# A new role of low-altitude sensors for supporting archaeological research.

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Remote sensing science is an achievement of the evolution of technology and is used to analyse and process both satellite and terrestrial spatial data with the support of software and computers [1]. Numerous definitions have been given from time to time for what remote sensing is but, basically, we would say that it is the art or science of explaining something about an object without touching it [2]. Remote sensing outperforms multi-temporal data collection and analysis, having the possibility to compare information between different time periods and over extended areas. In addition, remote sensing provides the possibility of multiple measurements of an object, giving us the possibility to collect and study its different characteristics. Another advantage of remote sensing is the fact that we can pick up information that is not visible to the human eye, such as receiving different wavelengths of electromagnetic radiation. The electromagnetic spectrum extends from a wavelength of 0.01 Angstrom to 3 x $10^6$ m, which characterizes the high and low frequencies of radio waves. The human eye is capable of sensing only a very small part of the electromagnetic spectrum, from 350–700 nm (Figure 1).

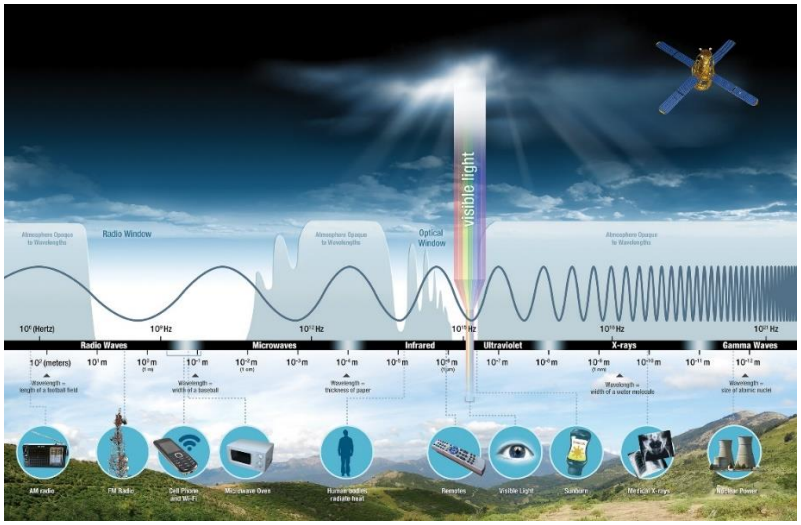


Figure 1: Electromagnetic spectrum (https://smd-prod.s3.amazonaws.com/science-red/s3fspublic/thumbnails/image/EMS-Introduction.jpeg.

Remote sensing already has a long history of research in archaeological practice, evident from the various scientific publications and applications in the field [3]. Satellite images can be an objective source of information for heritage managers as a relatively inexpensive solution for monitoring large landscape areas compared to traditional ground data collection [4]. In addition, there is the ability to run

iterative data analysis workflows for monitoring and condition assessment purposes (e.g., multi-temporal change detection).

Currently, a widely adopted solution for cultural heritage in the field of close range and low altitude acquisitions from unmanned aircraft systems/vehicles (UAVs). A significant advantage is that it can be accurately positioned over the area of interest—within a few centimeters. Indeed, areas of interest not easily accessible have been investigated by UAVs systems all over the world.

Orengo and Garcia-Molsosa, back in 2019 [5], published an article related to automated ML-based potsherd detection using high-resolution drone imagery. The results of that study show that the potential of this technique, if applied under appropriate field circumstances, can produce accurate distribution maps of individual potsherds providing new potentials of archaeological survey. The workflow combined drone photogrammetry and ML to automatically record surface distributions of archaeological material. As a result, it provided faster results and higher analytical capabilities under favourable conditions compared to a traditional pedestrian survey. Further important findings, together with those published by Agapiou et al. (2021) [6], followed the work of Orengo and Garcia-Molsosa (2019) [5], show that low-altitude remote sensing sensors (e.g., Drones, Unmanned Aerial Vehicles, UAVs) can provide significant outcomes.

Following these cases, a simulation study is implemented by authors in Cyprus, aiming to adopt low-altitude multispectral and RGB cameras to investigate whether a semi-automated methodology for detection of surface ceramics could be developed to answer research questions for a more efficient approach in terms of time and accuracy. The aim of this study is to investigate the potential of low-altitude remote sensing sensors that use high-resolution UAV multispectral sensors for archaeological research. It is part of ENSURE project (Innovative survey techniques for detection of surface and sub-surface archaeological remains, funded by the Cyprus University of Technology) and the newly established ENGINEER project (Innovative research on heritage in the domain of civil engineering and geomatics funded under the Horizon Europe) [7-8].

The overall findings so far, show that low-altitude remote sensing sensors can be innovative in the field of archaeological field research. Future archaeological projects may rely on such methodologies to be cost-effective, especially in cases where there is an urgent need to record rapidly disappearing archaeological sites or even when the research schedule is limited. In addition, it is especially important both before the flight operations with the UAV sensors, and during the image analysis, to make critical preparations such as spectral analysis of the camera, spatial analysis, etc. (Figure 2).

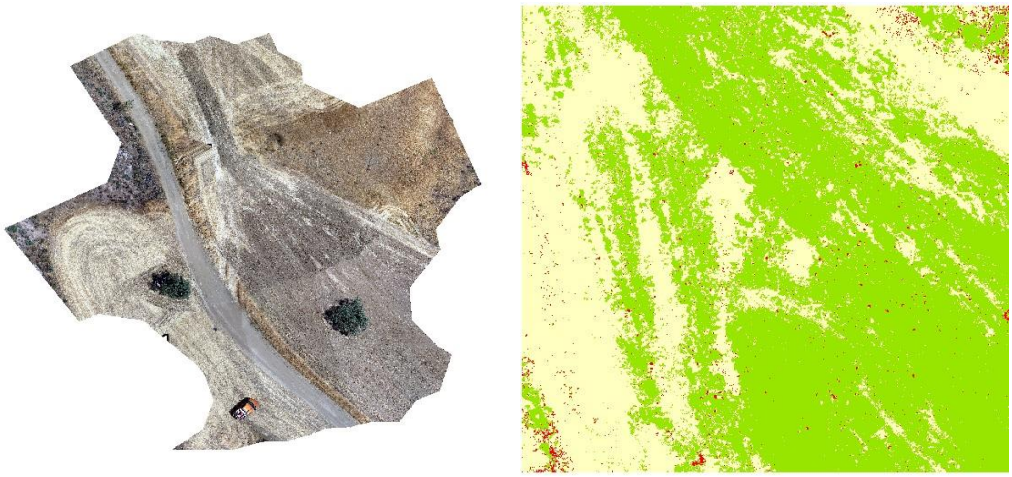

Figure 2: Simulation study. Orthomosaic of low-altitude sensors for detection of surface ceramics (left image) and preliminary results of a semi-automated methodology for the same research (right image).

Remote Sensing and lately low-altitude sensors show an increasing trend of interest from experts, as there is the possibility to combine three basic substances of archaeological research: objects, space, and time [9]. It is an important tool, enabling archaeologists to search for and understand ACH sites, as well as to discover and to monitor archaeological sites, but also to solve real archaeological problems, such as documenting and preserving cultural heritage.

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**Additional information**


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