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Original article

THE USE OF DIGITAL TECHNOLOGY (2.5D) IN THE AUTHENTICITY OF A MANUSCRIPT FROM THE ISLAMIC ERA

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Abstract:
One of the most important challenges to libraries and museums in many countries is the problem of forged Arabic and Islamic manuscripts, especially with the increasing global interest in the last three decades of Islamic art, in general, and the Arabic manuscripts, in particular. Forged manuscripts can be completely new manuscripts. They may also include added or deleted parts- called enhanced manuscripts- to achieve a target or to meet the global market demand for such Islamic manuscripts. The present study addresses the authenticity of a Quran manuscript dating back to 1834 AD using Digital Authenticity (2.5D). The image was divided into sections. Each section was analyzed by measuring the sensitivity of light absorption by (peaks). Then, the analyzed waves were divided into low and high frequencies that were compared. If there is a forged part, it appears in the frequencies in a way that highlights its difference from the other the frequencies on all bands. While the first band shows the form of nanometric details, such as the rough surface and the non-stable image, the second highlights the difference in the distribution of ink on the surface and the shape of the grain of the ink. The third one appears in the chromatic aberration with (peaks) from the different wavelengths in paper and ink in case of forgery words.

1. Introduction

The conservation of archaeological artifacts is linked to the preservation of their historical authenticity to identify them and define their importance and artistic value. Manuscripts have been used throughout the ages. They provide important information about the nature of life at the time. Thus, they are highly important in the construction and development of civilizations. Out of our care to preserve the heritage manuscript and stop forgers from faking heritage and original history [1], we have to face such frivolity and confrontation to find solutions and stop the bleeding of the continuous forgery of manuscripts. Therefore, the present study uses an innovative, modern, scientific, and non-destructive method for the authenticity of manuscripts using digital technology (2.5D) [2,3]. This method highlights the capability of utilizing the light and records its reflection on the surface of the manuscript. Therefore, the observation is the difference between the original manuscript and the fake manuscript directly at the same time. We recommend circulating the idea to other materials and monuments to be more useful [4]. There are two methods of digital authenticity detection: **a)** Active Detection; it is making comparisons by digital images between authentic and forged documents and manuscripts and the most important utilities in

signatures and watermarks * *The letters*: It is a type of diagrams, such as a net in the area of about 16×16 PIXEL. This net is around the fake and the original word. Then, we start the comparison to extract a unique feature of the thickness of the character or the amount of light absorption of the letter. We adopted this method in the present study. * *Watermarks*: We check the watermark by inserting the original beside the forgery marks. Then, we make a grid comparison and record the differrences [5]. **b)** Passive Detection; this method does not require the original pieces or signatures, which is an advantage. A complete scan of the forgery piece is done by digital photography. The manipulation and strange words are recorded with the different color features or the distribution of the grain of ink [6].

2. Materials and Methods

2.1. *Historical samples*

The study investigated a manuscript from the Islamic era (the 30th part of the Holy Qur'an), Penman (unknown) fig. (1).

Figure (1) Shows a manuscript of the Islamic era

The manuscript is from the library of Prof. Alsayed Mohamed; director of the Arabic Manuscripts Center at Minia Univ. It measures (33.5×23 cm) and contains 28 pages. The binder was made of textile supported by cardboard and textile fibers (cotton) dyed in dark gray. The manuscript was connected with three-piece stitches and has no tongue. It was written with liquid inks from the oxides. The (red) ink was used to write the names of the Suras, ornaments of some words, and the internal frame of the page. The (black) ink was used to write the main content of the manuscript fully, while the (blue) ink was used in the work of the outer frames of the pages only.

2.2. *Experimental samples*

2.2.1. SEM-EDX Investigation

The analysis and examination of our object (case study) were done to make the corresponding samples in the laboratory of the Egyptian General Authority for Mineral Resources, the Ministry of Petroleum using SEM-EDX (*Model Quanta 250 FE2G + ED-X Unit with accelerating voltage 30 K.V. magnification 14-x up to 100000-x, and resolution for Gun.in*).

2.2.1.1. *Paper*

SEM results illustrated that the manuscript paper was probably made from cotton because cotton fibers are long; the length ranges from 10 to 65 nm. Stain and dust contamination was noticed on the surface of the original paper. Damage caused by physical factors appeared in the form of pores and the tearing of fibers. The deformation the paper appearance was also noticed, fig. (2-a). EDX analysis, fig. (2-b) showed that the additives were (S, Al, and Si) with (Na and Fe) for dissolving the red and blue inks.

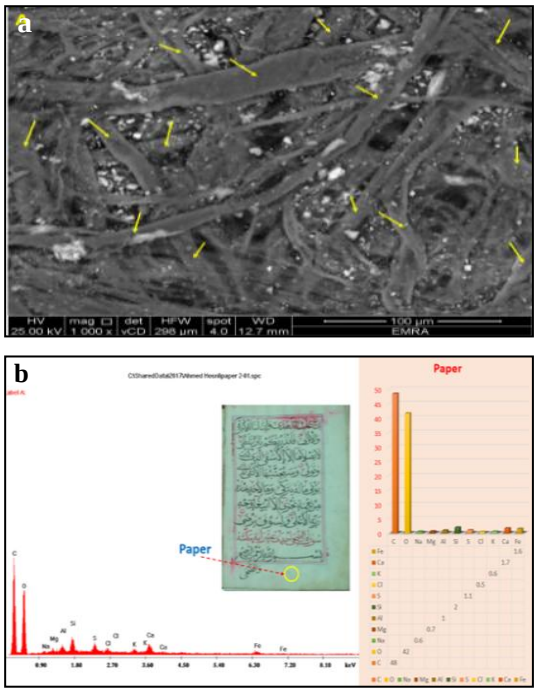

Figure (2) Shows **a.** photomicrograph of cotton fibers used in paper sample, **b.** EDX analysis of the manuscript paper using

2.2.1.2. *Inks*

***)** Blue ink; the chemical composition of the blue ink was the industrial ultramarine Sodium silicate, aluminum, and sulfur ($3NaO_3$. $3Al_2O_3$.$6SiO_2$.$2Na_2S$), fig. (3-a). ***)** Red ink; it composed of hematite with low ratio of iron. The alkaline elements (Na and Cl) and the additives (Al, S, and Si) added in the paper-making process were noticed, fig. (3-b). ***)** Black ink, The EDX analysis of the iron gall ink revealed the presence of alkaline elements (Na and Cl) and additives (Al, S, and Si) added in the process of paper-making. They were less than the red ink due to the strength of the coverage and the thickness of the black ink that blocked the emergence of the elements of the paper, fig. (3-c).

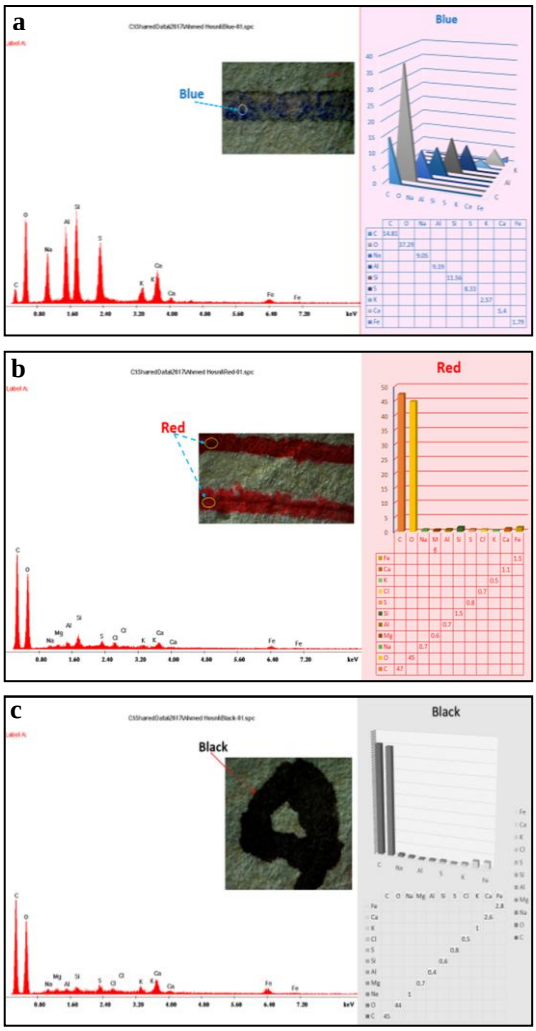

Figure (3) Shows EDX analysis of **a.** blue ink, **b.** red ink, **c.** black ink (*iron gall ink*)

2.2.2. Experimental samples preparation

The experimental samples were prepared according to the obtained results of paper and inks investigated by SEM+EDX. These results, which, proved that the paper pulp was made of cotton and contained additive materials in the pulp (*Rosin, kaolin, gypsum, and gelatin*). The experimental samples were prepared by hand mill to soften the ingredients and remove the undesirable materials (90% cotton and 10% additives). Moreover, oxides were used for the inks preparation for writing on the experimental samples. They were (black iron gall ink, hematite red, and ultramarine blue).

2.2.2.1. *Paper samples*

The experimental samples were prepared based on the analyses and tests of the applied manuscript by "*Rakta Company*" in Alexandria as shown in fig. (4).

Figure (4) Shows **a.** the pulp processing machine, **b.** experimental sample processing in a tablet form, **c.** sample in the form of a circular disk.

2.2.2.2. *Inks samples*

***)** Black ink was prepared as follow: 10 ml sulfuric acid to 20% tannic acid [7]. 100 gm grinding Pyrite **(**iron oxide**)** to the previous mixture and leaving it for three days to finally get the iron Sulphate [8,9].

***)** 100 gm industrial ultramarine **(**blue ink**)** [10,11]. ***)** 100 gm of hematite **(**red ink**)** by grinding and mixing them with 20 Arabian gm [12].

2.2.2.3. *Handwriting on the samples*

The experimental samples were written using red ink (hematite**),** black ink **(**iron gall ink**),** and blue **(**ultramarine**)** as shown in fig. (5).

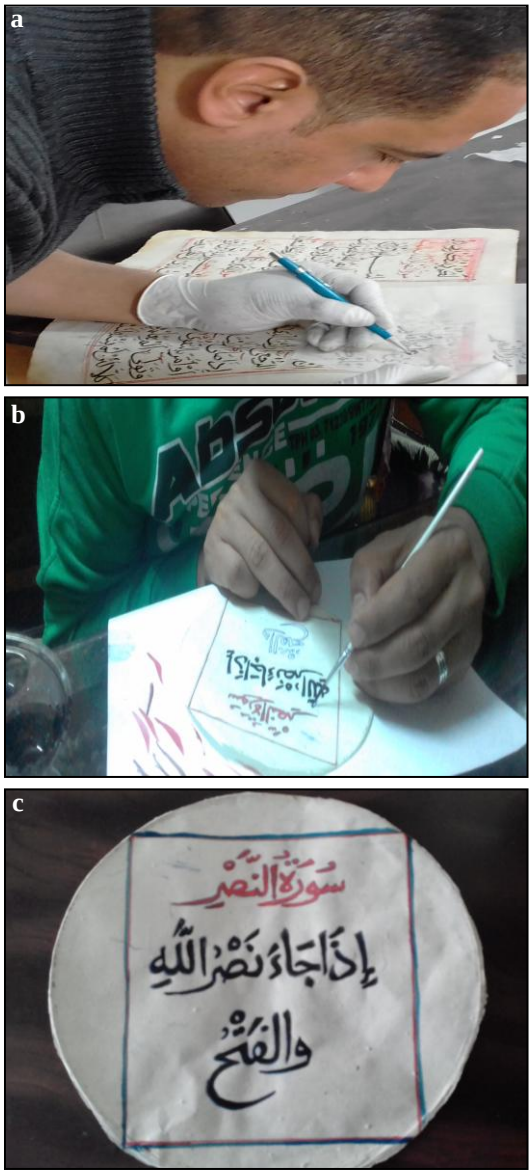

Figure (5) Shows **a.** copying the applied manuscript, **b.** writing with the same oxides used in the applied sample, **c.** final experimental sample

2.2.2.4. *Stereo microscope imaging*

Zeiss microscope model (*Stemi 508*) at the laboratory of restoration dept., faculty of fine arts, Minia University was used for the examination and imaging of the samples by (2.5D) digital technology.

3. Results

The investigation results of paper and inks using (2.5D) technique proved those there notable variations between original samples and experimental ones. All of these results could be summarized as follow:

3.1. *Investigated paper*

(2.5D) technique showed the difference in the topography of the applied manuscript surface. It is not flat to the experimental sample. In addition to the apparent difference in the sensitivity of light absorption, we noted that the applied manuscript absorbed much falling light and reflected a little to the topography of its uneven surface. Therefore, the optical bands appeared as one band in the spectral field of the red color. On the contrary, the experimental sample maintained the reflection of the big portion of the falling light and absorbed a little because of its even surface. Each band appeared separate from the three optical ranges as shown in fig. (6).

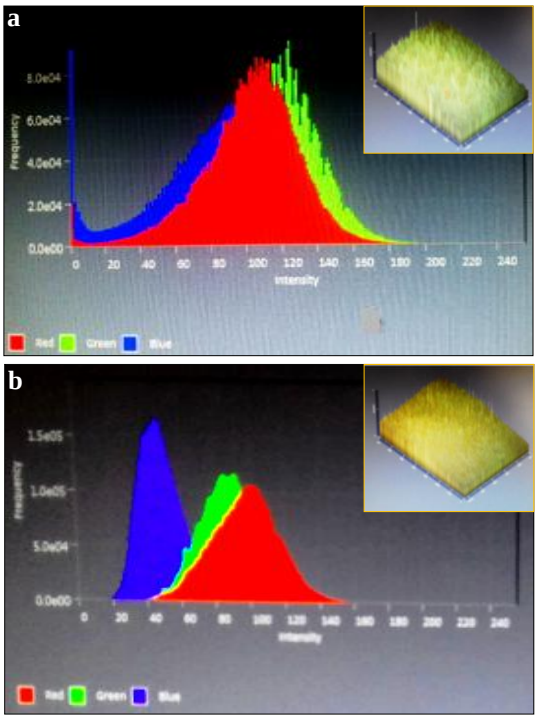

Figure (6) Shows 2.5D imaging of paper in **a.** the applied sample, **b.** experimental sample

3.2. *Investigated inks*

3.2.1. The blue ink

The comparison of the blue ink in the experimental and applied samples showed its weak coherence in the applied manuscript. It spread unevenly on the surface, and there were separate granules. On the contrary, the blue ink in the experimental sample showed a coherent color. There was an apparent difference in the sensitivity of the spectral absorption that was seen in the less capacity of the applied manuscript to absorb the blue spectrum, increasing the intensity of the blue spectrum of the applied manuscript as shown in fig. (7).

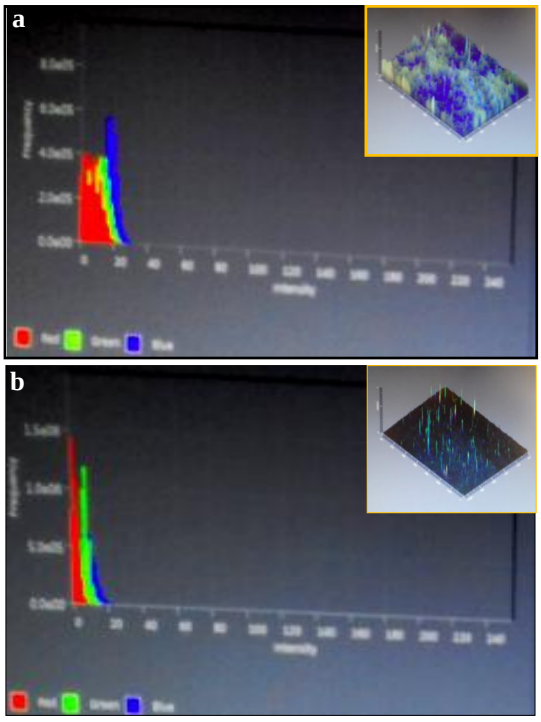

Figure (7) Shows 2.5D imaging of blue ink in **a.** the applied sample, **b.** experimental sample

3.2.2. The red ink

The comparison of the red ink in the experimental and applied samples showed melting the red ink in the applied manuscript. It spread widely on the surface. In the experimental sample, the color appeared coherent. However, the strength of the coverage of both samples was weak. An apparent difference in the sensitivity of the absorption of the spectrum was observed in the breadth of the red color in the applied manuscript that absorbed the red spectrum less than the experimental sample, as shown in fig. (8).

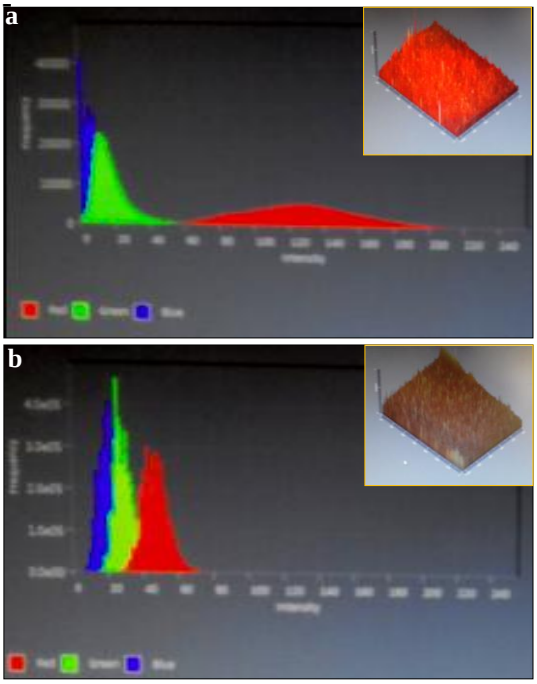

Figure (8) Shows 2.5D imaging of red ink in **a.** the applied sample, **b.** experimental sample

The black ink

The comparison of the black ink in the experimental and applied samples showed a significant similarity in the strength of the coverage and the sensitivity of both to the color. However, the distribution of the black ink granules in the applied manuscript was less coherent than the experimental sample as shown in fig. (9).

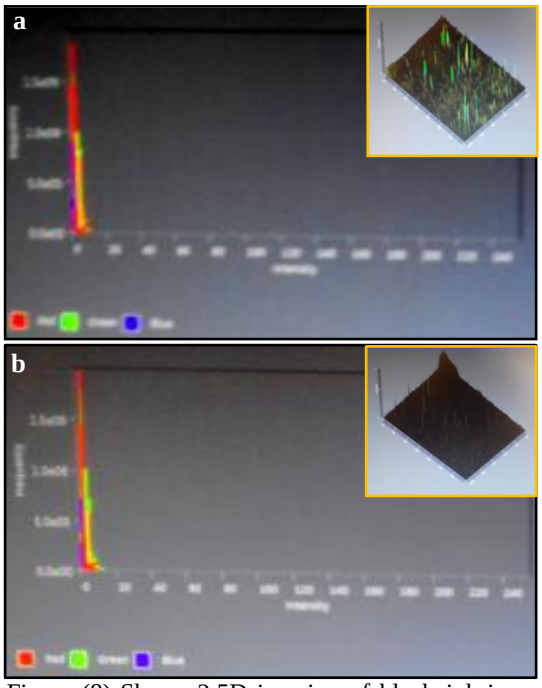

Figure (8) Shows 2.5D imaging of black ink in **a.** the applied sample, **b.** experimental one

4. Discussion

Through evaluating the investigation results by 2.5D technique, it could be asserted that there are changes between the historical paper and experimental samples. The surface of the Islamic manuscript was uneven, and the optical range appeared as one beam in the red color range. While the surface of the experimental sample was even, and the three optical ranges appeared in a separate form. The uneven surface of Islamic manuscript is due to the drought affected the manuscript, where, one of its areas absorbed much falling light and reflected a little of its uneven surface. Moreover, the optical bands appeared as one range in the red color spectrum, unlike the experimental sample whose flatness helped reflect all ranges. The results of examining ink in both original and the experimental manuscript revealed that the red ink in the original manuscript, spread more widely than the red ink in experimental sample. However, the light absorption range in the experimental sample was higher. The wide bleeding of the ink in the Islamic manuscript was attributed to its higher solubility, and this led to the wide thawing made the light absorption less and the reflection more. The absorption range of light in the experimental sample was higher than the applied manuscript. Regarding the blue (ultramarine) ink; it is unlike the experimental sample, it is spread unevenly on the surface with the distribution of separate granules in the applied manuscript. The blue ink completely lost the water content so it spread looser than the ultramarine in the experimental sample that retained the moisture content. The distribution of the black ink grains in both the applied and experimental samples was significantly similar due to the stability of iron ink in both samples.

5. Conclusion

The 2.5D scanning technique proved the possibility of detecting the fake and the added areas in the manuscript, whether paper or ink. It is one of the decisive methods for authenticity and detecting forgery. Furthermore, it is difficult for the forger to overcome. Therefore, we recommend disseminating it for rooting the artifacts. This study on the authenticity of manuscripts using (2.5D) technique may be the first of its kind in the field.

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