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"1 DECEMBRIE 1918" UNIVERSITY OF ALBA IULIA
FACULTY OF HISTORY AND PHILOLOGY

Ph. D. THESIS
Summary

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MINISTRY OF EDUCATION, RESEARCH, YOUTH AND SPORT
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Human Sciences

Digital Image in Archaeology
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CONTENTS

Summary

This research aims to be an interdisciplinary one, dealing with the usage of digital image in archaeology. Such an approach is recommended for at least two reasons: one is due to the destructive nature of the archaeological research (there is the no possibility to recover lost information); the other one is given by the advantages of using photo digital technology in archaeology; though, at present, in our country there is a lack of multi and interdisciplinary specialists and this makes more difficult the development of this segment in archaeology.

The interdisciplinary research is highly recommended given the development of the different areas that can contribute to solving specific archaeological problems and given the time distance till the results are published in traditional means, like books or journals. Moreover, using Internet facilities, a photo taken from a shuttle appears on the Web in a few hours or, at most, a few days. Following this idea, this paper also includes a large Weblibrary.

This type of work is not intended to launch its own historical interpretations, but to present the modern methods and techniques in interdisciplinary research, as well as some of the results that can be obtained by using such methods and techniques. Likewise, this paper is intended to discuss problems and solutions, applicable to present and future sites.

One example of interdisciplinarity is, without doubt, the usage of image in archaeology. An image can be the graphic rendering of an archaeological site in its various conventional forms (just like a radar image), as well as an aerial photo.

This thesis mainly deals with the applications of photography in archaeology, but also approaches other sources of image, which can serve archaeology. I try to I prove that image is now available to any researcher, but in order to understand and use image at its best, a foray into its origins and history is needed.

But image is a study object and a source of information in the history field, too. On the other side, the photo itself may be the subject of an archaeological study. In such a context, the photography is today a very efficient way of communication. Sometimes it is more appreciated than the written language. The image does not aim to replace writing, but to complete it and to be completed by it. We can reconstruct a barely visible hand-written or we can highlight a wall hidden beneath a land wave, wall which is impossible to see on the ground. Old archive pictures can be processed and reinterpreted. Thus, the possibilities offered by the digital image and its processing

are enormous. In such a context, finding and implementing working methods in shooting and processing the digital image can be a research theme by itself.

This PhD thesis is completed with some practical methods of obtaining digital image and by examples of how to process it. In order to list them, we researched methods and information resources dealing with computer usage. Afterwards, we dealt with the creation and management of data resulted after the field researches and the processing of land-, air- or satellite-resulted information.

CHAPTER 1 deals with this research objectives and their importance, with the definitions and the terminology necessary in order to understand the specific tools of this research; the first chapter also approaches the image origins, its importance as a historic resource and as a tool in archaeological researches; in the end, I straighten the importance of using image as a tool in archaeological researches.

The introductory part of CHAPTER 2 deals with the history and evolution of image, in general, and of photo, in particular. In the field of history, image itself is a research subject and a source of information. On the other hand, image is also a tool in the archaeological research and documentation.

CHAPTER 3 presents the necessary steps in order to get results usable in research; the first step is choosing a camera. In order to facilitate this selection, we present the general working principles of any type of camera, be it common, be it camera lens or the accessories needed in order to get performing results; everything is presented in a language accessible to both professionals and non-professionals.

CHAPTER 4 presents the first proofs of documented usage of a camera. It also deals with focusing and exposure times, depending on the conditions and specific features of the best moment to shoot the image of an object, be it in the archaeological field, in a museum or in any other not necessarily favorable environment.

We considered necessary a complex approach to the modern technology, as it has greatly evolved in the recent years; moreover, in some Romanians books there are many terms that no longer correspond to their correct or new sense (I refer here to some books translated into Romanian language and some others books - written by Romanian authors). In the context of the technological jump of the last decade, a problem arouse: the editorial field failed to keep up with

all of these innovations. So, there sometimes appear confusions and we deal with concepts, which were considered to be true 5 years ago, but they are not valid anymore.

CHAPTER 6 deals with the composition of the image. We approached the compositional rules, the philosophical side of image composition, underlying the pros and cons of using "the golden mean", a concept used in painting, sculpture, photography and other arts.

CHAPTER 7

Photography can be obtained only if there is light; the only exceptions are given by infrared or other range of radiation. Thus, I have dedicated a separate chapter to the problem of light in archaeological photography. Here I discussed the effects of light on image and the light importance in choosing the best angle when shooting an archaeological subject; here there is discussed the best moment of the day in shooting. I also approached and exemplified the technical solutions for the situation when light is little or non-existent.

CHAPTER 8 is dedicated to the archaeological image: methods for shooting the excavation works and the importance of photos scaling are highlighted. It is recommended using photo studio in order to shoot the artifacts, after their sampling in order to archive, inventory and exhibit them. This section advances various shooting techniques and lighting schemes in a studio so that artifact is best highlighted. All these situations are presented through practical examples and graphics.

CHAPTER 9 deals with aspects of digital image processing and some practical applications of the various effects that are obtained by such processing in digital image and in shooting archaeological objects. This section also approaches another important matter: the chromatic difference between a printed image and its appearance on the computer screen. Differences are also to be observed when an image is projected on two different monitors. My solution in order to remove these problems is to use the so-called "color management".

This solution involves the use of tools for measurement and control, the creation of chromatic profiles for each device and their implementation in the working way. These adjustments allow us to increase the contrast in order to highlight certain features in an image, to increase details, or to increase the clarity of an image. We can also correct the color temperature and the exposure after the photo was taken. Such adjustments have some limits and if the image is completely wrong, it is sometimes technically impossible to recover it.

In order to exemplify all these we dealt with processing like: the correction of the circular effect on Trajan's Column, the gradations of a sundial located inside the Alba Iulia Cathedral, combined effects in a darkened room in Pompeii, the inscription on the backside of an Olmec statue in Mexico. The results have been made available to Prof. Dr. Florin Stanescu, director of the Mesoamerican Research Center of the "1 Decembrie 1918" University of Alba Iulia.

CHAPTER 10 continues the series of practical applications with some aerial photos taken over the archaeological sites of Costeşti-Blidaru, Sarmizegetusa Regia, Corneşti-Iarcuri in Banat, and the Cistercian Abbey in Cârţa. In order to take these photos I used ultra light aircrafts that offered the possibility of shooting through a special window or the removed door. Before the flight, I took a ground trip of each archaeological site; I recorded GPS data and visual clues, in order to recognize the site while flying.

Even if an archaeological site is known, the aerial images, taken in different time moments, can emphasize some relief characteristics that were not visible originally. Vegetation, weather-climatic factors contribute to the visibility of the relief shapes that can be of an archeological nature. Regular archaeological flights are taken in the Western countries, in order to observe and monitor the known vestiges and to discover new ones. In archaeology, an aerial image can give us information on the size and purpose of a site, an aerial image can give us information on the area to be protected and relieved of agricultural works.

The aerial photos taken on the archaeological sites of Sarmizegetusa Regia, Piatra Roşie, Costeşti and the Cârța Abbey, aim to monitor these sites, to identify possible changes and new areas of interest. Looking ahead, it is possible that the information brought by these images to be the reason to open new archaeological excavations. A series of "shadows" highlighted by aerial photos, shadows to be observed inside the small rectangular destroyed sanctuary of Sarmizegetusa Regia for e.g., can suggest possible traces of underground walls, and thus can lead to new excavations.

On the other hand these pictures carry a touch of novelty as, for a relatively long time, there were no more flights over these sites. And I say its novelty keeping also in mind the current technology and its extra quality. The photos are taken in one raw graphic file called RAW, that contains a maximum of details and information. RAW is a file that can be edited at any time with new and improved programs.

Aerial photos taken in the Orăştie Mountains were sent to Professor Doctor Ioan Glodariu from "Babes Bolyai" University of Cluj Napoca, head of research in the area of the Dacian citadels.
Another point of great importance within my researches was the archaeological site near the village of Cornești, in Banat area. This site is located 18 km north of Timişoara. The Cornești fortification was known since the nineteenth century as it was shown on Austrian military maps. The site is composed of concentric rings spread over a land area of 1700 hectares. Archaeological researches were carried out over the decades, and in 2007, the investigations were resumed by an interdisciplinary team formed by specialists coming from Timişoara University, Cluj-Napoca, Arad, Frankfurt pe Main, Berlin, Wurzburg Exeter and Timişoara Museum.
In the late autumn of 2009, a weather anomaly proved to be good for shooting so, in collaboration with some specialists of the Banat Museum, I took a series of aerial images. Favorable conditions were due to completely dry vegetation; still stand agricultural lands, frequent and heavy rains - all these revealing land fortifications. In the rings area, the soil retained more water giving it a different tone. The images clearly show the 3 known land waves. At the moment of shooting, the existence of a 4^{th} ground wave was expected and the aerial images revealed segments of the 4^{th} ground wave, confirming thus its existence.
The resulting images were available for the Ph. D. coordinator and for Professor Doctor Alexandru Szentmiklosi, researcher of the Banat Museum. These photos also proved that the archaeological site is actual larger than it was initially estimated. They also bring new information as they provide more data on the general degradation of the site. One of my photos was published in the prestigious journal ANTIQUITY, no. 85/2011, pp. 821.
My thesis describes every stage of the practical applications in this research, till the GPS data to the image processing and results.

The practical applications series continues with stereoscopic (3D) photos of artifacts and with an aerial perspective over the archaeological sites of Costeşti Blidaru and the Cistercian Abbey of Cârța. These stereoscopic images allow us to perceive the effect of space and three-dimensional space in a flat photo. This is possible with the aid of some special glasses. The advantage is the following: these images give us a more fair and real image of the shot subject. An aerial photo shot in order to be rendered in stereo will provide much more information about the possible unevenness of the image surface than a flat image. The processes vary widely and some are very

expensive. The process that I suggest is very simple and cheap, compared to other methods which lead to the same results.

CHAPTERS 11 deals with some aspects of teledection, satellite and radar images, GPS and GIS. Applications of these facilities are summarized in the next chapter, which describes the possibilities to organize and manage huge databases, like spatial databases, and databases resulted after multidisciplinary researches in archaeology; all of them are widely presented in this paper.

Chapter 14 describes how to create and use a database of archaeological images on the internet. The database presented is functional can be accessed on the internet at the following address: http://imageart.ro/arheosit/

This database is intended to be used as easy as a website. You can upload images of high quality, you can access and download them from anywhere in the world, as long as you are Internet connected. Access to information is provided after registration, which is subsequently approved by the site administrator. After approval, the user may download or upload photos. The images are placed after the well-established criteria such as site name, county and location in geographical coordinates. After you enter this information, the location is displayed and viewed through maps.google.com. Localization is done through the service offered free of charge (under certain conditions) by Google. Source images are satellites as Cnes/Spot Image, DigitalGlobe, GeoEye.

The satellite location of an archaeological site offers the advantage of an overall perspective about the geographic position of the target-object. So the geographical coordinates, listed in the database, are very useful when you want to reach an archaeological site for the first time. We believe that this database is very useful to researchers - historians, archaeologists, and museographers - because it can be a tool of communication and of information storage. All these specialists have access to information entered by other users and they can complete it with both text and images.

Though the information is restricted and displayed only to persons registered and approved by the administrator. In other words, not anyone can have access to important information about a particular archaeological site. This restriction is a solid safety measure when operating a database. This database, although on-line and functional, can be implemented under the supervision of a

university or research institution. In this respect there is the opportunity and the desire of the University "1 Decembrie 1918" Alba Iulia, through the Institute of Systemic Archaeology, to implement this database in the University's official website.

PROSPECTS FOR RESEARCH

At least four important resources contribute at the research progress in the approached filed, and these resources are:

1) Human Resources and by this we mean preparing students and researchers in history, archaeology and museology, to use the IT technologies; unfortunately, this training is not ensured at an appropriate level in high school or even less in the humanist faculties. Afterwards, at master programs one can have students who do not know the basic programs of Microsoft Office. So instead of teaching computer applications specific to the master program, they teach basic knowledge on computers. This is the present situation, although all the Romanian universities have computer networks, including the electronic devices and software. We believe that the reintroduction of computer courses in the humanist faculties is a prerequisite for the development of research with modern means, means which are in a rapid evolution.

2) Technical Resources

In April 2012, Nikon Company launched on the market a camera that has a resolution of 36 mpix. This is a resolution three times greater than the resolution of the equipment produced only a year ago. The optical side has also greatly improved, in order to face these new resolutions. Thus, we have objectives/camera lens which are able to replicate the details for photocells (fotosit) with a size of 1, 5 microns! These innovations are translated by tripling the details of photo, and this is a very important fact in archaeological aerial image.

Slowly but surely, GPS systems are to be coupled to cameras. There are modules that can be connected to the camera and while you shoot, they also save the geographic coordinates in the image file (EXIF data). Cameras` future trend is to include a GPS module, another fact extremely useful in archaeology.

Another technological leap is recorded in increasing the sensitivity of the image sensor to light. This means that we can take quality photos in bad light. For the moment the most powerful camera has a light sensitivity much higher than the human eye. The trend is to lift this sensitivity; this trend is due to the stiff competition between producers, but the user is the winner.

Some rumors coming from the photographic equipment manufacturers say that it is quite possible to have a normal photographic equipment, but sensitive in infrared. This is a very plausible fact because the image sensor is also sensitive to the electromagnetic waves coming from invisible specters. Up to now, producers used to place barriers to these electromagnetic waves in order to prevent the passing of infrared and ultraviolet rays. The opportunity to take photos with a normal camera, but in infrared, would be another very useful tool for archaeology.

Actually, photographing in infrared (IR) is not a novelty. It is possible by removing the filters of a digital camera; I mean the digital sensor that prevents the passing of IR rays. But when doing this, the camera will no longer shoot in the normal way, buy only in IR. The novelty will be shooting with both visible light and IR, just as we want. Ten years ago, Sony conducted tests of this kind, but they were not very successful. Perhaps this will be possible tomorrow.

3) The software resources evolve in parallel and closely related to the technical side of industry. Thus, up to now there have been launched editing programs which enlarge the borders of photo processing; likewise, image editing made a big leap forward. Adobe Company, through the Photoshop program launched software of an unimaginable performance. Until recently a moved, unclear photos suddenly reached the Recycle Bin, but the Adobe team promises a program to correct this failure. Their tests, displayed on the internet, look very promising.

4) Financial Resources

In present, there is a serious gap between the technique price and our wages. The prices are Western-style, but the income is Balcanic type; for this reason, it is very difficult to keep pace with the evolution of techniques and to use them. This also happens in the editorial domain, which should guide us in using these new technologies to their maximum potential. Sometimes, this technology is totally absent.

On the other hand, the youth is attracted more to the commercial side of things, with a quick profit, and they pay less and less attention to the historical research. This situation can be translated into a lack: that of a new generation ready to use the latest technologies (to progress) and to teach from the old scholars, sometimes slightly conservative.

The Internet is also to be mentioned in this context: although it is a much-discussed tool because of the easiness with which anyone can add unchecked information, there still is a solid scientific side. The rapidity and ease of information exchange among researchers must be taken into consideration.

We also must recognize the effort of companies to provide, free of charge, satellite imagery of Terra. Probably all the archaeologists know the "Google Maps". The tendency of these suppliers is to improve the quality of their services, but their services are grouped in “packages“ made available to users.

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