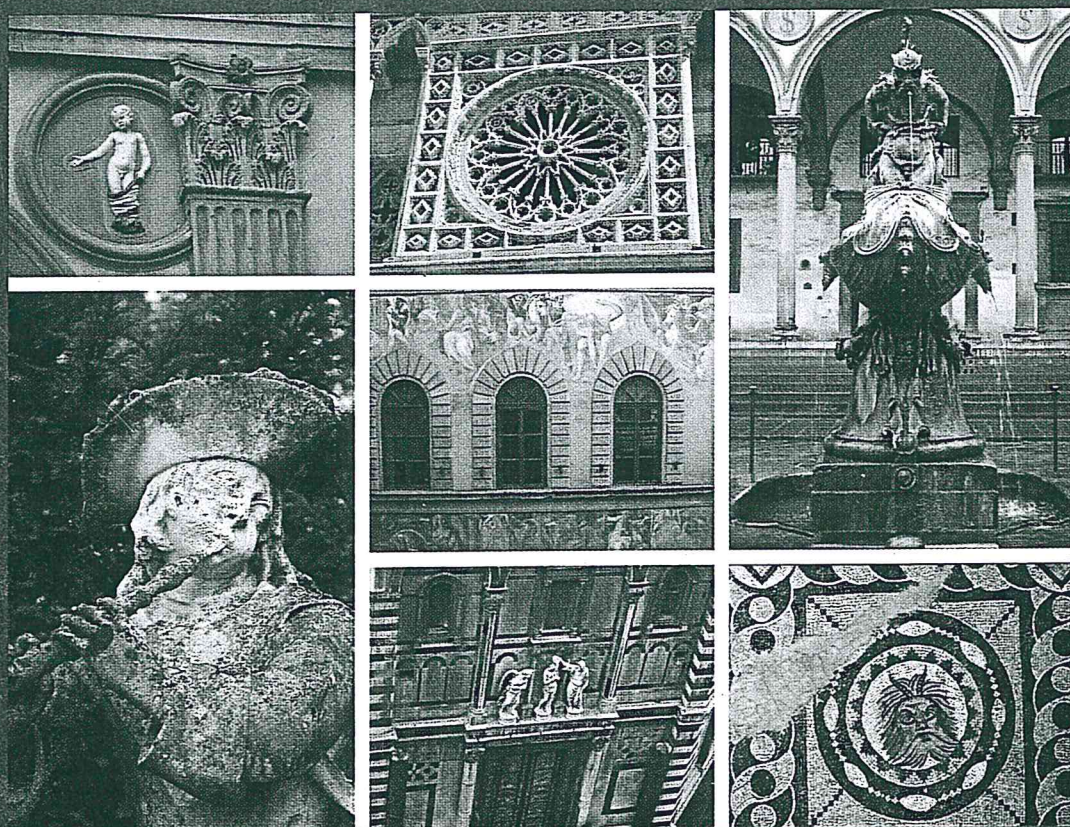


International Workshop SMW08



IN SITU MONITORING OF MONUMENTAL SURFACES

edited by
Piero Tiano and Carla Pardini



Dipartimento Patrimonio Culturale

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RAPID TECHNIQUES FOR MONITORING HISTORIC FABRIC IN PRESERVATION PLAN

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Abstract

The investigation techniques based on images analysis have a prominent role in the arena of NDT applied to Cultural Heritage, above all in the preliminary phase of the assessment. Previous researches (1-3) showed the most suitable, feasible and low-cost tests, and which devices offers major integrability for the best use of information. Innovative and highly precise instruments support the analysis, in the spectral ranges of Long Infrared (IR Thermography), visible (photos rectification), and UV (traditional photos at UV). An example of testing procedures is the study case of Marquis Palaces in Botrugno (Lecce). Monitoring microclimate (by probes and repeated psychrometric survey), mapping colder surfaces (thermal bridges, different materials of coatings and masonry, etc) and the analysis of risk factors inside and outside the buildings (environment, use of heating plants, presence of visitors, etc) allows researchers to identify specific microclimatic conditions and materials thermal-hygrometrical behaviours which are critical for conservation of surfaces.

1. Type of technology/methodology

In maintenance and monitoring phases, it is strictly necessary that techniques require a low budget, especially for what concerns time needed by inspection and data processing (4). Fast scan working techniques on wide surfaces have a considering advantage rather than those techniques that give punctual data back, after a long processing data time. Paper shows the integration of NDT for mapping and measuring thermo-hygrometrical unbalance of surfaces. Focus of investigation is the early detection of areas under risk of damage. Risk factors are due to occurred damage of structures (rising damp, water infiltration from the roof, form pipe leakage, presence of biodeteriogens), inadequate use of building and its plant (structural damage, surfaces damage), unbalance between structure and environment (thermal bridge, repeated and accelerate cycles of evaporation/condensation of water vapour on wet surfaces), interaction of incompatible elements (i.e.: alteration of restoration products, corrosion of metal elements embedded in masonry, proximity of materials requiring different standards for conservation). The collection of documentation about the building, damage location, its evolution in time, the use across years is mandatory to work out an effective diagnostic plan, especially for preliminary test. The first step of investigation is the assessment of surface conditions by means of multispectral

fluorescence can be connected at different damage and components (1). The techniques is traditionally applied on movable paintings, and scientific literature reports applications on frescoes and plasters only recently (9, 11).

4) Thermal infrared scanning.

The techniques of imaging in the spectral bands of visible and Infrared resulted very useful for detecting surface and subsurface anomalies. At critical microclimatic conditions these thermal anomalies are responsible for possible damage due to a differentiated thermo-hygrometrical behavior (5). Recaptures are shot by active and dynamic approach in three sets. A convective heating is addressed from the heater to the investigated wall by using reflecting sheets, to obtain a homogeneous heating. IRT permits to map the new patches and surface finishing when these materials have a different density than original fresco. Mapping surface temperature permits an early detection of risk areas in time: it is a totally non destructive test, it can be periodically repeated without any damage of investigated surfaces, time of survey is short and it can be applied on extensive areas.

Moisture detection: employed techniques

The methodology of moisture detection consists in crossing the results of innovative NDT with the data coming from low destructive techniques for measuring water content in selected samples. This application requires a preliminary scanning by Infrared Thermography (IRT). Thermal scanning has to be applied to the whole surfaces under investigation, with the aim to find out thermal gradients which are indicative of moisture evaporation. IRT mapping permits an early detection of damp areas, even though the damage is not yet visible. Even though the economic convenience of passive approach, operators have to take in account some severe limitations (12, 13) due to ambient conditions. A further integration with low destructive measurements of water content allows to quantitatively determine the amount of liquid water in the structure. Thermal analysis of IRT scanning allows the identification of critical zones where water content could be high. Operators collect few small samples of the surface material in the colder areas, and for comparison, on the warmer ones. A further step is measuring water content in the collected samples by gravimetric tests (14) (according to UNI 11085), calcium carbide, and more innovative tests, as the Fixed Points Method (PPM) (15).

Monitoring ambient and surface conditions

Monitoring air Temperature, RH and surfaces Temperature, is performed by means of non contact techniques such as probes, psychrometric tests (according to UNI 10829) and IRT. Repeated psychrometric surveys allow to record variations of microclimatic conditions; measurements are performed along a grid of measurement points which covers the extension of the whole building. Data processing consists on plotting the results into thematic maps (each for any measured variable, RH, SH, T), which have the same metric reference of measured drawings of the building. Integration between these data and thermal scanning of interior surfaces, at different ambient conditions, permits to find out most critical zones, in which operators will focus the further step of investigation (16). Operators set probes in these parts of the building in order to measures air T and RH at an

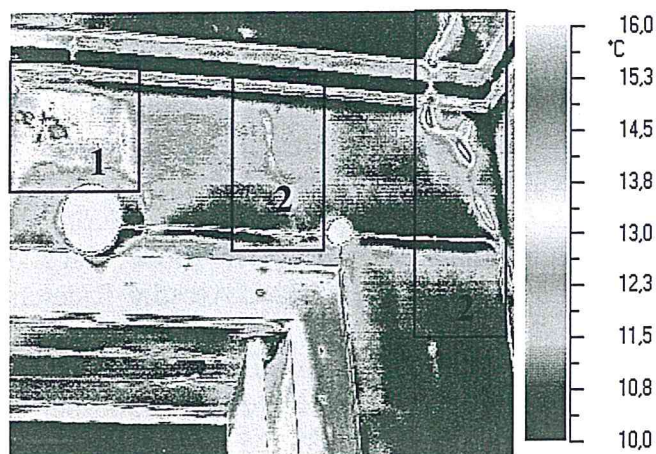


Fig. 3. Marquis Palace in Botrugno: infrared thermogram shot after a convective heating of 20 minutes, delamination of plaster appears as warmer areas (in the square 1), cracks are enhanced (square 2), and distribution of surface temperatures allow to detect the shapes of stone quoins of the masonry (in the right side of the thermogram).

4. Evaluation of methodology/technology used

The integration of the above listed techniques is particularly successful to support:

- mapping elements for the implementation of their safety interventions
- finding critical areas ongoing to further investigations
- contributing to list the priority issues for conservation
- leading the choice of HVAC system installation and use
- developing a reuse project based on real performances of the elements and building system
- Contributing to identify the costs of intervention.

Information in the preliminary phase of project is crucial to define a compatible reuse of the building and to address designers to develop residual performance of the building. The limited cost and invasivity of test allow to apply them on the widespread built environment, and to support all the planned conservation activities. In such a way, listed techniques are successfully applied in the most of non monumental historic building, where economic issue is a fundamental criterion for planning intervention and cares. Moreover, investigations allow to proceed to a further identification of those damaged areas and damage causes, to an increasing level of accuracy and effectiveness.

REFERENCES

1. S. Della Torre, E. Rosina, M. Catalano, C. Faliva, G. Suardi, A. Sansonetti, L. Toniolo, G. Valentini, R. Cubeddu, D. Comelli, 2005, *Early detection and monitoring procedures by means of multispectral image analysis*, in proceedings of "8th International Conference on Non Destructive Investigations and Microanalysis for Diagnostics and Conservation of the Cultural and environmental Heritage" (papers on CD), Lecce May 2005.
2. G. Suardi, E. Rosina, S. Della Torre, V. Pracchi, N. Ludwig, V. Redaelli, A. Sansonetti, R. Negrotti, 2005, *Le indagini multispettrali per il riconoscimento delle malte di restauro*, in proceedings of "XXI Convegno internazionale Scienza e Beni Culturali", Bressanone July 2005, Arcadia Ricerche ed., Venezia, 2005, pp. 907-915.
3. S. Della Torre, E. Rosina, C. Faliva, M. Catalano, 2006, *Sperimentazione di tecniche analitiche integrate per la diagnostica finalizzata alla conservazione preventiva*, in