ABSTRACT

Texture Analysis has been a study of Image Processing group of people quite recently. Since the advent of high processing, computing facility and mass storage devices, the use of computers for image processing became popular.

Digital image analysis has been in the active research area for the past two decades, because of its application in various fields. Digital images are broadly categorized into two types, namely, textured and un-textured. In un- textured images, the underlying assumption is that the intensity of the pixel is uniform over a defined region, whereas the real life objects, abraded, worn surfaces, satellite, medical images often exhibit non-uniform gray level variation. They are called textured images.

These texture analysis approaches are grouped into statistical, structural or spectral. For statistical approaches, popular schemes suggested so far include, Haralick's Co occurrence features, Galloway's run length matrix, correlation, auto regression, Markov Random Fields, Gabor's multi-resolution approaches. Moments-based approaches are used in structural approaches. Fourier descriptor-based features have been suggested and used in spectral approaches. Each method mentioned above has its own advantages, based on its application. Julesz, Ehrich and Foith have mentioned that observable textures can be characterized by a set of primitives and their placement rules. The implied suggestion is that, any texture image can be

characterized by a set of primitives and their distribution in the image. This is the motivation for our research work.

Hence, the objective of our research work is (i) to propose a set of texture primitives as local descriptor, (ii) to obtain the global descriptor for the texture image, namely, the primitive spectrum (iii) to perform texture analysis like texture classification and texture segmentation using the proposed primitive spectrum, and (iv) to perform skin disease analysis as a medical application with the statistics computed from the proposed texture representation.

This research work aims to combine the merits of both statistical and structural approaches. Any texture image can be represented locally by a descriptor called the texture primitives and globally by the texture primitive spectrum, i.e. the frequency of occurrences of the primitives. Each proposed primitive (of size 3x3) has been subjected to a statistical design of experiments-based test for identifying the presence of a micro texture.

The region under consideration has been represented by a set of orthogonal polynomials. Two sets of orthogonal effects have been computed, namely, main effects (variation in only one direction keeping the other coordinate constant) and interaction effects (variation in both the coordinates). The variances corresponding to these effects are subjected to a hypothesis test, that is, variances corresponding to the main effects contribute towards noise and the other group contributing towards the presence of texture. This is

effectively tested by computing the divergence among variances using the Bishop and Nair test.

A texture primitive is constructed by connecting adjoining pixels which have the same attribute. A set of 92 primitives are proposed. These primitives are used as local descriptor and the frequency of occurrences of these primitives over the entire image constitutes the global descriptor i.e, the primitive spectrum. The frequency of occurrences of these primitives are computed for images from the standard Brodatz and Vistex texture album. Since texture images are perceived differently, based on the primitives and placement rules, the primitive spectrums are unique for a texture image. The primitive occurrence may be visualized at any gray levels. By tolerance of 10, it implies that the primitives are assumed to occur, even the gray levels vary within 10. As the tolerance level increases, it is obvious that more primitives tend to occur and this is experimentally proved.

The characteristics of the texture primitive spectrum have been studied under (i) various levels of salt and pepper noise (ii) rotation of the images (iii) different window sizes and (iv) different tolerance levels. The conclusions are presented in this work.

Using the proposed primitive spectrums, texture classification in supervised and unsupervised modes has been carried out. Identification of a pixel or a region into any one of the known texture class, is texture classification. The minimum distance decision criterion is used and an average correct classification of 95 % has been obtained. The experiment gets

repeated for a number of images from Brodatz and Vistex images, and for various tolerance levels. As the tolerance level is increased, the classification accuracy also tends to reach a maximum of 100%. The classification accuracy has been compared with the earlier He and Li Wang's texture classification which yielded 84 %.

The segmentation of different textured regions in a texture image is considered as one of the important problems in texture analysis, as conventional edge detection methods fail to detect the texture boundaries. The distance between two primitive spectrums of adjacent regions is minimum if both regions are from the same texture and higher if they are from two different textured regions. Using this criterion, the target images are segmented into different regions.

Finally, the effective usage of the proposed primitive spectrum has been shown in the case of a medical application. Skin surfaces which are affected by various degrees of burn are considered as texture images. Based on the nature of the texture variation in these images, skin diseases are analyzed. The results of the analysis is very effective as per the expert opinion. The computed statistical features from the primitive spectrums of the skin images have been successfully used for quantifying the extent of burn and for the estimation of the time to get cured. The results are promising.