ART BIO
MATTERS

AI-assisted classification of microorganism strains on paper-based cultural relics

Chenshu Liu, Chongwen Liu & Allison Wall
University of California, Los Angeles

Microorganisms are one of the main deteriogens for paper materials in cultural heritage. They also pose a great threat to the health of individuals who handle the contaminated materials. Identification and classification of biodeteriogen species are important in the conservation of microorganism-contaminated paper collections in terms of determining the health impact to practitioners, as well as devising the most appropriate prevention and treatment measures. Current identification and classification methodologies use mainly culture-dependent and molecular biological techniques, which are highly specialized and instrument-dependent. For bio-organism identification in wider settings, such as libraries, archives, and small museums, this study initiates a simple image-based identification technique thanks to the recent development in artificial intelligence (AI).

Deep learning (DL) is a subfield of AI that focuses on training and building artificial neural networks with multiple layers, also known as deep neural networks. The primary mechanism of deep learning is to enable computers to learn from vast amounts of data and make accurate predictions or decisions without explicit human intervention. Using DL techniques, computer vision (CV) is a blooming field in AI to unearth intricate features in the images that may not be apparent to the human eyes and assist with image-related tasks, for example, classification, object localization, etc. In the medical field in particular, CV has proven to be effective in identifying abnormal tissue growth or nodules in CT and MRI scans.

This project explores integrating CV in the diagnosis procedure of conservation to allow fast and accessible identification of biodeteriogens on paper-based relics. Four microorganism species samples were retrieved from Qing Dynasty documents. The microorganisms were then sprayed onto Xuan paper to mimic the bio-contaminated ancient Chinese paper. A DL model was constructed and trained on microscopic images of the contaminated Xuan paper samples. A cohort of parameters of the DL algorithm was carefully engineered to achieve optimal classification performance. The model achieved promising classification accuracy scores during validation, demonstrating the potential of integrating computer vision in biodeteriogen detection and classification tasks to assist decision-making in conservation practices. The future of the study aims to expand the training set with a broader spectrum of species and substrates to improve the identification robustness and applicability in more cultural and museum settings. To achieve this, user-friendly application software and an online database are under development to collect more image data and dynamically improve the model's classification capability through a human-supervised adaptive learning scheme.

info@artbiomatters.org
https://www.artbiomatters.org/