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ARTWORK DIGITIZATION AND INVESTIGATION A CASE STUDY OF THE LOOM WEAVER OIL PAINTING BY HOSNI EL-BANNANI

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ABSTRACT

Art, Science and Technology are the main elements of Artwork Investigation which requires the mutual understanding of artistic, historical and technical issues in a multidisciplinary environment.

In this research we will introduce an oil painting from the collection of Hosni El-Bannani who was one of the pioneer's artists of the impressionist art movement in Egypt. His oil painting was suffering from many deterioration aspects and was planned for conservation treatments.

A digitization and investigation project was initiated to run in parallel to keep record of the physical condition of the painting and to monitor the remedial treatment process. This case study will focus on the digitization and investigation phases within the framework of a proposed workflow. Several acquisition techniques that have been used will be presented; multispectral imaging, high resolution scanning, microscopy, analytical qualitative and quantitative studies. The analysis of the results identified clear under-drawings and composition shift that correspond to the original style of the artist. Moreover, the digital record of the results for the surface and the strata will be used as an identifier of the art object and for further studies. Finally an interactive application has been developed to be used for investigation, layers comparison and presentation.

KEYWORDS: Multispectral Imaging, Spectroscopy, Composition Shifts, Conservation

1. INTRODUCTION

History by nature is multilayered and multidimensional. Thus, reading the history of an artwork is not limited to its surface information. Artwork is composite information about the artist, the style, the composition, the pigment, the surface as well as the strata. Digitizing a valuable historical object needs careful preparation, investigation and an evolving workflow.

We will try to shed some light on an oil painting from the work of an Egyptian artist who was among the second generation of pioneer impressionists in Egypt, Hosni Mohamed El-Bannani (1912-1988) (Ministry of Culture, 2010) and his oil painting "The Loom Weaver". And also, the methods that have been applied for the digitization, investigation and analysis of the painting during a conservation project through a proposed workflow that has been followed which divided the project into four integrated phases; contextual information, digitization, analysis and dissemination (Fig. 1).

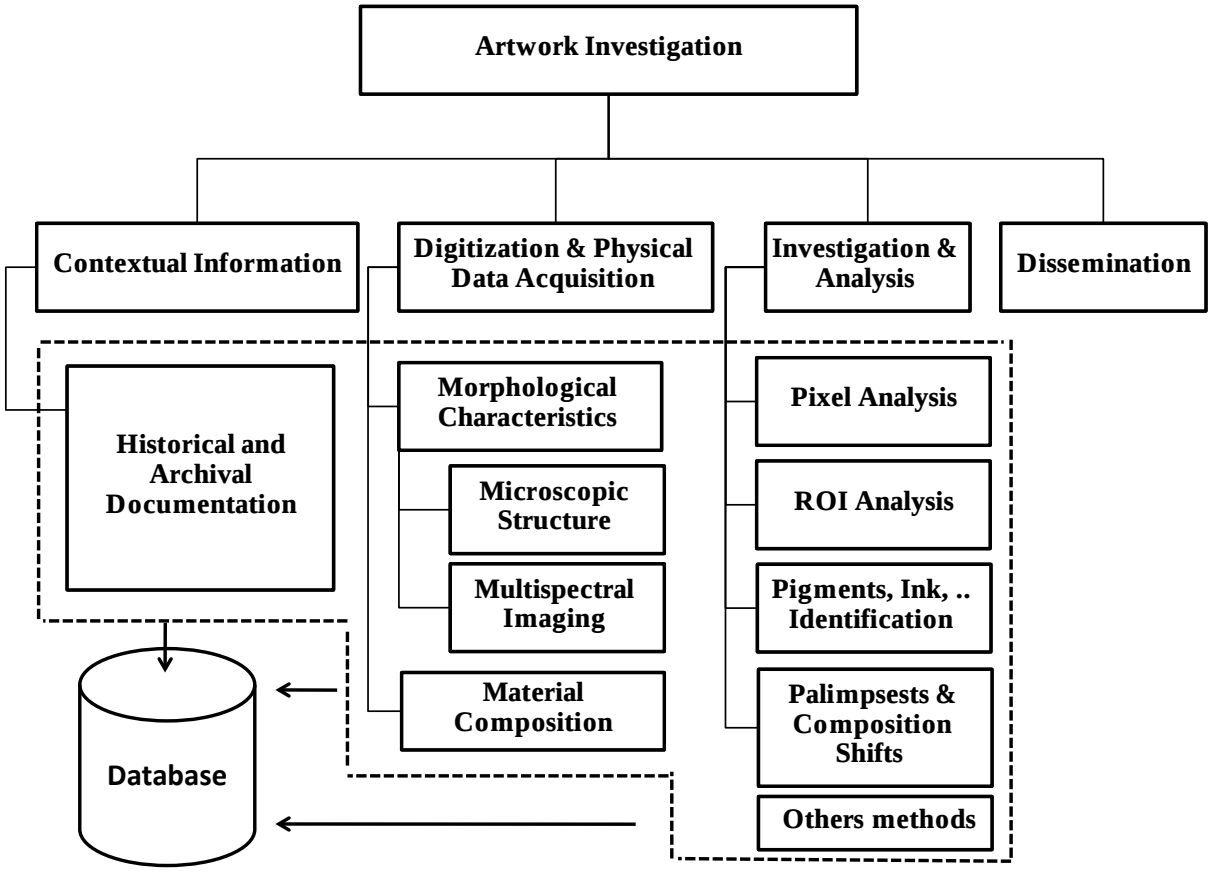

Figure 1. A proposed structure of the investigation workflow

Historical and archival documentation constructs the first phase of the contextual investigation process, followed by the digitization and physical data acquisition that covers; photographic and video recording, microscopic inspection and multispectral imaging before, after and during the conservation treatments, in addition to the extraction of the chemical composition of materials using qualitative and quantitative methods.

The digitization process is followed by the analysis and post-processing phase to process the immense amount of data. Finally, the dissemination phase delivers the results of the investigation to the targeted users in an organized, user friendly and descriptive way.

1.1 ARTWORK INVESTIGATION

Working within a framework of a specific workflow (Fig. 1) and using different relevant techniques (Liritzis et al., 2007), made it possible to achieve valuable insights about the painting, The sum of these results is considered as a fin-

gerprint of an original artwork which give to researchers, restorers, curators and art lovers the opportunity to access and study the painting with different layers of information to achieve a better understanding of the artwork.

2. CONTEXTUAL INFORMATION

Historical and Archival Documentation

2.1 Artist Information

Hosni Mohamed El-Bannani (1912-1988) (Ministry of Culture, 2010) is one of the faithful and dedicated artists of the impressionism school. He was very close to Youseef Kamel (1891-1971) who was the founder of the impressionistic movement in Egypt.

And according to an interview with his son Prof. Sameh Hosni El Banani who introduced us to his style, Hosni El-Bannani tried to project with his artworks the colors, the nature, the vastness and the beauty of the Egyptian countryside.

He linked the place, the people and the nature and mixed them all to illustrate the innate beauty of a localized impressionism (Liritzis et al., 2007).

2.2 Artwork Information

"The Loom Weaver" (Gazalah, 2007) 95x83cm oil on canvas is one of El-Bannani's artworks which currently exhibited at the Museum of The Egyptian Geographic Society. The painting represents a simple worker who is delicately working on a loom weaver, probably wearing typical villager clothes.

The surrounding environment is reflecting the artist's vision by using simple and bright colors, and introducing original elements such as a traditional drinking pottery jar, worker's loose garment (Galabiya) and turban which convey to the viewer the typical local Egyptian impression.

2.3 Preliminary Condition Assessment

The painting was suffering from many deterioration aspects (Fig. 2.a to c), like deep cuts, cracks, insects and frame damage. Remedial conservation has been planned for the rescue and consolidation of the painting and a digitization project has been initiated to work in parallel to record and monitor any modifications.

2.a: Cuts and paint cracks **2.b: Missing paint layer** **2.c: Paint cracks**

Figure 2 (1-c). Deterioration aspects of the painting

3. DIGITIZATION AND PHYSICAL DATA ACQUISITION

3.1 Morphological Characteristics

The painting anatomy showed a simple structure which consists of a wooden panel, canvas, ground layer and paint layer and no traces of varnish layer.

The canvas and different pigments have been recorded using optical and stereo microscope, In addition to the use of ultra-high resolution scanning (Ektessabi, 2008; Toque, 2010) and raking light technique to record the surface topography of the painting and color information.

Multispectral imaging has been used in the digitization of the front and back side of the painting in the visible, infrared and ultraviolet regions before and after conservation treatment.

3.2 Material Composition

To identify the components of each layer, several tests was conducted to determine the material composition of the painting. Some of which; X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) – Energy Dispersive X-ray (EDX), Gas Liquid Chromatography (GLC), and Fourier Transform Infrared (FTIR) were used to investigate and analyze the studied object. Results have been collected and organized into a master database of the Artwork, and it will be presented in the following sections.

3.3 Technical Methods

The following list has the technical methods that have been used in the data acquisition and material analysis (Table 1).

Table 1. Used methods and techniques

Methods	Equipments	Utilization
Multispectral Imaging		
	Canon EOS 5D MarkII	Visible Photography.
	Nikon D80 18W UV Black light	Visible/ Ultraviolet (UV) fluorescence Photography.
	FujiFilm ISPro (FujiFilm Co., 2007) B+W IR filter 093 (1% transmission at 800nm to 88% at 900nm) (Schneider, 2004) B+W UVA filter 403 (320 to 385nm) (Schneider, 2004) 75W Infrared (IR) reflector light	Infrared (IR) and Ultraviolet Photography. (UVA380nm/nIR1000nm)
	Toshiba f50	X-ray Radiography.
Ultra-High Resolution Scanning		
	Niji Scanner (Ektessabi, 2008; Toque, 2010), Line CCD Alex DS6700 (Kyoto Univ., advanced imaging technology lab)	High resolution scanning & Accurate color rendition.
Microscopic Inspection		
	Scanning Electron Microscope, Jeol Jsm 5200	Study of fibers of the canvas.
	Stereo and Optical microscope	Study of canvas and pigment characteristics.
XRD – SEM-EDX		
	XRD - Diffractometer PW 1480 SEM-EDX Jeol JSM 5200	Determination of the inorganic components in the ground layer as well as the colorants of the paint layers.
FTIR		
	BRUKER VERTEX 70	Determination of the organic binding medium in the preparation layer.
GLC		
	Perkin Elmer Auto-system XL	Determination of fatty acids of the binding medium.

4. INVESTIGATION AND ANALYSIS

4.1 Multispectral Imaging

Multispectral imaging has long been used in the field of Artwork investigation. The infrared region constructs an important part in this regard as it has many applications such as underdrawings inspection and pigment identification (Verhoeven, 2008). IR Photography and IR Reflectography are commonly being used in this field. Roughly, IR Photography is measuring reflection between 800nm and 1000nm while IR Reflectography (Boer, 1968) can measure up to 2000nm allowing for better revealing of strata.

Revealing of under-drawings has been determined to be more successful in the IR region above 1000nm, around 1000 to 2000nm (Walmsley et al., 1992, 1994; Boer, 1969). Thus, detecting underdrawings using IR photography between 800 to 1000nm has several challenges and limitations.

Figure 3: Transmitted IR photography

Under-drawing of a Lantern found on upper right corner

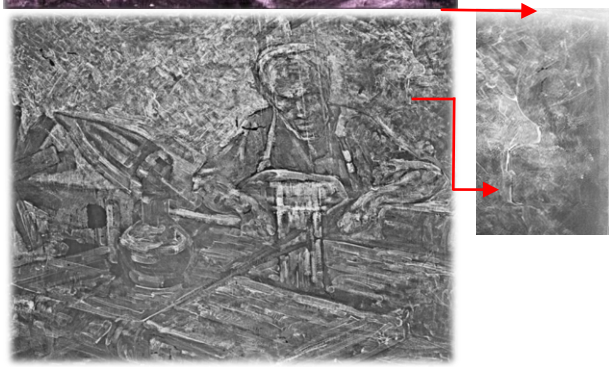

Figure 4: X-Ray radiography

Under-drawing of a Lantern has been confirmed

direction are some of the significant marks of Hosni El-Bannani style (Gazalah, 2007). X-ray radiography (Fig. 4) has been used to confirm the results.

Even with the relatively lower spectral sensitivity of the camera to near Infra-Red (nIR) radiation, the results are very encouraging to vest more in this technique.

With the transmitted IR Photography a complete and detailed image has been tured of the under-drawing with fine details of the brush strokes.

Visible and UV fluores-

Figure 5: Change of the proportions of the turban

X-ray [left] – Infrared [middle] – visible [right]

IR Photography can be conducted in several ways; reflected, transmitted, false color, fluorescence and raking light. The majority of literatures is focused on the reflected IR while the IR transmitted technique is not as prominent (Moutsatsou et al., 2011).

In this research the IR transmitted photography has been conducted; IR lights were positioned on a safe distance from the back side of the painting, while area camera sensitive in the range of 380 to 1000nm (FujiFilm Co., 2007) was facing the front side, the visible and UV radiation have been blocked by IR filter (Schneider, 2004), to capture IR transmitted images in the range of 830 to 1000nm.

Careful investigation has been conducted to analyze the results that identified clear under-drawings of a lantern in the upper right corner of the painting (Fig. 3), in addition to several modifications of the proportions of few elements like the turban (Fig. 5), drinking pottery jar and the wooden wheel.

These artistic modifications of the original composition and changing of light sources and

cence photography (Fig. 6. a : d) have been used to detect and monitor the ongoing conservation and to have an updated record of the treatments.

4.2 Ultra-High Scanning Resolution

has been used to capture surface information with different resolutions and depth of focus (Ektessabi, 2008; Toque, 2010).

The scanning is used as a non-destructive, high resolution and accurate color rendition digitization method (Fig. 7) which gave the ability to study the brush strokes (Fig. 8), fine cracks (Fig. 9) and analyze the pigments down to pixel level for spectral reflectance reconstruction.

6.a: Vis - before treatment

6.b: Vis – after treatment

6.c: UV fluorescence - before treatment

6.d: UV fluorescence – after treatment

Figure 6 (a to d): Multispectral data acquisition before and after conservation treatment

4.3 Microscopic Inspection

Optical microscope was used to inspect the different pigments (Fig. 10) in addition to the wooden frame which was identified as Pine wood and to study the weaves of the canvas which has a simple 1/1 structure (Fig. 11). While scanning electron microscope was used to study the fibers of the canvas which is composed of a mixture of cotton and linen (Fig. 12), the results have been confirmed by comparing the images with standard samples.

Figure 7: Scanning with Niji scanner (Ektessabi, 2008; Toque, 2010)

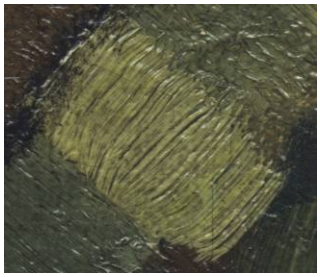

Figure 8: Brush strokes

Figure 9: Paint fine cracks

4.4 XRD and EDX

Qualitative and quantitative studies have been conducted to determine the inorganic components in the ground layer (Fig. 13) as well as the colorants of the paint layers (Fig. 14) and (Fig. 15). The results showed that the ground layer is made of a binding medium and white filler material mainly composed of Lead, Carbonate and Calcium. While the paint layer is made of Hydrocerussite, Celadonite, Ultramarine, Zincite, tite, Massicot and Carbon.

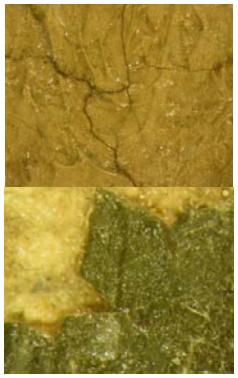

Figure 10: Close-up of Pigments

Figure 11: Canvas structure

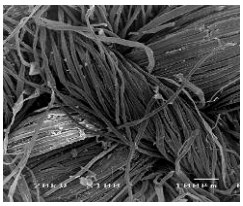

Figure 12: Fibers of the canvas using SEM

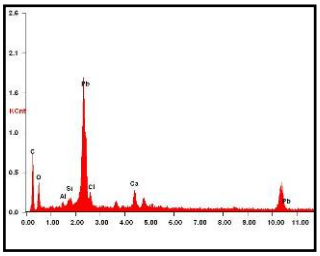

Figure 13: EDX results for ground layer

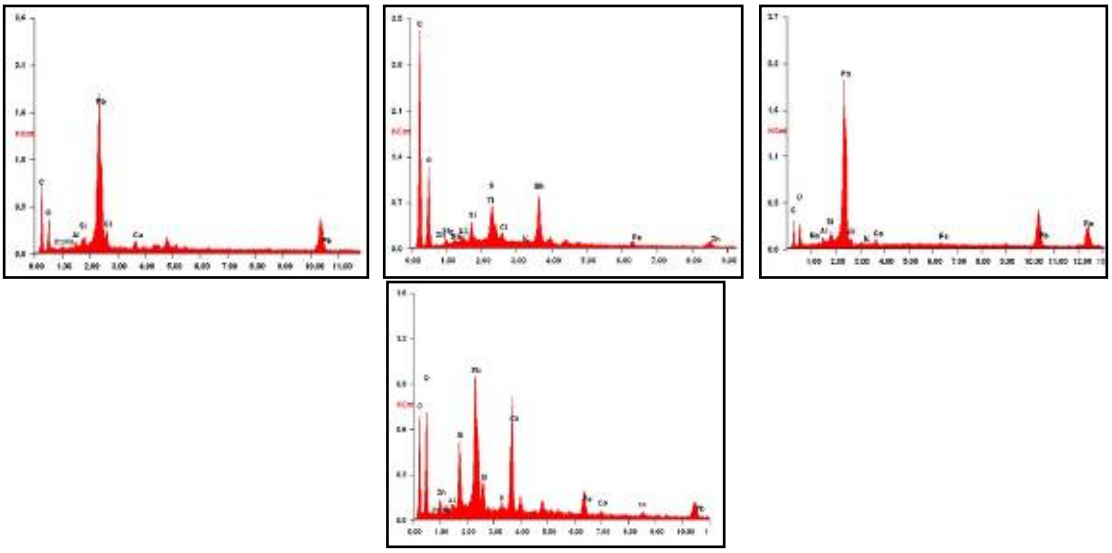

Figure 14: EDX results for paint layer (4 samples)

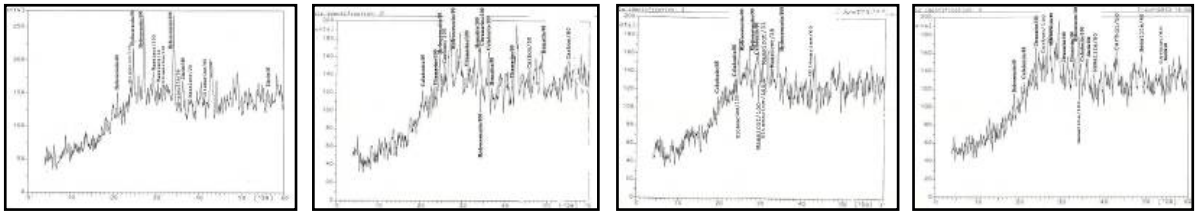

Figure 15: XRD results of paint layer (4 samples)

4.5 Fourier Transform InfraRed Spectroscopy – FTIR

The analysis has been conducted to determine the organic binding medium in the preparation layer.

The results (Fig. 16) showed that animal glue was used in the ground layer while oil was used as a paint medium, lead carbonate and barium sulphate were used as a prime layer, Oil and old animal glue contains some free fatty acids or / and ester of fatty acids.

4.6 Gas Liquid Chromatography Analysis – GLC

GLC is considered one of the most successful techniques for the determination of fatty acids of the binding medium and allow for studying the changes which take place during the aging process (Gimeno-Adelantado et al., 2001). The results of palmitic to stearic acids P/S ratio - 0.23 - identified that the Poppy Oil was used as the oil medium of the paint layers.

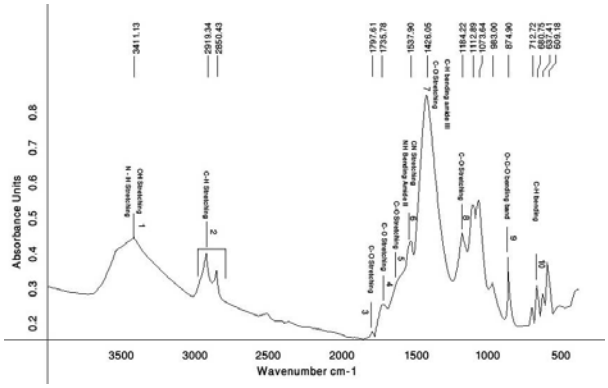

Figure 16: FTIR spectrum of binding medium

5. DISSEMINATION AND APPLICATION

Interactive application (Fig. 17) has been developed to present the multispectral information of the painting, compare different images, in addition to the identification and highlight of the under-drawings.

The data is prepared in different tabs that can be selectively ordered and the transparency value can be changed interactively to compare between layers. It has navigation bar which allows the user to zoom in and out, rotate and reset and print the screen.

Figure 17: Interactive application for investigation and presentation

All results beginning from the contextual information, digitization process and multispectral information, analytical testing in addition to the workflow can be inserted and presented interactively. The application is currently available on CDs initially dedicated to the current painting under study. While another version is under development to be available online that can serve more generic purposes.

6. DISCUSSION

IR Reflectography is considered more successful in revealing under-drawings, while IR photography is regarded as lower sensitivity, cheaper and simple method. Even with the ability of the IR Reflectography for the detection of any carbon-containing materials beneath the paint surface, it has limitations with dark varnish, thick and dark paint layers, colored chalk, brownish paints or non-carbon inks (Hand et al., 1986).

The lower spectral sensitivity of the Infrared Charge Coupled Device (IRCCD) makes it more complex to detect a reflected IR image of the under-drawings. But IR photography can benefit from the IR transmitted technique - of the verso and recto - that show more potential in this regard, taking into consideration few factors that affect the success of this method; the thickness and material of the support, the composition of the preparation and paint layers, IR reflectance property of the pigments, and the proper processing and stacking of the multispectral information.

It is also worth mentioning that few of the revealed under-drawings can be detected as protrusions in the visible range by raking light technique, but if this method used alone it may be harder to distinguish the under-drawings as meaningful elements in the composition.

7. CONCLUSION

In this research a case study has been presented for the digitization and investigation of an oil painting within a framework of a designated workflow. Different documentation and analytical methods have been applied in a multidisciplinary approach to document and investigate the artwork.

The research made use of the multispectral imaging technique which allowed for revealing under-drawings using transmitted IR photography; keep record of conservation treatments by visible and ultraviolet fluorescence photography and the high resolution digitization methods which keep record of the morphological and colorimetric information.

Technical and contextual information have been collected, analyzed and organized in a multilayered fashion to work as a fingerprint of the artwork. Furthermore, the results will be available for public through simplified, usable and user friendly systems that can handle the information by different methods and put it in a logical structure to be used by specialized and non-specialized users.

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