Holography in Accreditation of Works of Art

by Alkis Lembessis of TAURUS SecureSolutionS

HOLOPACK-HOLOPRINT 2012
Vienna - 30 Oct 2012
TAURUS SecureSolutionS

• Estd. In Athens Greece (1999)
• Provider of integrated authentication solutions
• Active locally and internationally

• ATHENS 2004 Olympics (merchandising, ticketing, accreditation, BIBs)
• Asian Games 2006 (ticketing, accreditation, BIBs)
• Jeddah CCI certificates (with CAVOMIT hot-stamping equipment)
• Serbia vehicle registration system (HOLOCIS)
Accreditation of ...

- Persons/animals
- Vehicles
- Documents
- Products

Now:
Accreditation of ... Works of Art

- Individual
- Unique
- Priceless
- Cultural Heritage
- Authentic vs. Original
ArtGnomom - Measuring Art

leading center worldwide for research and development of innovative laser and optical technologies for the diagnostics and conservation of works of arts and antiquities

(105) published articles in scientific journals since 1996,
(78) published conference proceedings since 1992
(1) book (2006) and (9) invited chapters in books
‘Live’ UV/IR laser cleaning at the new Acropolis Museum
Laser cleaning of Parthenon West Frieze

UV/IR pulse lasers
‘The AXA Reinhardt Project’
Guggenheim / MOMA

Spectral Imaging

Laser Cleaning
Laser Restoration
IRIS-II is a complete, flexible instrument for imaging the compositional and structural information of layered surfaces. It is fully portable and independent enabling the examination of objects *in situ* (museums, conservation laboratories, archaeological areas).
Multi-Spectral Imaging (IR-VIS-UV)
Revealing the signature/date of Luca Giordano (1653 AD)
The 13\textsuperscript{th} Apostle in
“The Last Supper” by El Greco (1567-1570)
The increasing demand for minimal intervention in combination with restrictions in sampling and transportation of cultural heritage and archaeological objects has led to the development of a transportable (LMNTI) and a fully portable (LMNTII) instrument for their analysis and characterization, based on Laser Induced Breakdown Spectroscopy (LIBS).
Laser-Induced Breakdown Spectral Analysis
The Baptism”, El Greco painting (1567)

LIBS analysis allowed the identification of the pigments used to form the blue, green and yellow paints and thus the pallet of the artist was confirmed. This study strengthens the originality of the painting.
The holographic speckle interferometry technique permits through real-time surface illumination the non-contact detection of invisible micro-deformations. The method registers deformations by whole-field differential displacement of surface field. Surface deformations are resolved in steps of 10.4 microns and the deformation value is measured by multiples of half wavelength. DHSPI-I & DHSPI-II are custom-made systems for sensitive interferometric imaging to capture alterations of surface topography. Hidden defects are revealed by inhomogeneous intensity distribution witnessing the deformation fields. Can be used on various artworks from panel paintings, canvas paintings, furniture, icons, to statues and wall paintings. Additionally can be used to monitor environmental change impact, transportation effects, restoration and interventive actions impact and originality verification on both movable/immovable artworks.
Holographic Interferometry provides a priority risk map for the structural state of painted artworks.

Irregular fringe pattern distribution reveals the active detachments which affect mostly the surface painting.

“The Baptism” El Greco painting (1567)

Zoom in defected region

In collaboration with HISTORICAL MUSEUM OF CRETE
Priority Risk Map

- Internal detachments
- Visible cracks
- Non original material

Before restoration

After restoration

In collaboration with Historical Museum of Crete
Digital Holographic Speckle Interferometry Structural Diagnosis

In collaboration with
Digital Holographic Speckle Interferometry Structural Diagnosis

Saint Sebastian, (attr. to Rafaelo)

Quantitative

PRIORITY RISK MAP
“RELATIVE MICRO-DISPLACEMENT”

2 µm/cm
1,6 µm/cm
1,2 µm/cm
0,8 µm/cm
0,4 µm/cm

In collaboration with
In collaboration with 13th Ephory of Byzantine Antiquities, Heraklion
ArtGnomom - Measuring Art

- since 1987
Preliminary Results (Nov 2011)

This is a photo of a hologram

- This is a photo of a hologram
Results (Jun 2012)

Hand-made wooden model 100x100cm

Industrial design
(awarded model-maker, ATHENS2004 Olympics torch)

Z3 Camera

Hand-made wooden model 100x100cm
ZZZyclops
ZZZYclops

iLumogram printed by GEOLA
size 30x40cm
The ‘Chios Epitaph’

an Optically Cloned Artifact
9th ISDH at MIT (Jun 2012)

The Hologram
OptoClones®

Masks on Red
June 2012

Minoan Goddesses
June 2012
an Optically Cloned artifact on ULTIMATE colour plates

Evzonas 1912
Sep2012
OptoClones©

Chief of Defence Gen. Kostarakos
24th Oct 2012

Thessaloniki War Museum
‘100 Years since Liberation’
Trichroic Prism
(Dec 2011)
HoLoFoS: an optimized LED illumination system for color reflection holograms display

by Andreas Sarakinos, Nikos Zervos, Alkis Lembessis, The Hellenic Institute of Holography (Greece) . . . . . . . . . . . . . . . . . . . . . . . [8644-19]

Monday 4th Feb 2013
Accreditation of Works of Art
Analytical Methods

<table>
<thead>
<tr>
<th>Imaging techniques</th>
<th>Molecular techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic photography (in raking, reflective,</td>
<td>X-ray diffraction (XRD)</td>
</tr>
<tr>
<td>transmitted light)</td>
<td>Fourier transform infrared spectroscopy (FTIR)</td>
</tr>
<tr>
<td>Multispectral imaging (UV, Visible and Infrared)</td>
<td>Raman spectroscopy</td>
</tr>
<tr>
<td>Microscopy and Microanalysis</td>
<td>Gas chromatography–mass spectrometry (GC-MS)</td>
</tr>
<tr>
<td>Fluorescence microscopy</td>
<td>Pyrolysis gas chromatography mass spectrometry</td>
</tr>
<tr>
<td></td>
<td>(Py/GC/MS)</td>
</tr>
<tr>
<td>Laser-induced breakdown spectroscopy (LIBS)</td>
<td>Holographic interferometry (HI)</td>
</tr>
<tr>
<td>Scanning Electron Microscopy coupled with Energy</td>
<td></td>
</tr>
<tr>
<td>Dispersive X-ray (SEM/EDX) Spectroscopy</td>
<td>Radiographic and acoustic techniques</td>
</tr>
<tr>
<td></td>
<td>Applied Thermography</td>
</tr>
<tr>
<td>Secondary ion mass spectrometry (SIMS)</td>
<td></td>
</tr>
</tbody>
</table>
Ultimate Documentation (UD®) in aid of expert opinion

is a new proposal for creation of "scientific artwork identity"

- Utilizes in-depth sources of information
- Overtime comparison protocol

Subsurface profiling, -1 mm

Structural deformation, at x,y,z 1,1,1

Subsurface profiling, -1.5 mm

Structural deformation, at x,y,z 2,2,2
Ultimate Documentation (UD®)
Methodology Concept of UD® - STEP 1

Morphological Profiling
- Physical Measuring
  - Surface Recording
  - Object Imaging
  - Surface Profilometry
  - Microscopic Analysis
  - Molecular Analysis
  - Elemental Analysis
  - Chemical Analysis
  - Radiography
  - Acoustic
  - Tomography
  - Interferometry

Material Analysis
- Evaluation of artist’s technique
- Identification of surface materials
- 3D holographic recording
- Detection of surface condition
- Identification of constituting materials
- Classification of pigments
- Determination of cross-sections
- Stratigraphy
- Ageing degree of materials
- Defect Detection
- Degree of deterioration
- Simulation of environmental conditioning
- Study on deterioration mechanisms for treatments and insurance protocols
- Handling, transportation effects

Structural Diagnosis
**UD Operation Principle:** Surface, subsurface and bulk information equally important sources for data feeding

**Surface signal**

**Subsurface signal**

**Frequent data update**

**UD© - STEP 2: Data Acquisition and Information Encoding**
# UD® Working Procedure

## STEPWISE WORKING PROCEDURE

| Step 1 | Surface data extraction  
|        | Chemical data extraction  
<table>
<thead>
<tr>
<th></th>
<th>Structural data extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2</td>
<td>Feed in UD® DATABASE: Permanent data of artwork</td>
</tr>
<tr>
<td>Step 3</td>
<td>Data PROCESSING: Secure data of artwork</td>
</tr>
</tbody>
</table>

## GENERATION OF ARTWORK UD®
Non-destructive diagnosis technologies for the safe conservation and traceability of cultural assets

Science in Aid of Expert Opinion: a Tell-Tale on Disputed Artworks

Fotini Koussiaki, Vivi Tornari, Eleni Kouloumpi, Alkis Lembessis

Friday 2\textsuperscript{nd} Nov 2012
Diamantidis vs. Sotheby's
Works attributed to Constantinos Parthenis (1878-1967)
‘Still Life before Acropolis’ pre-1930s
Sotheby’s Auction, Nov. 2006: **675,000 EUR**

‘Virgin and Child’ pre-1930s
Sotheby’s Auction, Nov. 2007: **950,000 EUR**
“Still Life before Acropolis”
Laser Induced Breakdown Spectroscopy of several paints

For the LIBS analysis, LMNT-II system was employed. The presence of calcium (Ca), titanium (Ti) and zinc (Zn) was detected in the majority of the paints. Such regular findings of white pigments and extenders signify a single paint manufacturer for most paints present on the painting.

Scanning Electron Microscopy coupled with Energy Dispersive X-ray (SEM/EDX) Spectroscopy of priming
X-ray diffraction pattern of sample from priming’s area (XRD)

Sotheby’s: ‘...before 1930s...’

Findings: Rutile \( \text{(TiO}_2 \text{)} \): after 1940s !!
24 May 2012

- “Virgin and Child” : fake
- Financial compensation awarded (950k EUR)
- Fraudulent activity
- Legal action in process

source: KATHIMERINI daily
UD® data Acquisition + Analysis + Diagnosis + Originality Identification + Certification

= Accreditation of a cultural object

• Data is archived to accompany endlessly the artwork in concern

• Data is classified and encoded adding a warranty for artwork originality

• Data is used to generate an identity

• Identity safeguards the artwork against forgery, mishandling, accidents

• Provides enhanced insurance and objective insurance values

• Increases the market worth of the artwork

• Artwork construction and constituent materials are known and can be monitored frequently for data update
NEW!

- Scientific approach (repeatable)
- Objective, impartial, independent
  - Mobile Lab: in-situ analysis
    - Non-destructive
    - Non-invasive (micro)
      - Forensic

- Museums (private/public)
- Collectors (private/public)
  - Auction Houses
  - Insurance companies
  - Transport companies
- Law enforcement agencies