Abstract

Edge-based and texture analysis methods are mostly used for image analysis at the low level segmentation stage. Edge-based analysis are commonly conducted during low level segmentation of untextured images whereas texture analysis methods are employed at the low level stage for analyzing textured images. Numerous edge-based methods that have been proposed for low level segmentation are not applicable in images of many real objects. This is because, these images often do not exhibit local regions with uniform intensities due to difference in object surface properties. An image that consists of local regions with uniform intensities is an untextured image. The main bottleneck in this regard is that no systematic way of combining the edge-based methods for analyzing untextured images and texture analysis methods for textured images exists so far.

The objective of this research is three fold, namely, to obtain a common framework for supporting both the edge-based as well as texture analysis paradigms which can be used, respectively, for untextured and textured monochrome images, to make the framework more general by extending the same for facilitating low level analysis of color images and to highlight an effective real life application of the proposed texture analysis scheme. In connection with real life applications, a simple quantitative analysis scheme is presented for analysis of surfaces of polymer products for their quality assurance.

The proposed framework is based on a class of orthogonal polynomials which are used for obtaining point-spread operators for different sizes of image regions. Any image region can be considered to be a linear combination of the responses of a complete set of these difference operators which are constructed from the point-spread operator. The responses towards noise can be easily separated out from the responses towards signal(edge or texture) by employing a simple statistical procedure. Edges or textures can be detected easily by validating conjectures which are proposed based on two complementary grouping criteria.

The widely known enhancement/thresholding type edge operators and Marr's LoG operators are representable in terms of the proposed polynomial operators. The proposed edge conjectures are also applicable in case of LoG operators.

Two edge detection methods for untextured monochrome images are devised using the proposed framework. In one method, the statistical procedures, which are proposed for separation of responses towards noise from responses towards edge and for measuring the significance of edge strength, have been used for computing the signal-to-noise ratio(SNR). The edges are detected by maximizing the SNR. In the second method, edges are detected by identifying zero-crossings in the second directional derivatives of images. A simplified computational approach for detection of zero-crossings by using the orthogonal polynomials based difference operators is presented.

A texture representation scheme based on the proposed framework is described. This representation scheme has been used successfully in supervised classification of textured images and detection of edges in textured images.

An extension of the polynomial framework is suggested for low level analysis of 2-D color images.

Finally, an effective usage of the proposed texture representation scheme in some real life applications is shown. In order to quantify textural information the proposed global descriptor of texture has been subjected to a simple statistical measure. This measure has been used for quantification of some important surface properties of polymer products for their quality assurance. It has been found through rigorous experimentation that the computed texture measure are in very good agreement with the standard values obtained by employing the existing tedious and laborious methods.