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

Affine Image Registration for Multispectral Images of Historical Manuscripts

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Introduction

Multispectral imaging is used to recover hidden information from historical manuscripts [1]. Reflectance and fluorescence images are acquired by illumination with various wavelengths and utilising optical filters.

However, refraction through the optical filters and movement of the document or camera shift the image causing misalignment.

These distortions tend to be translations and rotations, i.e. affine transformations. Therefore, images must be spatially aligned for accurate comparison and processing.

However, intensity-based registration techniques fail as they assume constant lighting conditions and monotonic spectra [2], so we use mutual information, which is independent of light intensity, to register multispectral images.

Method

Capture one image of a manuscript and segment into four regions (see figure 2).

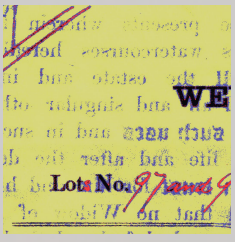
Create false set of MSI images using the reflectance spectra of commonly found materials in historical manuscripts: red ink, iron gall ink, print and parchment. These images are formed from one multispectral image by changing the intensity values according to the spectra and so I know this set is perfectly aligned.

Use MATLAB to distort the images by translation and rotations, so that I know the exact parameters of the misalignment.

Run the set of distorted multispectral images through the registration code

For each pixel, calculate the absolute value of the difference of the intensity values for the registered image and the original, undistorted multispectral image.

If the images are registered correctly, this will equal 0 for every pixel in the image. The more misaligned the images are, the higher this value will be.



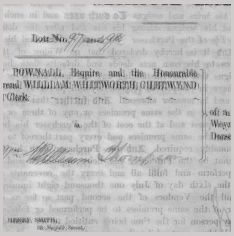


Figure 2

Top: Cropped section of image showing the different regions formed by segmenting the multispectral image illuminated in the green wavelength 519nm. The yellow region represents the parchment, blue is the iron gall ink, red is the red ink and the black is the print.

Bottom: A cropped section of the fixed multispectral image and one of the distorted images. This shows the misalignment which requires correcting before the images can be processed.

Literature

[1] Chabries DM, Booras SW, Bearman GH. Imaging the past: recent applications of multispectral imaging technology to deciphering manuscripts. Antiquity. 2003
[2] Yang Z, Shen G, Wang W, Qian Z, Ke Y. Spatial-Spectral Cross Correlation for Reliable Multispectral Image Registration. IEEE Applied Imagery Pattern Recognition Workshop. 2009

Aims

Create an automatic image registration program to correct for the misalignment present in sets of multispectral images of manuscripts in cultural heritage.

A fast registration code needs to be developed that can handle the large size and number of multispectral images.

The output should be user-friendly to ensure that libraries, archives and museums can use it efficiently and independent of an imaging scientist.

Figure 1
False set of multispectral images created by changing the intensity values of different regions in the fifth image above according to the reflectance spectra of red ink, iron gall ink, parchment and print.

Research Questions

1. Which metric is most suited for registering multispectral images, e.g. sum of square differences, Euclidean norm, mutual information or cross-correlation?

2. Can a registration code that corrects for affine transformations in sets of multispectral images be user-friendly and efficient?

3. How accurately can the distorted multispectral images be registered back to the original images?

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