Machine learning for hyper spectral imaging of painted artworks

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The conservation, restoration, and historical analysis of painted artworks require a deep understanding of the materials used. Hyperspectral imaging (HSI) has recently become a key tool in cultural heritage due to its non-invasive, robust, and portable nature, offering sensitivity to a wide range of artistic materials. HSI captures spatial maps, with each pixel containing a spectrum, producing a 3D hyperspectral cube composed of millions of data points. The main challenge is efficiently processing and analyzing these vast, non-linear datasets. Research focuses on techniques such as dimensionality reduction, classification, and spectral unmixing. These methods range from traditional multivariate techniques, like principal component analysis (PCA) and spectral angle mapper (SAM), to advanced machine learning (ML) approaches, including support vector machines (SVM) and neural networks (NNs). NNs are particularly valued for their flexibility and ability to uncover hidden patterns, enabling automated learning and rapid data processing. However, the scarcity of comprehensive HSI datasets often leads to suboptimal models. In this study, we address these limitations by employing an extensive HSI dataset across visible (VIS), infrared (IR) (400–2500 nm), and X-ray fluorescence (XRF) domains. Our findings show that deep neural networks, applied to combined VIS and IR spectra, achieve nearly 90% accuracy in predicting complex paint material mixtures, outperforming standard ML algorithms. Combining spectral data from different ranges proves essential for accurate material predictions.

Biography

Tsveta Miteva is a researcher at Sorbonne University, France, specializing in the application of hyperspectral imaging and machine learning in cultural heritage. Her work focuses on non-invasive techniques for material identification and preservation of painted artworks, with a particular interest in advanced data processing methods to enhance the accuracy and efficiency of hyperspectral analysis.

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