

CHAPTER 6

SKIN IMAGE ANALYSIS USING THE PROPOSED TEXTURE REPRESENTATION

6.1 INTRODUCTION

Texture images have been represented both locally and globally by the proposed descriptors. The usage of the representation for texture analysis, namely, texture classification and texture segmentation has been explained in the previous chapters. The application of the proposed texture primitive spectrum in skin image analysis is explained in this chapter.

The concept of the proposed texture primitive spectrum has been applied for medical image analysis and is explained in this section. The analysis is based purely on the experiment and its conclusions. The skin images are analyzed and the ground truths are available.

Most of the skin images are textured in nature. Skin diseases occur due to many reasons. A major cause of skin diseases is burns. A few skin images which are affected by various degrees of burns like hot water, chemical, cigarette and sun light etc are considered. The skin images are obtained from various age groups of people and from both sexes. The worst affected, damaged skin will take a longer time to get cured. The degrees of affectedness are exhibited by the texture present on the skin surfaces. A lesser damage on skin will not produce very high deformation on skin and hence it forms the macro texture (coarse texture). A higher damage will produce high

deformation on the skin surface and hence it forms the micro texture (fine texture). These variations of textures from micro to macro textures have been quantified using the proposed texture primitive spectrum. The skin texture images are analyzed by quantifying the textures. The analysis is carried out as follows. Standard texture images collected from the Brodatz album have been used for the experimentation. Texture images ranging from micro to macro have been analyzed. The images are chosen in such a way that the mean and standard deviation of the images remain almost constant. The primitive spectrums are obtained and the weighted mean computed from them. This statistical parameter has been used for quantifying the presence of texture. From the values of the weighted mean for the selected images, the trend of the variation is noted. Skin images are also collected with the same mean and standard deviation for analysis. The primitive spectrums are computed. Their weighted mean is computed and some useful conclusions are derived. The entire process of analysis is presented below.

6.2 ANALYSIS OF BRODATZ IMAGES

Several Brodatz images have been used for our analysis to compare analogous results with the skin images. Medical image analysis uses image processing techniques for so many reasons. One of the main advantages is that it provides accuracy in helping the diagnosis of experts. The methods already explained in the previous section have been extended in quantifying the textural contents based on the simple mean obtained from the images and the weighted mean computed from the global texture descriptors.

The analysis is performed in two stages. In the first stage, the texture primitive spectrums have been obtained for the Brodatz images shown in Figure 6.1. The images are of the size 128 x 128. These images are included in such an order that they vary from mild (or fine) to coarse textures.

The simple mean and standard deviations have been computed for the images and are shown in Table 6.1. The images are selected from the album in such a way that they have the mean and the standard deviation uniformly (within a defined range). The graphs showing the variation of the mean, standard deviation for the images under consideration are shown in Figure 6.2. These images are subjected to our proposed texture analysis, namely, obtaining the primitive spectrums. The number of primitives present in each image is obtained at different tolerance levels. The tolerance levels are fixed at 3, 5, 8 and 10. The presence of texture primitives for each image at different tolerance levels is presented in Table 6.2. As the tolerance level is relaxed, the number of primitive occurrences improved as expected. The variations of the number of primitive occurrences against various tolerance levels are presented in the form of a graph in Figure 6.2 for the various images shown in Figure 6.1. The images are serially numbered in such a way that they have variations in primitive presence from less to more, i.e., from macro to micro. The plot of primitive presence against the images for different tolerances is shown in Figure 6.3. The main observation from the results presented here is that as the texture image gets more and more refined and smoother, the primitive occurrence is more and hence the computed statistics exhibit the same trend. The weighted mean is computed from the primitive spectrum as follows.

$$\text{Weighted mean} = \frac{1}{R * C} \sum_{i=1}^{92} f(x_i)x_i \quad (6.1)$$

where $R * C$ is the image size, $f(x_i)$ is the frequency of the occurrence of primitive x_i . The computed weighted mean for the primitive spectrums of the images shown in Figure 6.1 has been presented in Table 6.3 and the corresponding graph is shown in Figure 6.4. The weighted mean increases as the texture image type is moved from macro to micro. That is, as the image

becomes smoother and smoother textured, the primitive occurrences are more and hence the weighted mean also increases. These observations have been rigorously experimented with a number of images collected from the Brodatz textural album. These analyzed results have been extended as analogous results for the medical skin images. The images are collected from the data base (Dermatlas). The entire analyses based on the analogous results are presented in the following sub-section.

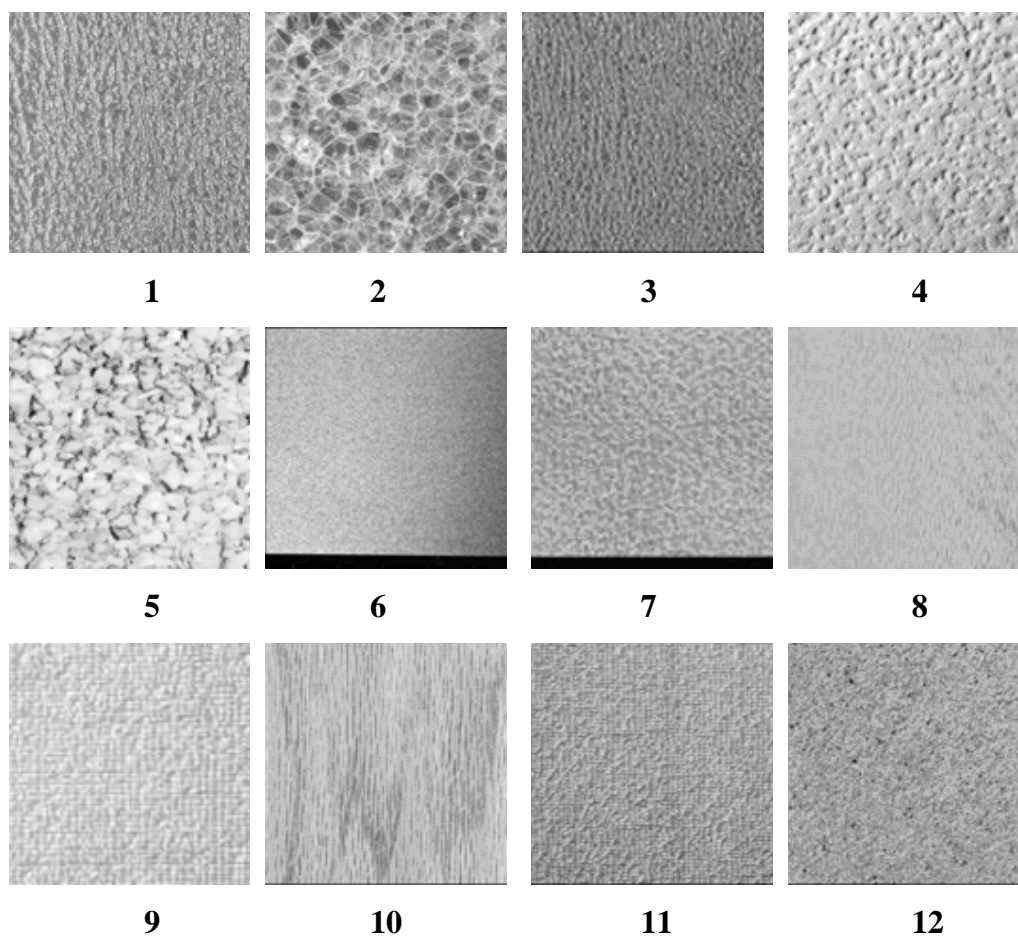


Figure 6.1 Brodatz Images Considered for Analysis by Analogy of Skin Images (1-12 images)

(1. PRESSED CALF LEATHER'2. PLASTIC BUBBLES'3. WOOLEN CLOTH,4. ROUGH WALL,5. SAND,6. GRAVEL,7. PIGSKIN,8. STRAW,9. RAFFIA,10. WOOD GRAIN,11. WATER,12. BEACH SAND)

Table 6.1 The Simple Mean and Standard Deviation for the Brodatz Images Considered

Images	Simple mean	Standard deviation
1	154.18	24.99
2	158.89	32.27
3	127.94	21.5
4	185.11	30.09
5	199.73	34.25
6	156.28	19.67
7	158.14	39.21
8	172.71	15.29
9	156.81	37.86
10	179.18	18.96
11	177.74	17.13
12	181.08	6.64

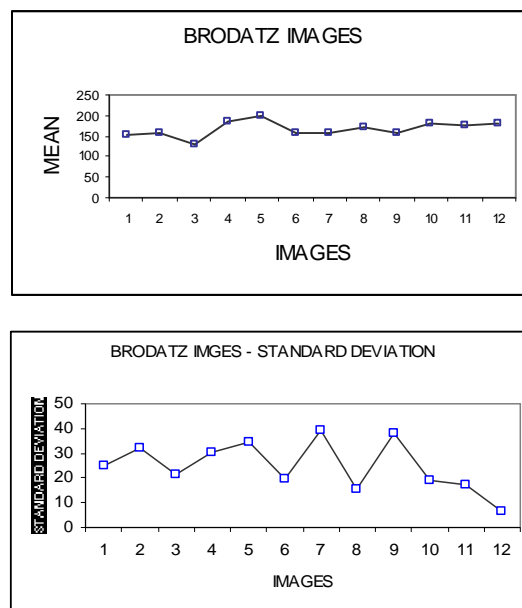


Figure 6.2 Variation of (a) Simple Mean and (b) Standard Deviation for the Brodatz Images Considered

**Table 6.2 Presence of Primitives for the Brodatz Images Considered
(Maximum Number of Primitives Possible: 1764)**

Tolerance Level	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	Image 7	Image 8	Image 9	Image 10	Image 11	Image 12
3	71	143	129	187	414	191	262	284	342	715	871	1288
5	191	338	297	379	698	434	542	565	642	1147	1315	1565
8	479	619	614	708	980	810	917	983	1096	1494	1611	1704
10	651	825	838	908	1116	1008	1139	1203	1318	1614	1688	1745

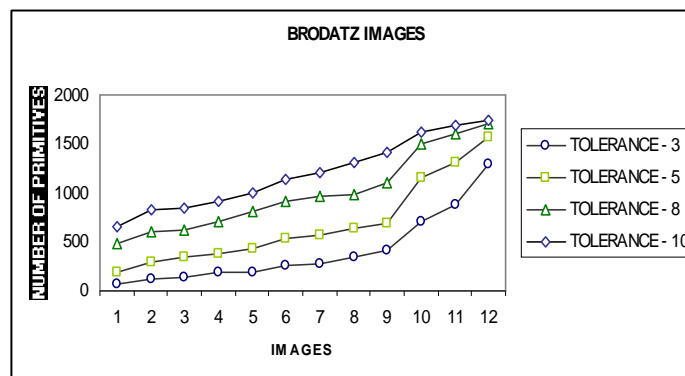


Figure 6.3 Primitive Presence for the Brodatz Images Considered for Various Tolerance Levels

Table 6.3 Weighted Mean for the Brodatz Images Considered

Tolerance Level	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	Image 7	Image 8	Image 9	Image 10	Image 11	Image 12
3	0.03	0.09	0.06	0.12	0.11	0.5	0.32	0.17	0.27	0.46	0.58	2.2
5	0.1	0.2	0.15	0.38	0.34	1.22	0.6	0.54	0.64	1.11	1.41	3.8
8	0.39	0.6	0.56	1.03	1.05	2.24	1.33	1.61	1.77	2.86	2.86	5.4
10	0.6	1.15	0.94	1.58	1.7	2.87	2.03	2.47	2.72	3.67	3.67	6.2



Figure 6.4 Plot of Weighted Mean for the Brodatz Images Considered for Various Tolerance Levels

6.3 SKIN IMAGE ANALYSIS

The skin images are collected from the data base (Burn images) and are shown in Figure 6.5. The actual images, where the damage occurred, are shown in Figure 6.5a. They are the chest, face, hand and leg portions of the human body which are affected by various burns. From similarly affected images, nine have been used for our analysis and are shown in Figure 6.5(b). The main objective of this work is to apply the concept of texture analysis based on the primitive spectrum for the analysis of skin images. These images are textured and the ground truths are available in Table 6.4. The images are arranged in the order of maximum severity to minor severity caused due to a variety of burns. The skin images are also collected from various age groups and both sexes. These images range from macro to micro. The statistics computed from these images are also presented in Table 6.4. These images have the mean and standard deviation approximately within a particular range as seen from Figure 6.6. The simple mean or variances or standard deviations do not infer any useful information except the gray level range. But only when they are subjected to texture analysis, it is possible to compute the

extent of severity. The primitive spectrums for two of the images shown in Figure 6.5(b) are presented in Figure 6.5(c). The presence of texture primitives is also computed and plotted as in Figure 6.7. The statistical parameter, namely, the weighted mean is computed using Equation 6.1 for all the nine images and is presented in the table for the tolerance of 5. The weighted mean for the remaining tolerances, namely, 3,8, and 10 is also computed and is presented in the form of a graph in Figure 6.8 . It is evident from the plot, that as the severity is lesser and lesser (the image with serial numbers from 1 to 9 in Figure 6.5), the weighted mean becomes more and more. Hence the main conclusion is that, if the weighted mean is more then it implies that the severity is less. It takes lesser time to get cured or healed. This is also ascertained and confirmed by a medical expert. The opinion of the physician is that from the appearance of the images (most of the skin images are diagnosed from the appearance and the extent or degree of burn) and upon the ground truth, the first image is worst affected and takes longer to get cured when compared to the last image shown in Figure 6.5. The results also reveal the same information. The weighted mean varies from 1.05 (for the image 1 in Figure 6.5(b)) to 6.7 (for the image 9 in Figure 6.5(b)). This matches quantitatively as well as qualitatively with the results of our analysis with the standard images, as is evident from the previous sub-section. The experiments have been repeated for a number of images at different tolerance levels. In all the cases, the trend is maintained and the results are appealing. The main application of this proposal in medical image analysis especially for skin images which are affected by burn, the extent of severity can be computed and quantified. The weighted mean is an index or quantification of the texture present and can be correlated to the degree of burn and can also be used as an estimate for the curing duration.



Figure 6.5(a) Skin Images (Chest, Face, Hand and Leg) Affected by Different Burns

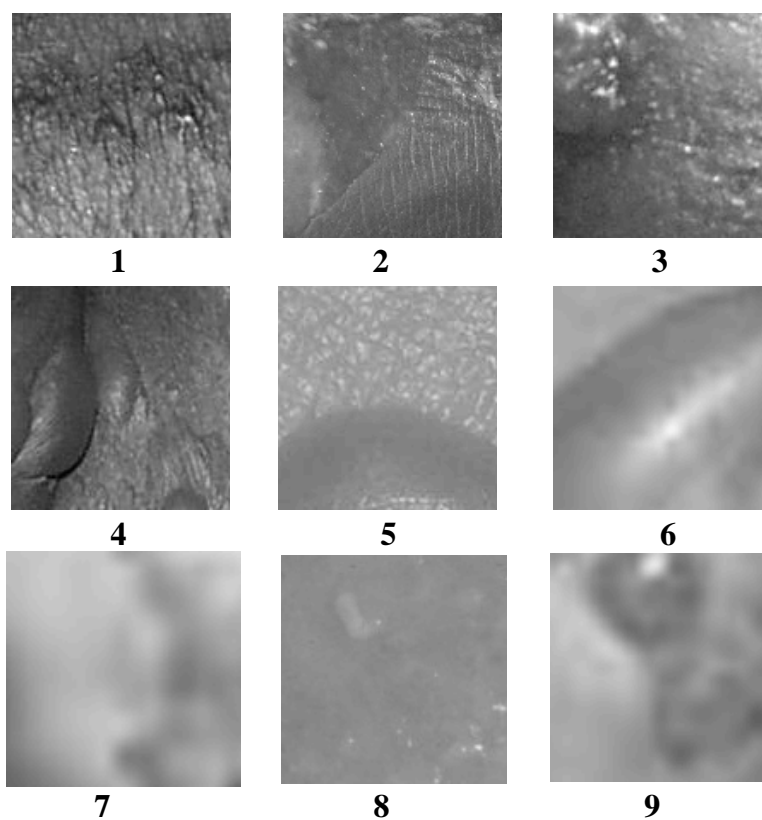


Figure 6.5(b) Sample Burn Images Considered for Analysis

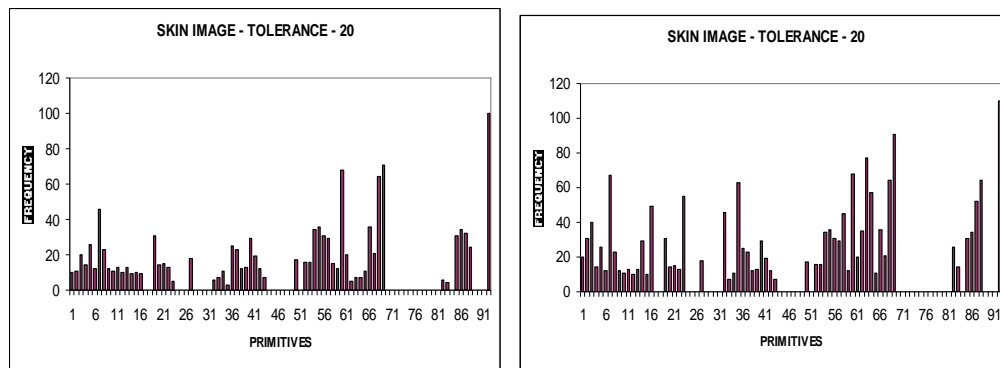
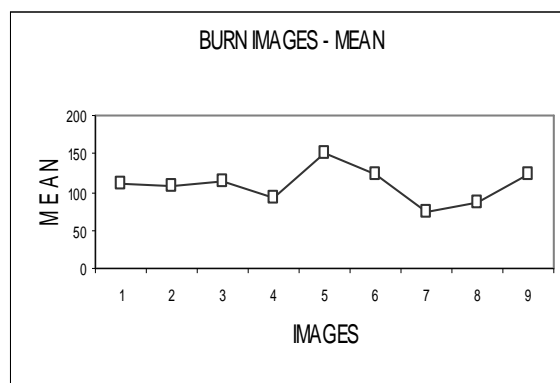


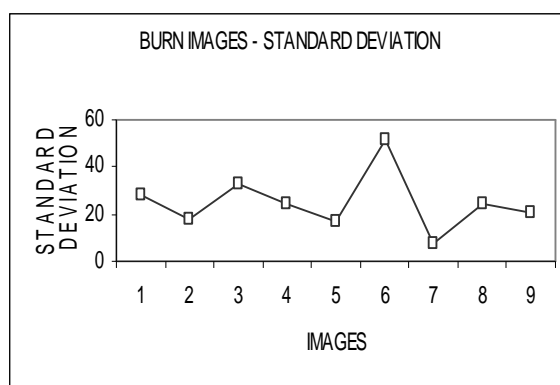
Figure 6.5(c) Texture Primitive Spectrums for the First Two Images of Sample Skin Images

Table 6.4 Details of Burn Images and their Statistical Parameters Computed for the Sample Skin Images

Images	Age	Male \ Female	Body Site	Mean	Sd	Weighted Mean
1	44 Years	Female	Hand	110	28.14	1.05
2	12 Months	Male	Foot	108.96	18.24	2.84
3	9 Years	Female	Face	114.59	32.47	3.14
4	35 Years	Male	Arm	93.49	24.72	3.27
5	20 Years	Female	Hand	150.33	17.32	3.8
6	17 Years	Female	Foot	121.74	52	5.02
7	10 Days	Female	Face	74.7	7.34	5.68
8	4 Years	Male	Chest	85.07	24.48	5.63
9	9 Years	Female	Arm	122.46	20.99	5.7



(a)



(b)

Figure 6.6 Variation of (a) Simple Mean and (b) Standard Deviation for the Sample Skin Images

Table 6.5 Presence of Primitives for the Sample Skin Images

Tolerance Level	Image 1	Image 2	Image 3	Image 4	Image 5	Image 6	Image 7	Image 8	Image 9
3	395	786	905	943	1278	1640	1696	1761	1762
5	756	1135	1281	1312	1504	1719	1740	1764	1764
8	1177	1451	1539	1575	1676	1741	1752	1764	1764
10	1380	1530	1629	1642	1718	1746	1753	1764	1764

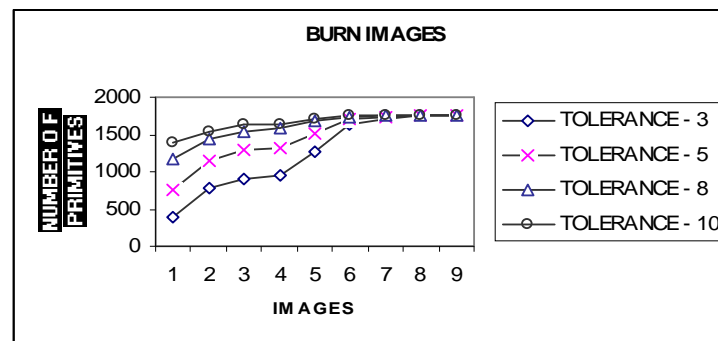


Figure 6.7 Primitive Presence for the Sample Skin Images for Various Tolerance Levels

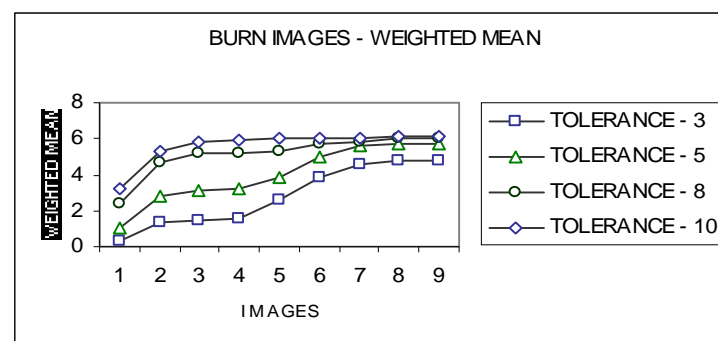


Figure 6.8 Plot of Weighted Mean for the Skin Images at Various Tolerance Levels

6.4 SUMMARY

The frequency of the occurrence of the primitives over an image is represented as a spectrum called the texture primitive spectrum. This is used as the global descriptor. The primitive spectrums are presented for standard textured images and skin images. The usage of the proposed global texture

descriptors has been experimented with a number of Brodatz images ranging from macro to micro. Various statistical parameters have been computed including the weighted mean from the primitive spectrums for drawing useful conclusions. The experiments have been extended for analyzing skin images which were caused by a variety of burns. When the simple mean and standard deviation could not be used for revealing any information about the extent of burn, the weighted mean computed from the primitive spectrum has been very useful in determining the severity and the approximate time for getting cured. The worst affected and the least affected images have been experimented and their severities have been estimated. The weighted mean is related to the severity and also to the time required to get cured. Thus the weighted mean is an indication of the extent of burn or its severity and it is inversely related to the curing time. The conclusions with reference to the skin images have been confirmed by medical experts. The results presented agree with the medical experts' opinion. Hence the usage of the texture primitive spectrum is effectively shown for the analysis of textured skin images which are affected by different degrees of burn. This provides an estimate to know the time to get cured from the diseased skin image.