# Automated Archaeological Feature Detection Using Artificial Intelligence on UAV Imagery: Preliminary Results

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***Keywords:*** *Artificial Intelligence (AI), Object detection, UAV, Surface ceramic detection*

## Introduction

Archaeological remains can be found either on top of the surface or hidden below the ground. As stated in their article Orengo H.A. and Garcia-Molsosa A. (2019) the analysis of the dispersion of surface remains, provide to researcher's information related to changes of the landscape use or the destruction or disappearance of sites. Over the last decade, we have seen an evolution in analytical tools, including the use of techniques such as machine learning (ML) combined with geometric morphometry and, more recently, computer vision techniques with artificial intelligence (AI) through deep learning (DL) as referred by Domínguez-Rodrigo et al in 2020 for supporting archaeological research.

Nevertheless, traditional pattern recognition methods (i.e., through photointerpretation) may have limited applicability for archaeological research for covering large areas or looking into an extensive archival dataset. A significant factor that affects the success of surface research is the methodology itself that is followed during the research, which may not be sufficient or less reliable. Therefore, there is a difficulty regarding the correct evaluation of the results and the validity in their interpretation to consider the research objectives successful. Jamil et al. in recent research (2022) refer that in archaeology field, most of the ML and DL algorithm are used for classification and identification of artifacts, nevertheless the detection of archaeological structure using DL algorithm especially using aerial imaging the results are still insufficient.

Thus, conclude that surface survey is a relatively straightforward survey method but at the same time its success and correctness is multifactorial. To improve both the design of the survey itself and the results themselves, we may integrate other complementary methods into the surface survey, such as earth observation methods, remote sensing, artificial intelligence etc. Consequently, by combining all these methods together we will be able to come closer to locating archaeological remains, information, and try to understand how the environment in the past affected the oldest populations and their interaction with the landscape.

The aim of our study is to investigate whether automated archaeological feature detection using Artificial Intelligence on UAV imagery could be developed and furthermore answer research questions for a more efficient approach in terms of time and accuracy compared also to traditional fieldwalking archaeological surveys.

## Methods and materials

In this study different Artificial Intelligence (AI) image processing methods were implemented. The workflow included drone-based image acquisitions, using (a) the DJI P4 Multispectral system with the following spectral bands: Blue (B): 450 nm ± 16 nm; Green

(G): 560 nm ± 16 nm; Red (R): 650 nm ± 16 nm; Red edge (RE): 730 nm ± 16 nm and Near-infrared (NIR): 840 nm ± 26 nm and (b) using DJI Phantom 4 Pro system with the following spectral bands: Blue (B): 468 nm ± 47 nm; Green (G): 532 nm ± 58 nm; Red (R): 594 nm ± 32.5 nm. Flight height was set to approximately 20m above ground level (AGL), providing orthophotos with a spatial resolution of a few centimeters, and sufficient to clearly identify ceramics over the study area.

Next process included standard photogrammetric processing to combine all these photographs into a single orthophoto-mosaic. Finally, two steps included computational processing (AI techniques) and geospatial analyses (GIS software) as illustrated in figure 1 below.


**Figure 1:** Framework of the processing steps using UAV images beyond the visible part of the spectrum.

## Results

Various AI techniques like machine learning algorithms (Random Forest classifiers) have been implemented and compared along with the results from foot surveys. Overall accuracy and relative accuracy were estimated. First steps of computational processing included RGB images in which supervised classification like Random Forest in was applied using the Snap software. The results show significant correct prediction (more than 85% overall accuracy). Other algorithms were also tested, like Maximum Likelihood Classifier with also quite significant results of correct predictions. The overall results were compared with the in-situ survey records showing that automatic AI methods using UAV high resolution imagery can be used as a first proxy indicator for the detection of surface archaeological ceramics (figure 2).

Despite the above results the classification resulted many soil pixels as ceramic fragments. To remove false cases of ceramics, morphologic filters were developed in GIS environment, that eliminated isolated high-value pixels without affecting large groups of these belonging to sherds. Same algorithms are in process of testing using multispectral images and the results will be evaluated and compared with those from the RGB images.

**Discussion**

Generally, results and accuracy can vary, depending on variety of factors like the type of soil, the conditions of the plot, the period of flight, the visibility and quantity of the material culture but also the number and experience of the inspectors. Further improvements are expected such us more sophisticated remote sensing algorithms will be tested, even larger areas will be tested to cover with a higher success rate, improve classification, using techniques to clean up random noise, improvements including filtering, smoothing class boundaries, and removing small, isolated regions.

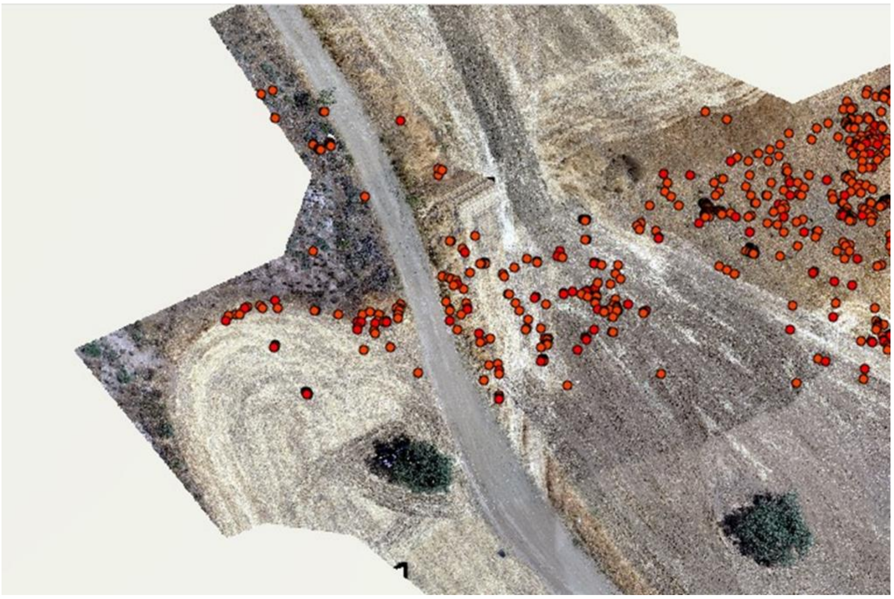

**Figure 2:** The classification resulting from the process identifying ceramic fragments

**Acknowledgments:** The authors would like to acknowledge the ENSURE project (Innovative survey techniques for detection of surface and sub-surface archaeological remains, CUT internal funding). Also acknowledges to Dr Elikkos A. Elia, Director of the Department of Lands and Surveys (DLS) of Cyprus, for the opportunity for Argyro Argyrou to participate in the ENSURE project. This paper is a part of the research project ENSURE and the PhD of the first author in the same topic.

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