Hyperspectral Imaging for the Digital Preservation of Stained Glass Windows

Name: Suzan Joseph Kessy
Laboratory' s name: Optical Media Interface
Supervisor' s name: Yasuhiro Mukaigawa

Abstract:

Digital imaging and analytical techniques have been used for decades to document Cultural Heritage (CH) artefacts. This documentation supports curators, scholars, conservators, archaeologists, and conservation scientists in gaining knowledge of artefacts and archaeological CH objects. Spectral imaging captures information beyond the visible spectrum by splitting light into many wavelengths, revealing details invisible to the human eye. It creates a "chemical map" of objects, useful for identifying material composition and uncovering hidden details in artworks and documents. One technology is hyperspectral whisk-broom imaging, which scans the scene sequentially, capturing a complete spectrum at each spatial coordinate pixel-by-pixel over time. However, whisk-broom imaging technology is still developing and faces challenges. One issue is the difficulty of conducting high-precision spectral imaging outdoors, largely due to temporal variations in ambient light. Another issue is the narrow Field-of-View (FoV) of the hyperspectral measurement. HSI's long scanning time implies a low spatial density or a narrow FoV.

To address these issues, this study aims to achieve multiple modality measurements for digitally preserving and analysing stained glass windows for restoration. We aim to achieve high-precision spectral imaging measurements under varying ambient light conditions and capture RGB images with a full view of the stained-glass windows. We propose two methods: an effective photometric compensation technique to compensate for temporal variations in ambient light and verification of its effectiveness through various experimental setups. Next, we propose a geometric compensation model to align the narrow field-of-view hyperspectral images to full-view RGB images. The interest is to locate hyperspectral measurements in an environment described by an equirectangular image. Our research provides a method to compensate for temporal variations in ambient light to achieve high-precision spectral imaging under varying environmental lighting conditions. Furthermore, the HIS/RGB alignment method facilitates cross-analysis and data exchange among conservation scientists, enhancing collaboration and collective knowledge in cultural heritage preservation.