SURFACE REFLECTANCE COMPONENTS SEPARATION FROM SINGLE COLOR IMAGES USING THE MEAN-SHIFT DECOMPOSITION TECHNIQUE

MOUNCEF LAHLOU AND MALEK ADJOUDI
Department of Electrical and Computer Engineering
College of Engineering and Computing
Florida International University
10555 West Flagler Street, Miami, FL 33174, USA
{mouncef.lahlou1; adjouadi}@fiu.edu

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ABSTRACT. This study provides a resolution to the separation of specular and diffuse reflectance components in images of textured scenes. The proposed method can be used to solve several challenging tasks associated with computer vision applications ranging from specularity removal, image filtering, and surface reconstruction. We present a unified framework to achieve object surface reflectance separation by studying the dissimilarities between the reflectance components distribution in scene images delineated on a normalized color space. A simple but robust reflectance decomposition technique is introduced based on the Eigen-decomposition transform we named the Mean-Shift Decomposition (MSD) method. This technique provides a direct access to surface shape information through diffuse shading pixels isolation. In addition, the proposed method does not require any local color segmentation process as it differentiates between both reflectance components efficiently. This is viewed as a significant contribution to the prevailing approach of several proposed methods in the literature that operate on images by aggregating color information along each image plane. To recover objects surface geometry information, we formulate a specularity removal process by shifting the specular reflectance components toward the decomposed diffuse reflectance distribution. An empirical evaluation of the proposed reflectance separation technique is performed on several images comprising uniform color surfaces, multicolor surfaces, and highly textured surfaces.

Keywords: Reflection separation, Shape invariants, Specular reflection removal, Surface reconstruction, Image restoration, Dichromatic reflection model

1. Introduction. In computer vision, the modeling of surface reflectance is a topic of vital importance for purposes involving surface analysis and image understanding. By separating objects surface reflectance properties, powerful Lambertian-based methods can be applied for tracking, classification, reconstruction and recognition accurately to real-world scenarios [1]. Scenarios are assumed by many algorithms to consist only of diffuse reflections while specular ones are considered in many occasions to be negligible. Specular reflections confuse many vision problems since they produce image attributes that do not bind directly with intrinsic surface properties such as shape and spectral reflectance. Thus, methods that successfully separate both reflectance components in images are desired to advance current and future methods that do or will suffer from this complex reflectance occurrence.

This paper addresses the separation of reflection components in scene images as means to improve the effectiveness of the aforementioned applications. Unlike many of the existing methods, which limit their application to the reflectance component [2,3], our approach considers analyzing the image intrinsic properties relating to both diffuse and