The IFIDA Project: Intelligent Fast Interconnected Devices and Tools for Applications in Archaeometry and Conservation Practice

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Abstract. The correct documentation and scientific attribution of ancient works of art requires the processing of relevant amounts of images and interdisciplinary data usually kept in non-compatible formats and objects of different property. The main goal of the IFIDA project Intelligent Fast Interconnected Devices and Tools for Applications in Archaeometry and Conservation Practice is to collect and integrate the dispersed models, tools, case studies, imaging and analytical resources resulting from previous investigations of works of art in repositories that facilitate extraction and sharing of new knowledge for cultural heritage research. This information will be further assessed applying sophisticated analytical and computer technologies in order to develop or adapt interconnected software tools for very fast authenticity certification and applications in archaeometry and conservation practice; to benefit development of new scholarship and technologies.

Keywords: Data Repositories, Analytical Technologies, ICT, Expert Systems, Archaeometry.

1 Introduction

The mass introduction of any kind of analytical techniques in the study of cultural heritage (CH) produces increasing rates of extremely inhomogeneous information that necessitate an increase in the sophistication of the technologies applied to its storage and efficient assessment, articulation and interconnection.

One other problem represents the transformation into real knowledge of these enormous but dispersed resources previously acquired in occasion of different art technical investigations and restorations. Their correct interpretation often causes difficulties and requires interdisciplinary and cross-sectorial collaboration as well as further explorations in specific fields of expertise.

It should be remembered with the occasion that detailed authenticity investigation and art technical and technological assessment must be obligatory carried out before

any sampling for in-lab experiments on every kind of historic art works. The practical experience and the historic documents demonstrate that easel painting for example often underwent renewals and only a lowest part of what has survived to our days is 100% original. Instead, in too many cases concerning historic artefacts sampling yet follows the protocols for quality control in contemporary industrial production, without taking into consideration the specific alterations that could have been introduced not only by natural and ambient factors, but also by human hands. This makes unreliable the interpretations of the lab issues in most of the peer reviewed publications on physiochemical analyses or the hyper spectral measuring of historic artefacts, discrediting their scientific character and value. The objectives of this project include therefore strengthening the scientific-technological base and reliability of publications on art works in general, advertising "hard" scientists but also art historians about the broad extension of nonprofessional restorations and fakes even in renowned museums, and the necessity to consider them with the due attention.

IFIDA starts from the idea that the complex nature of CH requires a dedicated inter-disciplinary networking effort for to clear the make-up of single works and to can select the most appropriate strategies for large-scale, long-term damage prevention and preservation. Knowledge of the CH resources scattered worldwide is actually very fragmentary. Remarkable gaps, particularly in strategic and politically sensitive sectors, still divide the different national schools in their approach to the proper CH. Whenever single projects have already faced determined aspects of this problematic in Russia [1], W Europe [2] and the USA [3], the creation of complete, interconnected libraries, efficiently organized and specialized referential tools, and of facilities based upon advanced computer technologies for very fast analytical processing of the accumulated resources results in delay and doesn't correspond to the actual needs of the scientific community. Moreover, promulgated information and references for specific studies on artistic objects often derive from libraries elaborated for external or generic purposes; linguistic and copy right barriers obstacle access to the sources, and this access is further compromised by difficulties with and between national and international, private and public institutions.

2 Integration of Models, Tools, Data Repositories, and Case Studies

Integration of the extant qualitative and quantitative research is needed, to unite knowledge on technical applications and strengthen cross-enrichment in current CH studies and conservation practice. This is fundamental to overcome the present diverse and unequal institutional and geographical distribution of competences in academia, and across stakeholders, which results in excessive self-reference of disciplines and approaches to CH preservation.

Qualitative and quantitative studies concerning CH have yet to combine with recent innovative computational and experimental studies, which use advanced large-scale empirical and computational techniques to understand the structure, make-up, the causes of damage in different material categories and the long-term behavior and

efficiency of methods and materials applied in specific areas. For excessive dependence from particular interests (e.g., business, career or political), to date CH studies have not given rise to coherent, dedicated inter-institutional efforts at EU or international level, for example to permanent research initiatives. This has brought to the fragmentation and dispersion of knowledge united in previous contexts; hence studies on CH preservation and its modern exploitation need better coordination and synergies. A network operating as a subsection of the DIPP Conference, as the proposed one intends to develop, could constitute an efficient tool in the condition to foster generation of new, specialized and interactive databases updated with the most recent investigative issues, standardization of criteria and improvement of methods in all phases of CH preservation.

Although links and collaboration with important stakeholders are already in place, until a common framework is developed a fruitful co-evolution of findings and practices cannot be achieved. Researchers, scientists and professionals from multiple disciplines are encouraged to join this project for data sharing and networking in order to compensate the aforementioned drawbacks with their particular skills, unique access to data sources, work experience and equipment across various fields of expertise.

Given that initiatives in this field have been always fragmented and pursued mainly individually, networking is beneficial to reach a sufficient mass of (human and infrastructural) resources, where positive effects could be enlarged and activate positive cascade effects (e.g., by involving other important stakeholders, such as funding agencies, art collectors, industrials). The impact of the envisaged internationally coordinated data collection concerns as the history of technology of the Eastern European area, the better represented at the DIPP forum, as well as that of W Europe and beyond: many of the Renaissance “discoveries” in fact may be based on goods and know-how imported from the Near, Middle and Far East, but our knowledge of the source area is presently much too modest. Evaluating the chronologies of key developments will be important in this respect.

The participation of DIPP' stakeholders in other projects and networks, whose programs can be eventually synchronized with the present project, enables an efficient and high impact use of resources. In first place thanks to the possibility to share data already collected by regional/national programs on a common international platform, for which no funding is presently forecast by international infrastructures.

2.1 Data Sharing Conditions

In first place, this project will ask and search to define the most realistic conditions for data exchange and sharing. It will explore data sharing standards that could make interdisciplinary initiatives easier in the future (e.g., the web access and marketing of the elaborated software). as this factor results fundamental for the collection of sufficiently rich and variegated input. The focus initially will be put on the data functional to the most widespread applications: authenticity certification and archaeomery/innovative non-destructive measuring technologies; conservation practice. Particular attention will be paid to the development of dendrochronological standards

based upon X-ray imaging measurements as reliable non-contact method for dating of wooden artifacts.

2.2 Multi-sensorial Approach on CH

The project aims to generate useful information resources collecting issues of any kind of sensorial CH investigation. Regarding works of painting for example, the input will extend to:

- support type on wood, on canvas and on wood covered with canvas),
- ground composition and structure,
- pigment's composition (of white, red, blue and yellow mineral pigments),
- presence of over paintings with natural pigments,
- characteristics of the protective layer.
- eventual mycological presence in the ground and the paint layer,
- stratigraphic structure of the ground and paint layer.
- protective layer,
- craquelée typology,
- status of conservation,
- presence of non-original interventions,
- art-technical and art-technological characteristics.

Of interest for the repositories will be as results obtained with the actually more widespread investigative (non, less, and destructive) techniques, as these produced by relatively new ones, i.e.:

- professional photography, high resolution microscope;
- spectroscopy (SP), monochromatic filtering of visible light, visible reflectance spectroscopy;
- SP in ultraviolet and visible light, UV-Vis luminescence, ultraviolet reflectance (UVR), colored imaging in the near (NUV) and in the far ultraviolet (FUV) light;
- spectroscopy in the infrared range (IR): near infrared (NIR), monochromatic IR, short wave infrared spectroscopy (SWIR), Mid-IR, LWIR; IR reflectance (IRR) and luminescence (IRL);
- recognition by electronic-optical transformers (RTI), by TV-IR systems;
- laser induced fluorescence (LIF), laser induced breakdown spectroscopy (LIBS);
- micro-Raman resonance, Raman and IR-Furrier spectroscopy, mass-spectroscopy;
- interferential methods for non-destructive monitoring (double exposed holography, Speckle imaging , laser Doppler vibrometry (LDV), shearography etc.);
- x-ray methods, neutron diffraction, optical coherence tomography, terahertz imaging and spectroscopy, ion beams application (IBA);
- 3-D laser scanning;
- induced thermo-luminescence, fluorescence hyper spectral lidar;
- optic-acoustic methods;
- solid immersion imaging interferometric nanoscopy, etc.

The assessment and interactive organization of the repositories by various categories should be aimed at fostering better and faster exploitation of existing knowledge and technical potential, introducing or recommending innovative technologies and policies in collecting and proceeding of data resources, hence it should benefit development of new scholarship and technologies.

3 Application of Advanced Computational Technologies

The use of advanced computational technologies will regard in first place the modelling of the conservation status and merging the different visual and non-depictions and support information as well as the integration, interactive linking, analysis and interpretation, driven by the specific aforementioned objectives. These will include for example data alignment and confrontation after different criteria; optical pattern recognition applied to the acquired craquelée graphics; classification, clustering and individualization of anomalies, virtual reconstruction of losses etc. that serve specific applications as the characterization of the various artistic productions or the distinction between originals, past repairs, unprofessional and/or professional restorations, falsifications, copies, and replica [4, 5].

It is envisaged to integrate the data in conformity with user questions, for example to assign to IR spectra the material correspondence resulting from realized complex (ND and in-lab) investigations, technical treatises etc., in order to avoid destructive analyses and save time .

Of major importance is the development of contemporary IT solutions (viz. relevant sources/environments of data and facilities) for data and knowledge sharing and distribution for CH preservation, reuse and integration. The solutions will maintain interactive use of CH data and their processing and analyzing and so contribute to the understanding of historic and natural materials, art technology and techniques, chemistry of natural compounds, etc. [6][7]. Moreover, the objective is to enhance the analysis of cultural resources to improve the understanding of how European identity can be traced and constructed, and to use those resources to foster innovation across sectors (cultural sector, ICT). Naturally, the project will generate innovations, leading to richer interpretation of the past, bring new perspectives to question of identity and culture.

4 Target Users and their Needs

Target users: restorers, conservation scientists, art experts, museum curators, art historians, scientists engaged with lab analysis of artifacts. They could require further standards, atlases with examples, dedicated publications, best guides or software for fast ND recognition of fakes or of nonprofessional restorations.

5 Expected Results and Potential Interdisciplinary Value of Research Carried out

The systematic integration between theoretical investigation and empirical data, the coordination of dispersed knowledge into a coherent framework and the promotion of adequate cross-methodological, trans-disciplinary research in collaboration between science stakeholders (e.g., academic teams, restorers, and funding agencies) in data sharing will consider the results obtained through assessment of older data carried out in the multi decennial past practice in order to establish continuity and compatibility.

IFIDA will explore ways to develop excellence in the collection and data processing for CH preservation and natural substances characterization, and so contribute to the understanding of historic and natural materials, art technology and techniques, chemistry of natural compounds. This will provide a better basis for the scientific attribution of the artifacts, improve conservation and restoration treatments, and produce inspiration for new research and applications directions.

Therefore it is expected that it will provide a relevant source of data and facilities for their efficient interactive use not only for stakeholders involved in the field of CH management and preservation (authenticity certification, non-destructive diagnostic of the conservation status, elaboration of archaeometric references and deterrents against fakes, virtual reconstructions of lost artifacts) but also in related sectors like authenticity certification for legal purposes, criminology, material characterization, for improvement of technical devises, software programming, and production of materials (for restoration or painting).

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