A. DIMITROV, M. GOLPARVAR-FARD, F. PEÑA-MORA. ***Robust material recognition for automated semantically-rich 3D modeling.*** *Gerontechnology 2012;11(2):73;* doi:10.4017/gt.2012.11.02.021.00

Purpose Material recognition is an important part of any automated vision-based system for generating semantically-rich as-built 3D models. In recent years, advances in image-based 3D reconstruction have made possible the generation of dense point cloud models. However, automatically generating building information models from site images in particular, requires specific semantic information to be associated with building elements, but in the case of materials such information can only be derived from appearance-based data. In the meantime, the state-of-the-art texture recognition algorithms in the computer vision community are very promising, yet they have so far only been tested in strictly controlled conditions and often they do not perform well with images collected from construction sites. In addition, there is no benchmark that validates their performance under real-world conditions. To address these limitations, we propose a new robust vision-based approach for material detection and classification from single images taken under unknown viewpoint and illumination conditions. **Method** In the proposed method, first a library from the visual appearance of various construction materials is created. This library describes each material as a set of color images taken in uncontrolled settings, from actual construction sites. The sets are comprehensive documentations of appearance, accounting for different lighting conditions, scales, orientations, as well as differences in data quality (image compression). In the learning stage of the proposed algorithm, images are initially convolved with a comprehensive filter bank to generate filter responses. Next, using K-means clustering, the filter responses are clustered into a set of filter textons per material. The same process is conducted on hue-saturation-value (HSV) color values and a set of color textons is also formed. The joint histogram of filter and color textons is used to form models corresponding to each category of material. In the classification stage, the same process is followed to generate joint filter and color histograms corresponding to the novel image. The histogram is then compared with the models learned during training stage and the material is classified based on a multiple one-against-all support vector machine classifier. The performance of the classification algorithm is compared with the state-of-the-art algorithms both in computer vision and AEC (Architecture, Engineering, and Construction) community and it is demonstrated that superior performance is achieved here. **Results & Discussion** Experiments are conducted on fifteen typical construction materials with a total of 200 images per category. The effects of various parameters such as the choice of the filter bank, the size of the histogram, the number of training images used, and different SVM kernels are discussed. Overall, an average accuracy of 95% in material recognition is reported. The results define a new benchmark for robust classification as a practical tool. The perceived benefits and limitations of the proposed method for automated generation of semantically-rich 3D models are also discussed.

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Affiliation: Columbia University, New York City, NY, USA; *E:* ad2895@columbia.edu
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