HYPER-SPECTRAL IMAGING SYSTEM WITH EMBEDDED SPECTRAL SEGMENTATION AND CLASSIFICATION ALGORITHMS FOR THE NON-DESTRUCTIVE ANALYSIS OF ARTWORKS AND MANUSCRIPTS: AN APPLICATION IN PAINTINGS BY EL GRECO

Costas Balas[1,2], Grigorios Antonopoulos[2], Georgios Epitropou[1], Georgios Tsairis[3], Kallia Argyriadou[2], Alexandros Georgakilas[2], Nicos Hadjinicolaou[4]
[1]Department of Electronic and Computer Engineering, Technical University of Crete, Chania, Crete, Greece; balas@electronics.tuc.gr;, Fax: +30 210 64 12 869
[2]FORTH-Photonics Hellas SA, 19-21 Theofanous Street, Athens 11523, Greece
[3]26th Ephoriate of Byzantine Antiquities, Ministry of Culture, Kalamata 24100, Greece
[4]Department of History and Archaeology, University of Crete, Greece & Institute for Mediterranean Studies, Foundation of Research and Technology Hellas, Greece

We report on the development of a spectral database and of spectral classification and segmentation algorithms and software, which have been integrated to MuSIS Hyper-Spectral camera (MuSIS HS) for improving its diagnostic capabilities in non-destructive analysis of works of art and manuscripts. MuSIS HS comprises an innovative imaging monochromator, operating as an electronically tunable optical filter in a wide wavelength range (370-1000 nm). The monochromator is coupled with a megapixel CCD sensor and MuSIS HS records light intensity as a function of both wavelength and location. Operating in imaging mode, an image at each wavelength band is acquired while, in spectroscopy mode, a fully resolved diffuse reflectance and/or fluorescence spectrum per image pixel can be recorded (image spectral cube). Both the monochromator and the camera are driven by electronic controllers. We have developed a series of painting material replicas, with known chemical and structural characteristics, following their original development processes and corresponding to different artists and eras. Both diffuse reflectance and fluorescence spectra have been measured from these samples and stored in a MuSIS HS integrated database. The stored spectral data are retrieved and compared with the spectra collected during the non-destructive analysis of an object, with the purpose of material identification and mapping. We present results from the comparative evaluation of a series of Spectral Classification Algorithms (SCA) such as Maximum Likelihood, Spectral Angle Mapper, etc. applied in paintings by El Greco. Our findings suggest strongly that MuSIS HS with embedded spectral database and SCA comprise a powerful diagnostic tool in non-destructive analysis.