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The comprehensive practical documentation of one of the spaces of the historical palace in Cairo for starting Conservation work - case study

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ABSTRACT

Many historical buildings and palaces in Cairo, Egypt are exposed to several damaging factors. Therefore, this research deals with the comprehensive documentation of archaeological buildings including documentation, research, examination, recording, analysis of materials, structural analysis, and physical and mechanical tests for alternative mortars. The ground floor of the Historical Cairo palace was documented, using AutoCAD and a manual meter to draw walls and openings. The spaces were then numbered in a fixed system for all the building's spaces, walls, and openings. After that, the wall to be documented is determined on the horizontal plane, then the wall is photographed using professional cameras. Filming is done in a fixed system, from right to left, where the first picture includes the entire wall from the top down the images are sequenced from a fixed distance, and finally, Photoshop is used to assemble the images and display the wall as a whole. All wall elements are photographed and placed in matching panels; the details are drawn using the images on the AutoCAD program to a specific drawing scale. Afterwards, a map is made of where the damage appears and color detectors are created to determine and analyze the original color layers. This then displays some selected modern devices that depend on the laser scanning technology used in the field for documenting heritage and archaeological buildings.

INTRODUCTION:

Many historical buildings and palaces in Cairo, Egypt are exposed to numerous damaging factors, so restoration projects are being implemented for these historical palaces and buildings, such as the Baron Palace, Al Zafaran Palace, Aisha Fahmy Palace, Amr Ibrahim Palace...etc in Cairo – Egypt. Therefore, this research aims to document, the steps of examination and analysis as an application to one of the spaces of the historical palaces in Cairo, Egypt. Three-dimensional modeling from images when carried out entirely by a human, is time-consuming and impractical for large-scale projects, Three-dimensional (3D) image acquisition systems are rapidly becoming more affordable, especially systems based on the availability of electronic cameras. (Bernardini, F. & Rushmeier, H 149: 172)

Efforts to model the appearance and dynamics of the real world have produced some of the most compelling imagery in computer graphics. In particular, are those that model

architectural scenes, from the Amiens Cathedral to the Giza Pyramids to Berkeley's Soda Hall, which have produced impressive walk-throughs and inspiring fly-byes. It is an attractive application to be able to explore the world's architecture unencumbered by fences, gravity, customs, or jetlag. (Debevec, P. E., Taylor, C. J. & Malik, J 11:20)

Occlusions, lack of texture, and light variations between images are persistent problems for stereo matching, especially with widely separated views. (Terms, R. T. NRC Publications Archive)

In Photographic documentation with digital cameras, images are processed electronically by a computer. Documentation work was almost exclusively carried out at night, to avoid the effects of non-controlled, unwanted ambient light. Raking light (i.e., direct light projected onto the subject at a very oblique angle) was used for all photographs. This has the advantage of producing a strong contrast that often helps to bring out the eroded contours of figures and glyphs. The disadvantage of this technique is that, on very battered surfaces, it also brings out all the imperfections and scrapings on the rock, making it hard to distinguish between true carving and the random scratches produced by weathering and erosion. (Lara, J. P. De & Justeson,J)

Digital cameras are considered one of the most important devices used on archaeological sites, as they are distinguished by their high-quality images, and by their connection to a computer, hundreds of images are obtained daily with the ability to filter out and delete invalid ones. Knowing the result of the shooting immediately and printing it on plain paper or photographic cards, including models that can depict moving images (digital video), is invaluable. A picture can be stored digitally by representing the brightness at each of the points shown by a binary number.

For a color picture, each point becomes a vector, that describes the brightness, hue, and

saturation of that part of the picture. (John Watkinson)

After completing the photographic documentation work, the images are classified, stored, saved, and archived in a specific system on the computer memory, so that a fixed and organized system is created to encode roles, number the spaces in the building, and number the walls and openings (doors and windows). Then items are made to place the pictures according to the specific data which is agreed upon between the owner and consultant of the project. Then the architectural and spatial lifting is done using the Total Station device.

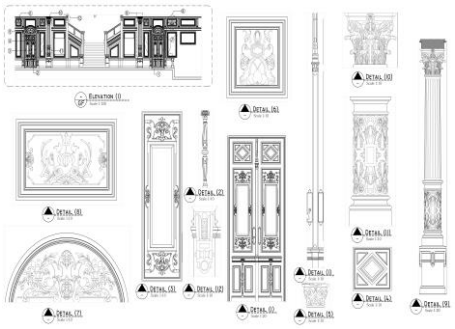
Color detectors are made after the architectural and photographic recording and documentation of the damage have been examined, and analyzed, color detectors are made on the walls, ceilings, and doors to identify the color sequence of the paints to enable reproduction of the original type of paints that are approved by the responsible authorities. This will assist us in understanding the correct components for restoring paints with the same original color. After carefully restoring the preparation layer and the layer of putty under the final color, the multiplicity of paints and colors reveals the palace's use of administrative work, which resulted in painting several times in spaced periods

1-Comprehensive documentation of historical buildings:

1-1 Documentation:

Photographic documentation of the current status of the architecture of this Historical Building is recorded during work and after the completion of the restoration work. (Emad Eldin Ibrahim)

The digital documentation and 3D modeling of Cultural Heritage monuments and sites have received great attention in the last years. (a Rizzi and others)



After restoration

Before restoration

1-2 Search:

Here, research and studies are carried out on the history of antiquity, its ancient techniques of implementation, the age of construction, its building styles, the archaeological, historical, and descriptive study of antiquity, the stages of its creation, the additions made to it, and a description of its structural and architectural elements (Emad Eldin Ibrahim)

1-3 Examination :

The entire architectural and structural elements of the building are examined using different types of microscopes such as the scanning electron microscope ،optical microscope ، polarizing microscope ،and digital microscope (Emad Eldin Ibrahim)

1-4 Recording:

At this stage, all data is monitored and recorded in both printed and digital files on computers with a tight system for ease of handling and ease of recall of the data.

1-5 Material analysis:

This is done using both chemical analysis and X-ray diffraction methods to know the compounds of materials, X-ray fluorescence, analysis using infrared and Raman rays, and analysis using the scanning electron microscope (EDAX) unit for analysis of material elements and analysis of microbiological injuries (Emad Eldin Ibrahim)

1-6 Structural analysis:

This is done by using computer programs to analyze pressures and loads and distribute them on the archaeological structure to monitor places of high pressure, treat them, and strengthen them, especially columns, beams, and foundations (Emad Eldin Ibrahim)

1-7 Testing of building materials:

Here physical mechanical tests are done on materials such as measuring density, weight, and porosity, and mechanical tests such as stress tolerance, tensile strength, flexibility, and others.

2-How to document photographic, photogrammetric, and architectural for one of the interior facades of the lobby of the ground floor of the Zafaran Palace - Ain Shams University:

2-1 The horizontal projection of the ground floor of the palace is worked out using the meter and drawing the walls and openings with AutoCAD.

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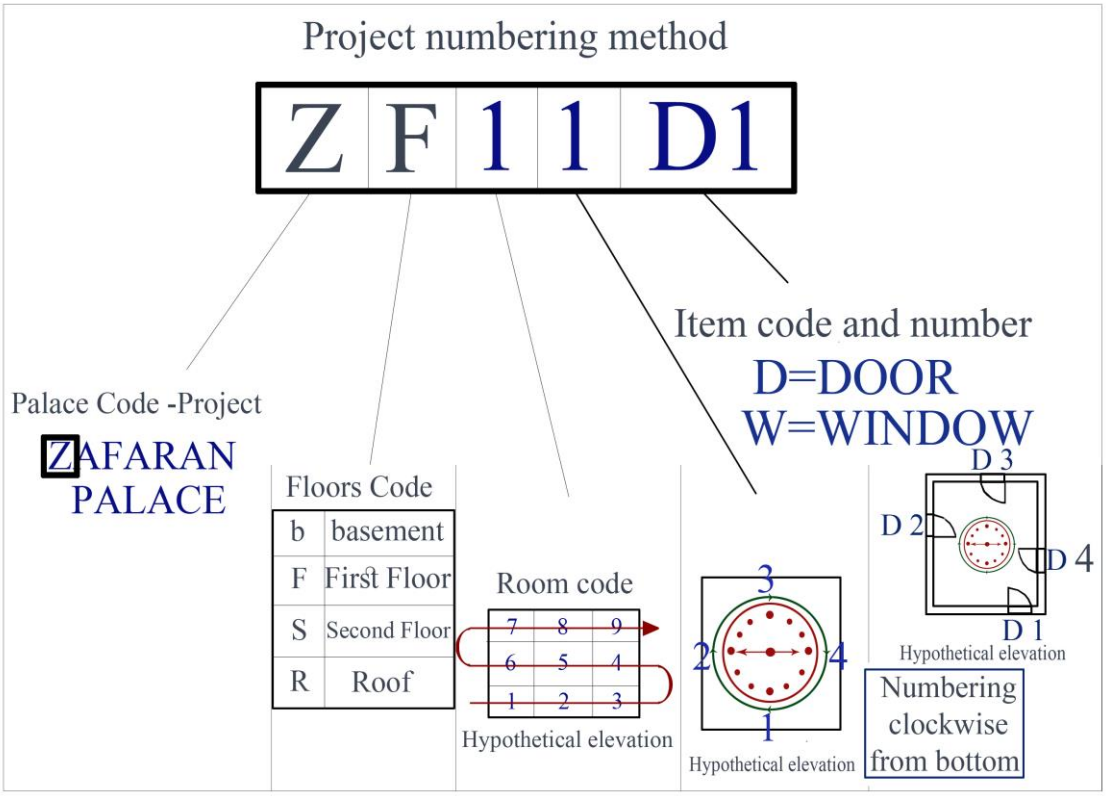
2-2 Spaces are numbered in a fixed system for all spaces, walls, and elements.



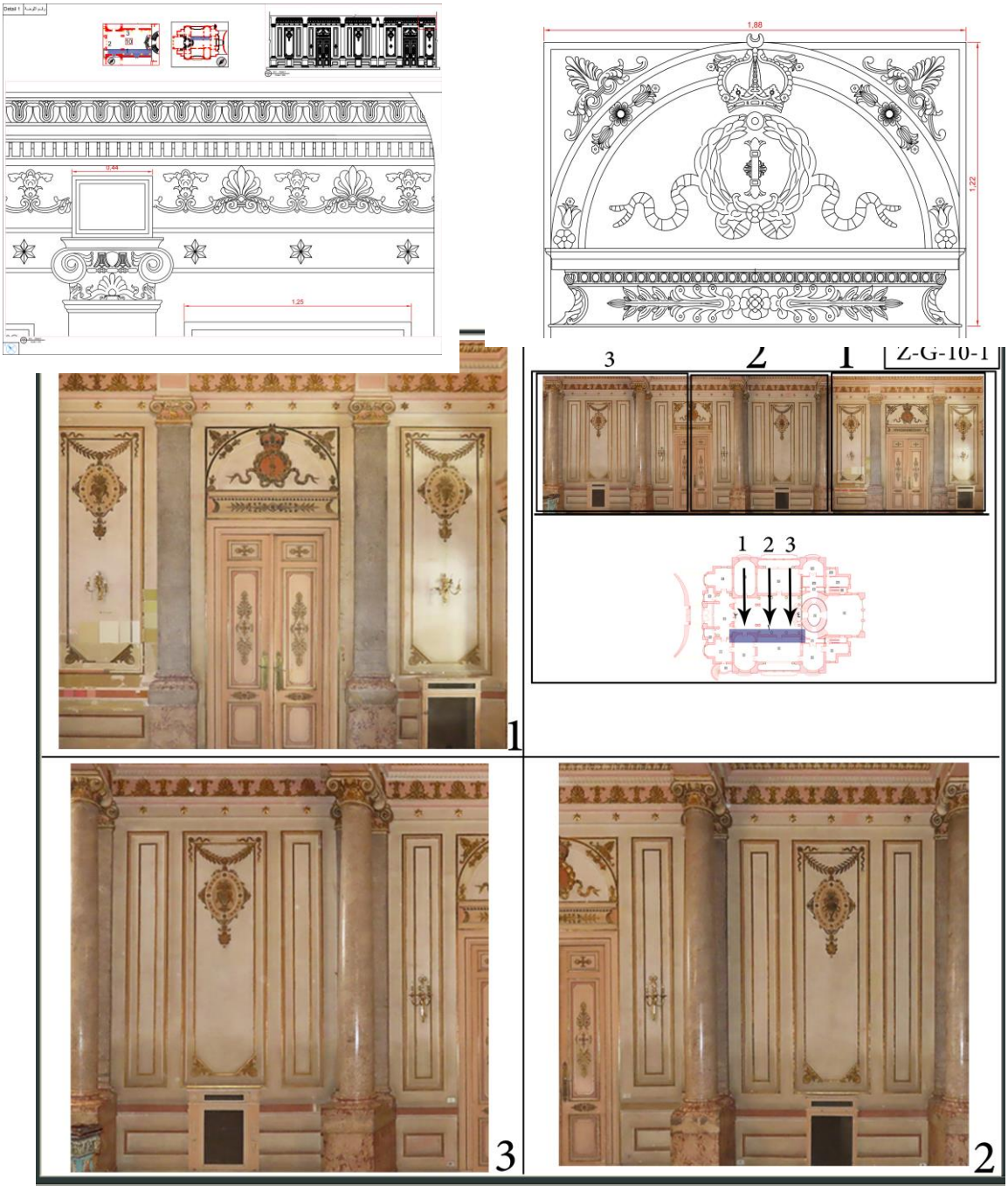
2-3 The wall to be documented is determined on the horizontal plane of the space.

2-4 The wall is photographed using professional cameras, and shooting is done in a fixed system, from right to left, the first image includes the entire wall from top to bottom, then the images are sequenced from a fixed distance and the Photoshop program is used to assemble the images and form the wall as a whole.

Z-G-10-1

2-5 All elements of the wall are photographed and placed in coordinated panels.

2-6 Then the details are drawn using these images on AutoCAD, with fixed dimensions and drawing dimensions relative to the dimensions of the palace at a specific scale.



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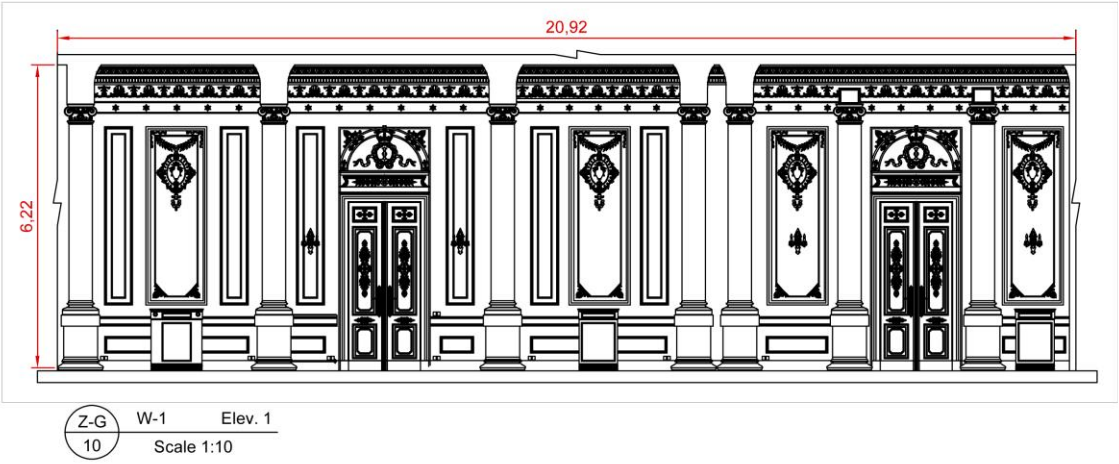
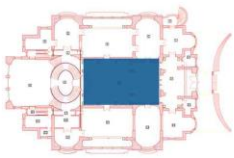
2-7 Next, the entire interface is drawn according to the combined image.



2-8 Then a map of the appearance of damage to the wall is made according to the site.

2-9 Finally, the detectors are made to show the stratigraphic sequence of the colors used in the palace in the past.



2-10 Original color layer analysis:

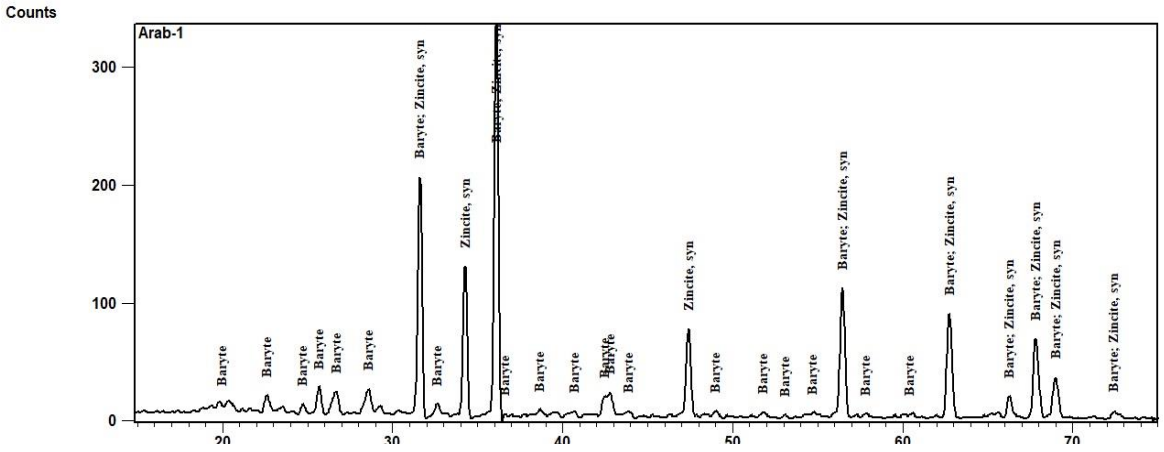
2-10-1 sampling location.

2-10-2 during sampling

2-10-3 Examination of the sample using a digital microscope.

The sample consists of peels from the color layer and a thin layer of the preparation layer, the color tends to be olive, and the preparation layer tends to be white.

2-10-4 Analysis using X-ray diffraction:



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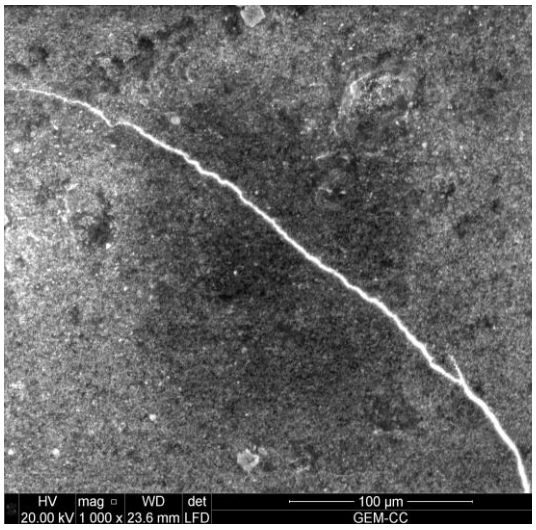
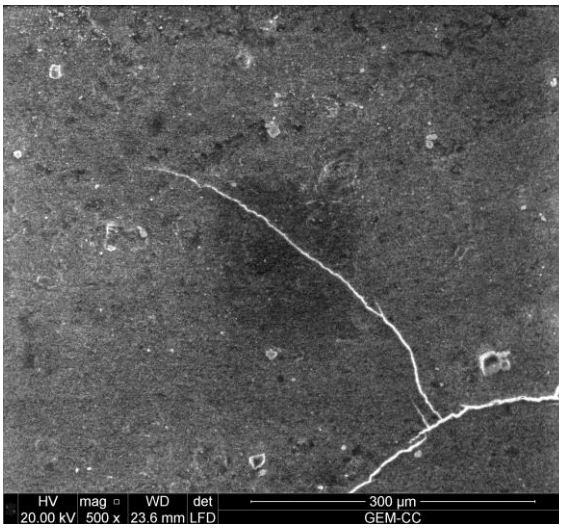
Ref. Code	Mineral Name	Chemical Formula	Semi quant (%)
01-079-0208	Zincite, syn	Zn O	85 %
01-072-1390	Baryte	Ba S O_4	15 %

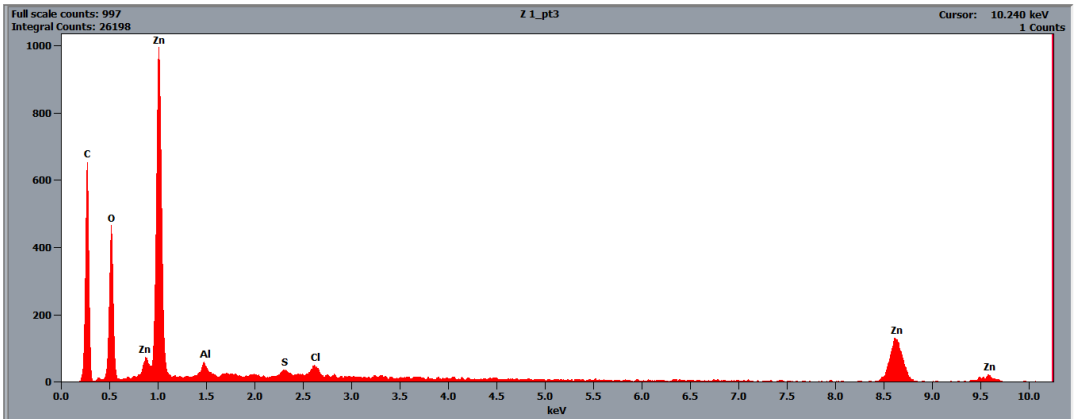
(Zn O) Zincite: This is zinc oxide, and it is the main component of the analysis using X-ray diffraction. It is used in the manufacture of paste, preparation, paints, and colors with which the interior facades of buildings are painted. The quality of the sample explains that these paints are modern paints.

Baryte (Ba So4): It is a compound mineral of barium sulfate, and it is often white or colorless and has color added. It is an industrial component used in the manufacture of modern paints and colors, and it is the component of the outer color layer.

2-10-5 Examination and analysis using a scanning electron microscope:







Element	Z 1_pt3			
	Intensity	Net Counts	Weight %	Atom %
C K	10.21	3062	32.11	53.36
O K	7.29	2188	26.45	32.99
Al K	1.13	340	1.29	0.95
S K	0.78	235	0.59	0.36
S L (D)	0.00	0	---	---
Cl K	1.18	353	1.02	0.57

Per % - 3	Per % - 2	Per % - 1	Element	
32.11	23.29	25.65	C	Carbon
26.45	22.79	22.44	O	oxygen
1.29	0.73	0.71	All	aluminum
0.59	0.49	0.37	S	sulfur
38.55	52.71	50.84	Zn	zinc
100	100	100		

Three samples were taken from different places for analysis using a scanning electron microscope.

The Axia ChemiSEM is unlike traditional SEMs in that it always collects EDS data in the background. It uses unique algorithms to process the SEM and EDS signals simultaneously, allowing it to display the morphology and quantitative elemental makeup of a sample together in real-time. It constantly processes EDS data in the background, giving you live updates on elemental data as it is acquired. Elements found in your sample can be toggled on and off, allowing you to isolate areas of interest. The Axia ChemiSEM features a superior user experience enhanced by automation, such as Smart Align technology for alignment-free operation, newly developed automatic functions, and live quantitative EDS mapping. This always-on processing makes analysis twice as fast compared to traditional methods. The Axia ChemiSEM Scanning Electron Microscope puts SEM/EDS analysis within reach of a wider scientific audience, speeds up your workflow, and saves time on training.

The result of the analysis using a scanning electron microscope is consistent with the analysis by X-ray diffraction, where the predominant proportion is zinc oxide.

Summary of the examinations and analyses of the sample:

Zinc oxide is the main component of the preparation layer and the putty under the paint. Barium sulfate is the main component of modern paints with a color layer, and sulfur and aluminum are added to the barium, which is the component of the modern color layer in the sample.

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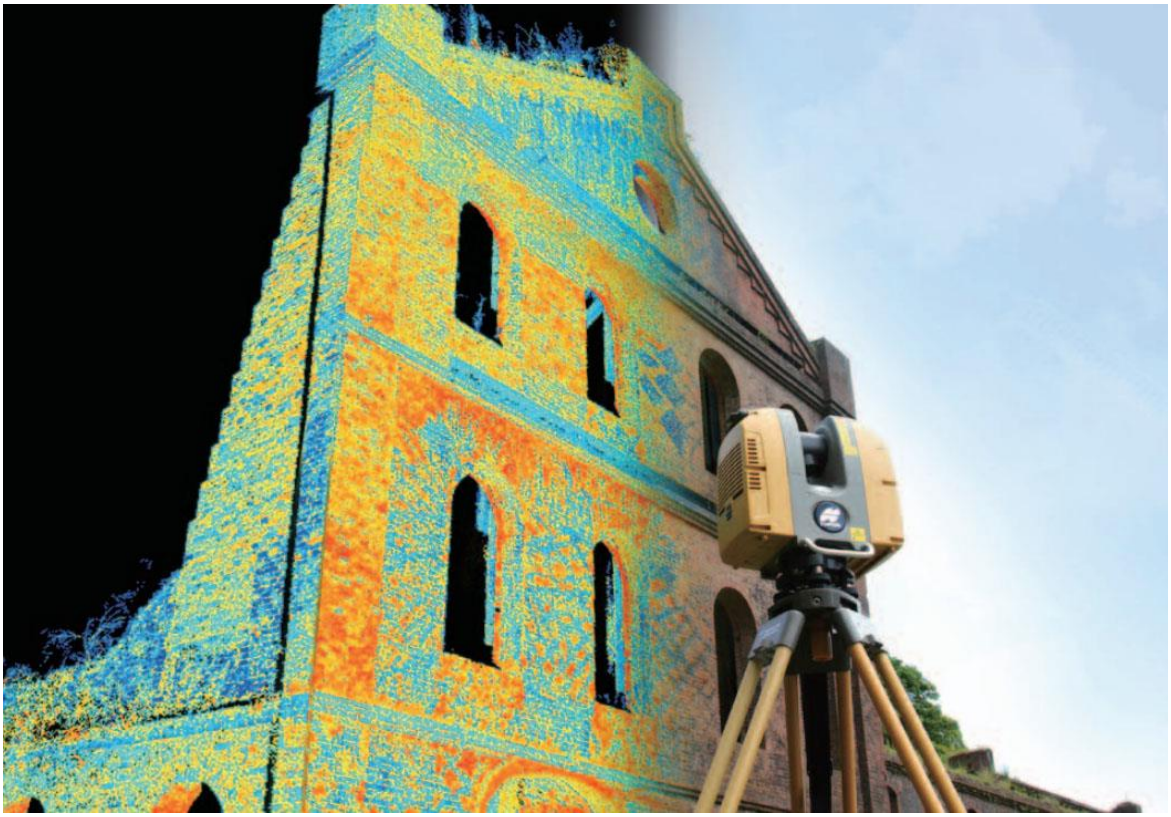
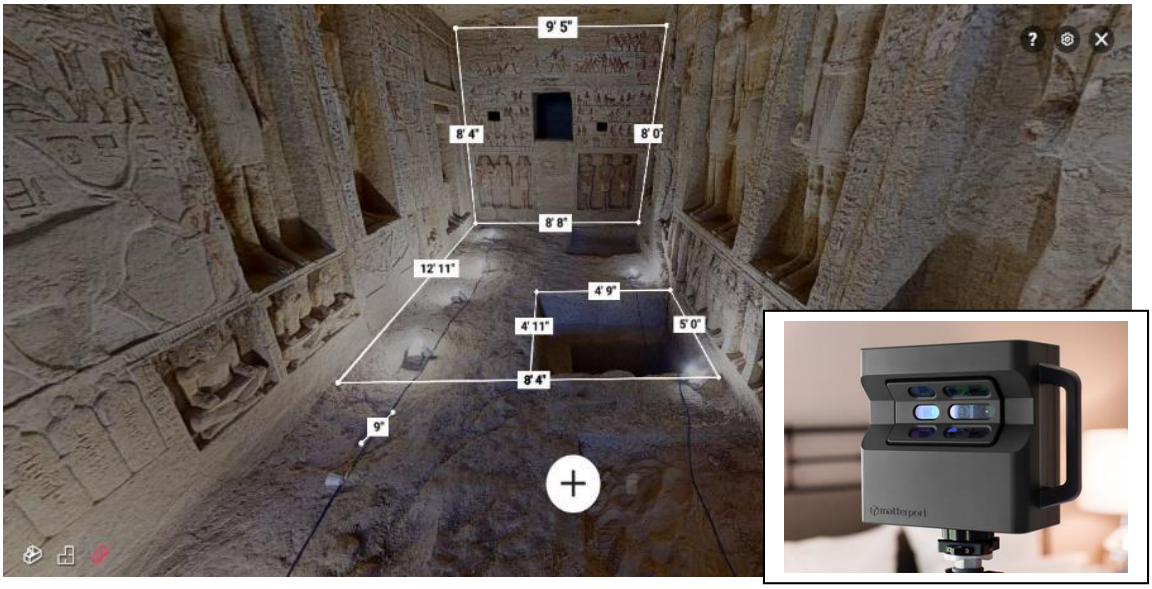
3- Some of the selected modern devices that depend on the laser scanning technology used in the field of documenting heritage and archaeological buildings:

3-1 Topcon -GLS-2000. Laser Scanner Device:



This laser scanner is fast and accurate and can be used anywhere. It is characterized by its small size and lightweight. It scans the place at an angle of 360 degrees in a few minutes and is characterized by ease of operation and dual internal cameras, therefore it is one of the modern devices suitable for use in archaeological sites of all shapes and sizes.

3-2 Matterport standard cameras and their applications in the field of archaeological documentation:



These cameras monitor several consecutive shots of the building with a uniform and sequential traffic system. These snapshots, using certain applications, result in an imaginary visit to the building. Through this application, the image is enlarged or reduced, the distances between points are measured, and thus the dimensions of the site or inscriptions are known. The manifestations of damage are depicted, and its details and dimensions are monitored.

3-3 Leica PLK360. Standard 3D Laser Imager Scanner:

This is a 3D laser scanner equipped with cameras observing 360° x 300° with a spherical imaging system and a 360° x 70° panoramic thermal imaging system. It is used to photograph and survey archaeological sites, heritage buildings, and excavations by monitoring several consecutive snapshots to create an imaginary path for an imaginary visit to the site while monitoring dimensions and distances using specific applications.

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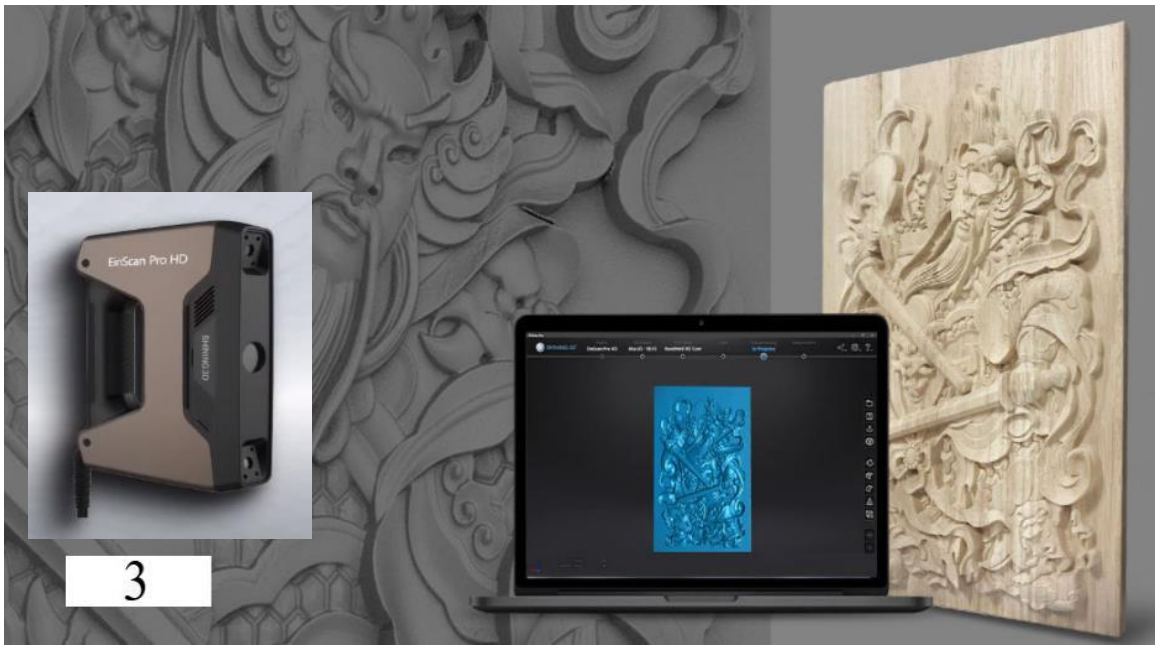
3-4 AinScan Precision Laser Scanner:

The work of this device is based on optical surveying using laser beams and its return and recording using an application program that complements the documentation process and converts data to a point cloud. It can be done using the same program to convert a point cloud into a surface by connecting these points to give a flat, homogeneous, and continuous shape.



3-5 Geoslam Zeb horizon laser scanner:

It has a range of 100 meters and is used to lift buildings, sites, and archaeological excavations. It is light in weight, easy to carry and use, and can be held in the hand while moving with it, or by attaching it to a car or a drone to survey large sites at high speed and with high accuracy.

Results:

Determine a specific implementation method for documenting historical buildings according to the following:

1- Encoding all palace spaces with codes organized in a fixed system.

2- Documenting these spaces in a fixed system.

3- Complete photographic documentation of the palace spaces in a fixed system.

4- Complete architectural documentation of the palace spaces with a fixed system.

5- Documenting the manifestations of damage to the spaces of the palace in a fixed system.

6- Examining and analyzing all minor elements in a fixed system.

7- Identify the modern devices used in documenting buildings, facilities، and heritage sites.

Conclusions:

An organized foundation is laid for the process of documenting historical buildings.

The foundations were laid for the quality of photographic and architectural documentation and the manifestations of damage in projects for the restoration of archaeological buildings.

The foundations of the examinations and analyses to be carried out for the colors and layers of color greening in historical buildings have been laid.

How color detectors work for interior wall color layers in historical buildings.

Using modern techniques for 3D modeling and laser architectural lifting.

Recommendations:

We recommend the use of all these modern devices in documenting and raising heritage, historical, and archaeological buildings, or using the appropriate ones in architectural and three-dimensional lifting and scanning using laser beams.

These modern technologies have many benefits in terms of extreme accuracy and speed, and therefore the speed of completion of the documentation and restoration process for heritage buildings, as well as preserving this architectural heritage from extinction or damage and forming a digital archive of three-dimensional models of heritage buildings that help us with virtual visits to those sites in the future.

Due to the exposure of many heritage buildings to various damaging factors and their survival for hundreds and sometimes thousands of years, we stress the need to make digital models through modern devices to make a digital cloud and models that simulate the original three-dimensionality to preserve this heritage.

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BIBLIOGRAPHY:

- Range, C. & Techniques, V. NRC Publications Archive Archives des publications du CNRC Semi-automatic 3D Reconstruction of Occluded and Unmarked Surfaces from Widely Separated Views Semi-automatic 3D Reconstruction of Occluded and Unmarked Surfaces from Widely Separated Views *. (2002).
- Bernardini, F. & Rushmeier, H. The 3D model acquisition pipeline. Comput. Graph. Forum 21, 149–172 (2002).
- Debevec, P. E., Taylor, C. J. & Malik, J. Modeling and rendering architecture from photographs: A hybrid geometry- And image-based approach. Proc. 23rd Annu. Conf. Comput. Graph. Interact. Tech. SIGGRAPH 1996 11–20 (1996) doi:10.1145/237170.237191.
- Terms, R. T. NRC Publications Archive (NPArC) Archives des publications du CNRC (NPArC) Images A Sequential Approach to Capture Fine Geometric Details from Images *. (2014).
- Lara, J. P. De & Justeson, J. FAMSI © 2006: Jorge Pérez de Lara and John Justeson Photographic Documentation of Monuments with Epi-Olmec Script / Imagery. (2006).
- John Watkinson, The Art of Digital Video, The Art of Digital Video, 2013.
- Emad Eldin Ibrahim Hamed Osman, Study on Conservation of Architectural Stucco in Historical Buildings Applied on Some Selected Models, Cairo University, Faculty of Archaeology, Conservation Department THESIS, THESIS Sub. (2019).
- Rizzi and others, 'Digital Preservation, Documentation and Analysis of Paintings, Monuments and Large Cultural Heritage with Infrared Technology, Digital Cameras, and Range Sensors', International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 36. (Part5/C53) (2007), 1–6.
- Osman, 'Surveying and Architectural Drawing Curriculum Book 2 - Faculty of Archeology - Ain Shams University'.
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التوثيق الشامل لأحد فراغات القصور التاريخية بالقاهرة للبدء فى أعمال الترميم - دراسة حالة

الملخص

تتعرض العديد من المباني والقصور التاريخية في القاهرة -مصر للعديد من عوامل التلف ،لذلك يتناول البحث التوثيق الشامل للمبانى الأثرية من توثيق وبحث وفحص وتسجيل وتحليل المواد وتحليل إنشائى و إختبارات فيزيائية وميكانيكية للمونات البديلة ،كما يتناول البحث خطوات التوثيق الفوتوجرافى و الفوتوجرامترى والمعمارى لأحد فراغات مدخل الدور الأرضى لقصر الزعفران -جامعة عين شمس ،وذلك بعمل المسقط الأفقى للدور الأرضى للقصر بإستخدام برنامج الأوتوكاد والمتر اليدوى لرسم الحوائط و الفتحات ،ثم يتم ترقيم الفراغات بنظام ثابت لجميع الفراغات والجدران والفتحات بالمبنى ،ثم يتم تحديد الحائط المراد توثيقه على المسقط الأفقى ،ثم يتم تصوير الحائط بإستخدام كاميرات إحترافية ،ويتم التصوير بنظام ثابت ،حيث يتم التصوير من اليمين إلى اليسار ، وتشمل الصورة الأولى الحائط بالكامل من أعلى إلى أسفل ،ثم يتم تسلسل الصور من مسافة ثابتة ويستخدم برنامج الفوتوشوب لتجميع الصور وتشكيل الحائط ككل ،يتم تصوير جميع عناصر الحائط ووضعها في لوحات متناسقة ،ثم يتم رسم التفاصيل باستخدام هذه الصور على برنامج الأوتوكاد بمقياس رسم معين ،ثم عمل خريطة مظاهر التلف وعمل المكاشف اللونية لتحديد طبقات الألوان الأصلية وتحليلها ،ثم عرض بعض الأجهزة الحديثة المختارة التي تعتمد على تقنية المسح بالليزر المستخدمة في مجال توثيق المباني التراثية والأثرية.

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بيانات المقال

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تم استلام النسخة المنقحة في ١٤ يونيه ٢٠٢٣
تم قبول البحث في ٢ فبراير ٢٠٢٤
متاح على الإنترنت في ١٠ اغسطس ٢٠٢٤

الكلمات الدالة

توثيق الآثار؛
التوثيق المعمارى؛
الفوتوجرامترى؛
الفحوص؛
التحاليل.

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