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Mini Review: laser scanning intensity data applied to damage detection for historical buildings

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Abstract

The usage of both continues wave and pulsed lasers in archeology growing day by day. For the new members in this field it is very important to the readers to understand the bad effect of using this technique on the archeological objects. This mini review built completely by very young archeologists and directed to their equals in both under and post graduate colleagues. In this mini review we presented the effect of lasers and some methods to determine that effect as a step towards developing this important technique.

Keywords: Archeology- Restoration- Conservation- Culture heritage- Laser

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Introduction

Protection and preservation of the cultural heritage, utilizing various restoration techniques that could be used to alter the works of art, depending on the materials, the type of decay, also the historical importance of the work.

In some cases, conservators have enough knowledge to identify the problems and give a rapid diagnosis: he can easily identify a localized detachment of rendering layers using an acoustical sounding, and decide to stabilize the layer with a suitable grout. In some other cases, a characterization of the material by means of physical and chemical analytical techniques is necessary. Indeed, before any decision concerning the restoration of a work, it is important to know as precisely as possible the nature and structure of the artwork areas to treat and the actual damages to adapt conservation products and techniques used [1-6]. The Cultural Heritage's analysis follows two main paradoxical constraints: given the historical value of the works studied, the samples require that the intrusion of laboratory analytical techniques should be as limited as possible, to minimize their number and quantity, but however, information must be as complete as possible to answer questions. A third constraint concerns the speed of analysis, needed for a reactive decision and a sound support to conservators and curators' work.

Before and after any work on the archeological objects some investigations should be done on aged models simulates the actual historical piece to be sure from the correctness of the used methods. Spectroscopic investigations should be done using molecular and atomic spectroscopy to be sure from the end product that this method will not affect the real object. Such an example of the spectroscopic techniques are the FTIR, Raman, Micro-spectroscopy, LIPS, UV-Vis spectrophotometry, molecular modeling and simulation could help prior any actual work to select the preservation method and if it will affect the molecular structure of the object or not [7-12].

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The top features of laser

Laser techniques are among the modern technologies that have entered the field of antiquities restoration and maintenance as a tool for examining the archaeological material and identifying the most important elements of its components in addition to the use of laser beams in cleaning the surfaces of the archaeological material from what has been attached to it from the various damage products of an organic or inorganic nature by breaking the bonding and adhesion between These outputs and surfaces of this substance1.

Where laser technologies are distinguished by several advantages over other techniques used in the field of analyzing archaeological material and diagnosing its current state, and on its surfaces or between its components, damage products of varying source and severity.

Among the most important of these features are the following:

1- Laser techniques are not non-destructive, M. As trace material samples are not taken for analysis and examination as is the case with most techniques.

2- It is a method whose rates and directions can be controlled without touching the surface of the trace material.

3- It saves time and effort and can be used outside the walls of the factories, whether inside museums or in archaeological sites.

4- A healthy and safe method for those who use it if it is used based on experience, scientific principles and rules.

5- It can be used in the analysis and cleaning of archaeological materials, organic or inorganic.

6- It is no longer an expensive method as it was in the past.

7- The analysis and cleaning processes are carried out in the least fraction of a second, using the Nano second laser.

History of the use of lasers in scientific research

In 1958 AD, the two physicists Town and Shawlow presented a study on the effect of light amplification by a radioactive source and how to benefit from it in various scientific fields, where they obtained this research on the Nobel Prize.

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In 1965, Shawlow tested lasers in the field of removing unwanted materials from the surfaces of some archaeological materials, especially by evaporating black ink on white paper by the thermal energy emitted from the laser.

The year 1973 AD witnessed a tremendous development in the field of cleaning stone surfaces by laser beams, when asmus from the University of California, USA, removed the black salt layer accumulated on the surfaces of marble tiles by directing the laser beams to it, and in fact, this experiment was not completely successful as it caused the high thermal energy of those The rays cause minute cracks in the surfaces of the marble tiles as well as their coloration to a yellowish color over time.

The generation of 3D models of historical buildings is frequently required during the documentation of heritage sites i.e. for tourism purposes or to provide education resources for students and researchers. During the generation of these models, requirements such as high geometric accuracy, availability of all details, and efficiency in the model size and photo-realism have to be met by the different approaches used for data collection. One well-accepted technique frequently applied in the context of heritage site documentation is close range photogrammetry. In the past decade, these traditional terrestrial approaches have also benefited from the fact that digital image collection is now feasible with of-the-shelf cameras. Thus, the efficiency of photogrammetric data collection could be improved considerably by the integration of semi-automatic tools based on digital image processing. Additionally, laser scanning has become a standard tool for 3D data collection for the generation of high quality 3D models of cultural heritage sites and historical buildings. These systems allow for the fast and reliable generation of millions of 3D points based on the run-time of reflected light pulses. This results in a very effective and dense measurement of surface geometry. Current limitations regarding the measurement rates, accuracy, or spatial point density will further disappear in the near future, thus laser scanning seems to become the dominating approach for the generation of 3D documentations and presentations of heritage sites.

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Limitations affecting the 3D Laser Model

Despite the considerable progress of these approaches, there are still some limitations, which have an effect on the quality of the Final 3D model. Even though current laser scanners can produce large point clouds fast and reliably, the resolution of this data can still be insufficient, especially if edges and linear surface features have to be collected. In the contrary, the digital photogrammetry is more accurate in outline rendition, especially if they are clearly defined in the reality. On the other hand, image based modeling alone is difficult or even impractical for parts of surfaces, which contain irregular and unmarked geometrics details. Additionally, the identification of points to be measured, being manual or semi-automatic, requires a long and tedious work, especially if a considerable number of points has to be captured.

The complete coverage of spatially complex objects like heritage sites can only be guaranteed, if data collection is realized from different viewpoints. Even though this is possible in most scenarios, problems can result from the fact that setting up and dismounting the complete laser system is relatively time Consuming. In contrast to that, the effort to collect additional Images with a standard digital camera can almost be neglected [4].

Additionally, compared to laser scanning there are fewer restrictions on the range of measurements during image collection, which simplifies the selection of different viewpoint In order to cover the complete structure of the object. For this reason, it can be advantageous to complete a geometric model, which has been generated from the laser measurement, based on Intensity images captured independently from the range data.

By these means object geometry, which is not available in the range data due to occlusions is provided based on photogrammetric measurements [5].

Laser scanners normally provide high accuracy of data acquisition, while it also provide extreme amount of data which may cause some problems in the processing. The huge amount of data, which is obtained by laser scanners and the extreme need for computer resources to process this information afterward, is considered a usual challenge. While many algorithms are developed and will be developed to tackle this subject, there are also other solutions to aid the process of the simplification of data. This paper approaches the subject from a practical point of view.

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We will present our workflow and the steps and measures we take to make it easier for us to acquire the data and in the same time to make it easier for us to process and edit6.

Non-contact techniques for built up structures survey and documentation have evolved significantly in the last decade allowing the metric survey, the image gathering and the 3D modelling of the whole structure and parts. We might cite 3D laser scanning and close range photogrammetry as exponents of the evolution of the surveying techniques since they provide geometric information with millimeter accuracy, texture information and the possibility of building 3D detailed models of the structure. These techniques have become especially useful as 3D modelling tools in heritage applications, where surfaces are complex, and the direct contact might be kept to a minimum [13].

The 3D modelling through close range photogrammetry is based in the spatial reconstruction of the rays involved in the image gathering to estimate the camera positions and subsequently the 3D coordinates of the points defining the object geometry. On the contrary terrestrial laser scanners are based in the active emission of a pulse of radiation in the visible or infrared domain (depending on manufacturers) which spreads through the air until the surface of a solid object is found that reflects the signal The instrument is equipped with a photodiode that detect the reflected pulse so that the instrument to object distance is estimated[14].

References

1- Zafiropulos, V., Georgiou, S., & Tornari, V. (2006).Fotakis, C., Anglos, D., *Lasers in the preservation of* cultural *heritage: principles and applications* CRC Press.

2- Shih, C. Y., Streubel, R., Heberle, J., Letzel, A., Shugaev, M. V., Wu, C., ... & Zhigilei, L. V. (2018). Two mechanisms of nanoparticle generation in picosecond laser ablation in liquids: The origin of the bimodal size, *Nanoscale* distribution,10,6900-6910.

3- Alshawabkeh, Y., & Haala, N. (2004). Integration of digital photogrammetry and laser scanning for heritage documentation, *International Archives of Photogrammetry and Remote Sensing,35, B5*.

4- Alshawabkeh, Y. (2006). Integration of laser scanning and photogrammetry for heritage documentation.

5- Al-Kheder S., Shawabkeh, Y. & Haala, N. (2009)., Developing a documentation system for desert palaces in Jordan using 3D laser scanning and digital photogrammetry, *Journal of Archaeological Science* ,36, 537-546.

6- Rüther, H., Chazan, M., Schroeder, R., Neeser, R., Held, C., Walker, S. J., ... & Horwitz L.K.,(2009). Laser scanning for conservation and research of African cultural heritage sites: the case study of Wonderwerk Cave, South Africa,Journal of Archaeological Science 36, 1847-1856.

7- Farrage, N.M., Oraby, A.H., Abdelrazek, E.M.M., Atta, D.,Synthesis, characterization of Ag@PANI core-shell nanostructures using solid state polymerization method, Biointerface Research in Applied Chemistry, 2019, 9(3), pp. 3934–3941.

8- Atta, D., Gomaa, F., Elhaes, H., Ibrahim, M.,Effect of hydrated dioxin on the physical and geometrical parameters of some amino acids, Journal of Computational and Theoretical Nanoscience, 2017, 14(5), pp. 2405–2408.

9- D Atta, A Fakhry, M Ibrahim, Chitosan membrane as an oil carrier: Spectroscopic and modeling analyses, Der Pharma Chemica 7 (10), 357-361

10- D Atta, A Okasha, M Ibrahim, Setting up and calibration of simultaneous dual color wide field microscope for single molecule imaging, Der pharma chemica 8 (19), 76-82

11- Atta, D., Okasha, A., Single molecule laser spectroscopy, Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy, 2015, 135, pp. 1173–1179

12- Okasha, A., Atta, D., Badawy, W.M., ...Elhaes, H., Ibrahim, M., Modeling the coordination between Na, Mg, Ca, Fe, Ni, and Zn with organic acids, Journal of Computational and Theoretical Nanoscience, 2017, 14(3), pp. 1357–1361

13- Armesto-González J., Riveiro-Rodríguez B., González-Aguilera D. & Rivas-Brea M. T. (2010). Terrestrial laser scanning intensity data applied to damage detection for historical buildings, Journal of Archaeological, 37, 3037-3047.

14- Kaasalainen, S., Jaakkola, A., Kaasalainen, M., Krooks, A., & Kukko, A. & Kukko, A. (2011). Analysis of incidence angle and distance effects on terrestrial laser scanner intensity: Search for correction methods, *Remote Sensing, 3, 2207*-.2221.