SEAHA EPSRC CENTRE FOR DOCTORAL TRAINING SCIENCE AND ENGINEERING IN ARTS HERITAGE AND ARCHAEOLOGY

A Hyperspectral Imaging System for Cultural Heritage

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Introduction

A hyperspectral image contains spectral information for each pixel. Many hyperspectral imaging systems have a limited spatial resolution due to their optical configuration and technological limitations. Many items of cultural heritage have a large surface area. To capture the detail of these surfaces with hyperspectral cameras, image stitching techniques are required. Image stitching techniques have been well researched for greyscale and RGB images[1,2] , but there is a lack of literature on the scientific accuracy of these techniques and their application to hyperspectral images.

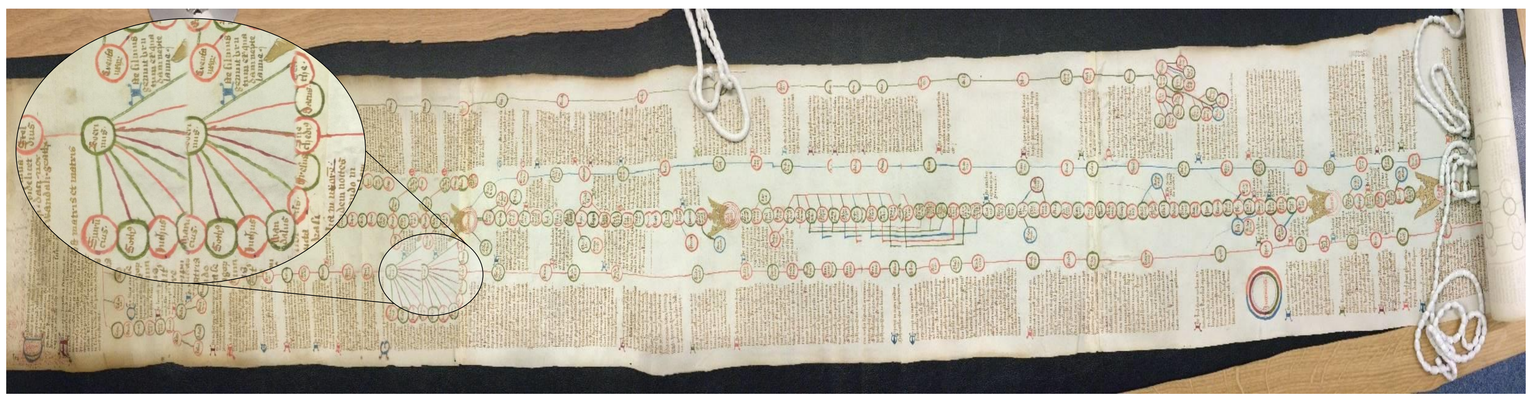

Fig. 1 - Genealogical roll showing the lineage of the kings of England, taken on mobile phone in panorama mode. Inset highlighting one of multiple stitching errors.

Research questions

- How can hyperspectral images be accurately and efficiently mosaicked?
- How can spectral information be accurately represented across seams in mosaicked images?
- How useful can this technique be for heritage science?

Methodology

Calibration

Spectral calibration
Image samples and compare with accurate spectrometer readings.

Lens Distortion
Image chequerboard and correct for distortions in the grid.

Flat fielding
Correct for variations in illumination using images of white reference material and subtracting background sensor noise.

Alignment

Direct Matching
Use MATLAB to compute the Fast Fourier Transform (FFT) of each spectral layer of each image.
Compute matches between images on the same spectral layer.

Blending

Laplacian pyramid blending
Calculate Laplacian pyramids for each spectral layer.
Calculate Gaussian pyramids for each spectral layer.
Combine image pyramids to form final blended image.

Outcomes

- New hyperspectral mosaicking algorithm.
- Accurate spatial information, ± 50 µm.
- Accurate spectral data, ± 5 nm.
- Case study report on large heritage surface.

Benefits and impacts

This project will develop a method which will facilitate the improved documentation of heritage surfaces.

Accurate documentation of heritage surfaces can be used for educational materials for heritage subjects and will also facilitate global and remote collaboration on scientific analysis of heritage objects.

Along side these benefits to heritage science, there are potential broader impacts in adjacent fields including medicine, military, engineering, environmental monitoring.

References

1. SHIKHA, A. 2015. A Review on Image Stitching and its Different Methods. *International Journal of Advanced Research in Computer Science and Software Engineering,* 5**,** 299-303.

2. SZELISKI, R. 2006. *Image Alignment and Stitching*.

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