

Detecting archaeological surface ceramics using remote sensing based on low-altitude images and weak learners.

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Introduction

Remote Sensing science has become increasingly valuable for archaeological research (Traviglia and Torsello, 2017). Drones and low-altitude systems provide a cost-effective way to document archaeological sites. In 2020, Domínguez-Rodrigo et al. highlighted the increasing use of advanced technologies such as machine learning and artificial intelligence. However, the success of remote sensing approaches largely depends on the methodology used during the research process. Sometimes, the methodology may be inadequate, making it difficult to assess the results accurately. Consequently, interpreting the results to align with the research objectives becomes challenging.

Our study suggests that low-altitude remote sensing sensors and advanced image-processing techniques have immense potential to revolutionise field archaeological research. We discovered that detecting archaeological surface ceramics through drone

imagery poses a challenge due to an 'imbalanced data distribution' issue, which leads to an accuracy paradox. Our study aimed to develop a new, robust methodology to optimise archaeological surface ceramic detection by blending AI methodologies for non-uniformly distributed classes.

Methods and materials

Our approach uses RGB, multispectral images, and AI techniques to detect surface archaeological ceramics in both archaeological and controlled settings. We use standard photogrammetric methods to create an orthophoto-mosaic. Initially, we employ supervised machine learning (ML) classifiers in the high-resolution derivatives. We then use different evaluation metrics to evaluate the classification performance and guide the classifier modeling. This process is illustrated in Figure 1 below.

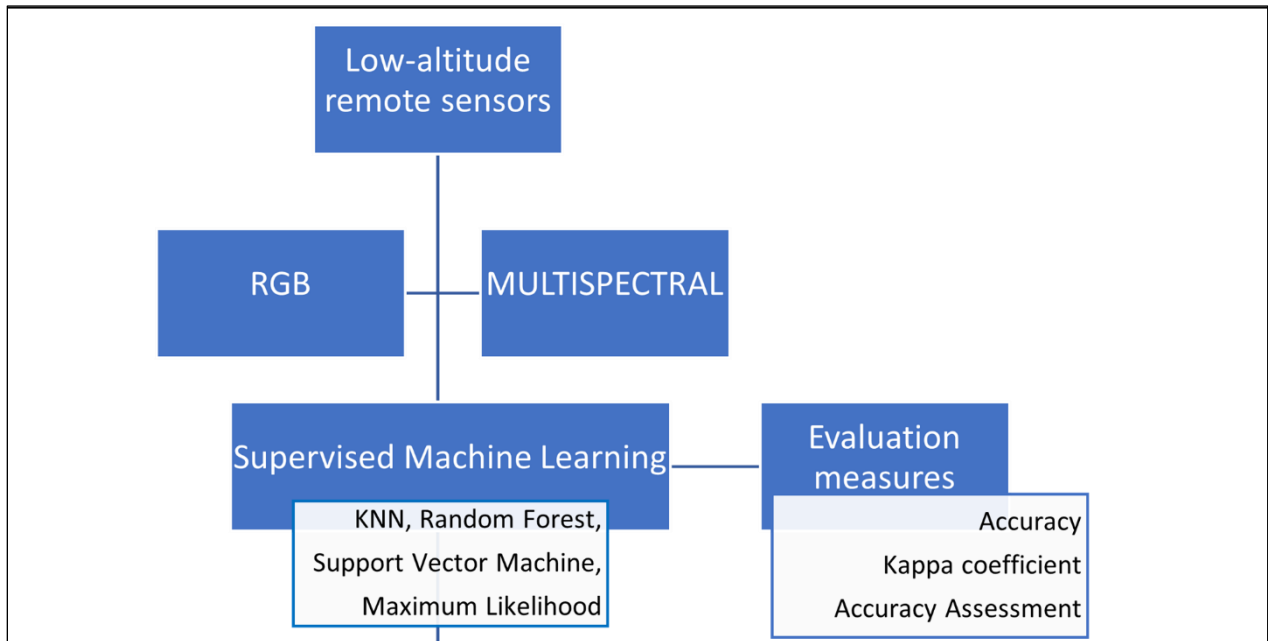


Figure 1: Research methodology using UAV images and artificial intelligence.

Results

The study utilised supervised classification algorithms to identify three categories in the acquired UAV image: ceramics, soil, and crops. To evaluate the performance of each classification model, the overall accuracy was estimated using randomly distributed samples. The research found that soil and crop classes had approximately 80% accuracy, while ceramic class had low accuracy. The study questioned the number of testing pixels needed for reliable accuracy estimation, and according to Prati et al. in 2009, 225 samples are required for 90% accuracy and 119 testing pixels are required for 95% accuracy. The results from the ceramics class indicate that the accuracy range is quite broad. The RGB image accuracy ranged from 12% to 24%, while the multispectral image accuracy ranged from 23% to 61%. Classifiers are good at predicting the majority class but less effective in predicting the minority class (like ceramics). To address this problem, we have used boosting algorithms in our decision-making process, significantly improving the accuracy of our predictions compared to relying solely on a single decision tree.

Discussion

Our research aimed to use artificial intelligence techniques to identify archaeological ceramics with high-resolution drone images. We employed supervised machine learning algorithms that used both RGB and multispectral images. The classifiers worked best for soil and crops but were less accurate with surface ceramics. To improve our results, we proposed a new methodology that uses a boosting technique and weak learners, which

provided more reliable and precise results. To enhance our algorithm training, we will use upcoming drone survey initiatives to eliminate noise, enhance separability, and evaluate imbalanced ceramics data using F-measure, G-mean, and ROC analysis measures.

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