A database of polarimetric and multispectral images in the visible and NIR regions

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INTRODUCTION

Multi-band polarization imaging, by mean of analyzing spectral and polarimetric data simultaneously, is a good way to improve the information recovered from a scene. This work presents a database of polarimetric and multispectral images that combine visible and near-infrared (NIR) information. An experimental setup is built around a dual-sensor camera.

CONTRIBUTIONS

1. A practical imaging pipeline, including a calibration procedure, for recovering spatial, spectral and polarimetric data from a set of photographs.
2. A database of multispectral and polarimetric images of various materials in the visible and near-infrared part of the spectrum.

EXPERIMENTAL SETUP

The spectral signature is recovered using an RGB/NIR camera plus a couple of bandpass filters. Multispectral images are constructed from the dual-RGB method [1].

- The polarimetric feature is achieved using rotating linear polarization filters in front of the camera at four different angles (0, 45, 90 and 135 degrees).

DATABASE

The database and source code in Matlab are available at: https://github.com/pjlapray

IMAGING PIPELINE

DATABASE

Figure 1: Experimental setup and optical path.

Figure 2: (a) RGB/NIR camera sensitivities. (b) Transmittance of the bandpass filters. (c) RGB reassembly using blue-green (bg) and yellow (y) filters. (d) Final camera responses.

Figure 3: sRGB visualization of the scenes. sRGB are reconstructed from a linear transform of the 6-band multispectral images after polarization component removing.

Figure 4: Simple RGB visualizations without any spectral and polarization processing.

FUTURE DIRECTIONS

1. Improve pipeline and SNR using high dynamic range technique (HDR), and evaluate benefits of such technique on polarimetric and spectral estimations,
2. Unify the polarimetric and spectral models using the dichromatic model, to get better understanding of spectral and polarimetric behaviors of specular and diffuse components,
3. Data correlation analysis: could be investigated for spectral and polarization correlations among different materials.

RESULTS

Figure 5: 12 raw images for the "Glass" scene after registration.

Figure 6: 6-band linear Stokes images s0, s1 and s2.

Figure 7: Glass scene: (a)-(b) Visualization of Angle of Degree Of Linear Polarization for band 3. (c) Potential defect detection application.

Figure 8: Painting scene: (a) Visualization of Angle Of Linear Polarization for band 3. (b) Angle of polarization reveals brushstrokes direction. (c) Shapes of spectral reflectance for 3 pigments used in the painting.

Identified drawbacks:

- Training for spectral reflectance reconstruction is done using the Xrite ColorChecker. But reflectance estimation highly depends on the training dataset.
- There is an energy balance disparity among all channels (see Figure 2d).
Thus, all spectral bands don’t share the same noise level for a single shot.

REFERENCES