An Innovative Technique of Marble Texture Description Based on Grain Components

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Abstract:
The present paper proposes a method of Marble texture description based on number of grain components. A grain component is a primitive unit of morphology. The most significant and meaningful information of a texture often appears in the form of occurrence of grain components. That's why the present paper used sum of occurrence of grain components for feature extraction. Many researchers attempted to describe and discriminate textures based on linear and non-linear patterns. The linear and non linear patterns on any window are based on formation of grain components in a particular order. This reason made the present paper to propose a novel method to describe the primitives of the same class of textures, based on frequency of occurrence of grain components. The present method is applied on natural marble textures, and good results are obtained.

Key words:
Texture, Grain component, feature, morphology.

1. Introduction

Texture has long been an important topic in image processing [1-18]. Generally speaking, textures can be classified into two major categories, i.e. regular and irregular. To be more specific, irregular textures like cloud or grass cannot be constructed by regularly arranged patterns; while regular textures like brick wall, are composed of structurally repeated similar patterns which can be modeled by texture primitives with two displacement vectors along which the texture primitives are formed. To represent irregular textures, many statistical approaches have been proposed, they use parameters to measure texture content in terms of smoothness, coarseness and regularity.

Texture description is an image processing technique by which different regions of an image are identified based on texture properties. This process plays an important role in many areas such as industrial automation, biomedical image processing, Content Based Image Retrieval and remote sensing application. In spite of the importance of textures in many areas of image processing, there is no universally accepted definition for the texture. We prefer to adopt the definition suggested in [19], because of its generality and it is given as follows:

"The notion of texture appears to depend upon three ingredients: (i) some local 'order' is repeated over a region which is large in comparison to the order's size, (ii) the order consists in the nonrandom arrangement of elementary parts, and (iii) the parts are roughly uniform entities having approximately the same dimensions everywhere within the textured region"**.** Textures have been classified by pattern based approaches [20-23].

This definition explains that the texture is characterized not only by gray value at a given pixel, but also by the gray value pattern in the surrounding pixels. The texture has both local and global meaning, in the sense that it is characterized by the invariance of certain local attributes that are distributed over a region of an image.

This paper is organized as follows: In section 2, the methodology of counting grain components has given. The analysis on texture classification based on experimental results is presented in section 4. Concluding remarks are given in section 5.

2. Methodology

The frequency of occurrence of grain components is calculated in the following way. A grain component is counted if and only if the central pixel of the window is a grain. If the central pixel is not a grain then the window is treated as a zero grain component window which is shown in Figure 1. In the following figures '0' indicates no grain, '1' indicates a grain and'd' indicates don't care i.e. it can be either 0 or 1. There can be 8 combinations of one grain components, which are shown in the Figure 2.

d	d	d
d	0	d
d	d	d

Figure 1. The possible zero grain components.

1	0	0
0	1	0
0	0	0

(a)

0	1	0
0	1	0
0	0	0

(b)

0	0	1
0	1	0
0	0	0

(c)

0	0	0
0	1	1
0	0	0

(d)

0	0	0
0	1	0
0	0	1

(e)

0	0	0
0	1	0
0	1	0

(f)

0	0	0
0	1	0
1	0	0

(g)

0	0	0
1	1	0
0	0	0

(h)

Figure 2. Representation of one grain components.

In the similar way two grain components can be counted. Figure 3 shows the formation of two grain components by fixing one of the grains at pixel location (0, 0).

1	1	0
0	1	0
0	0	0

(a)

1	0	1
0	1	0
0	0	0

(b)

1	0	0
0	1	1
0	0	0

(c)

1	0	0
0	1	0
0	0	1

(d)

1	0	0
0	1	0
0	1	0

(e)

1	0	0
0	1	0
1	0	0

(f)

1	0	0
1	1	0
0	0	0

(g)

Figure 3. Representation of two grain components by fixing one of the grain component at (0, 0).

In the similar way there can be six forms of two grain components by positioning one of the grains in the (0,1) co-ordinate positions as shown in Figure 4.

0	1	1
0	1	0
0	0	0

(a)

0	1	0
0	1	1
0	0	0

(b)

0	1	0
0	1	0
0	0	1

(c)

0	1	0
0	1	0
0	1	0

(d)

0	1	0
0	1	0
1	0	0

(e)

0	1	0
1	1	0
0	0	0

(f)

Figure 4. Representation of two grain components by fixing one of the grain component at (0, 1).

From the above it is evident that there can be 7! ways of forming two grain components for a 3×3 window. In the same way 3, 4…8 grain component frequencies are counted. The entire algorithm is given in Figure5.

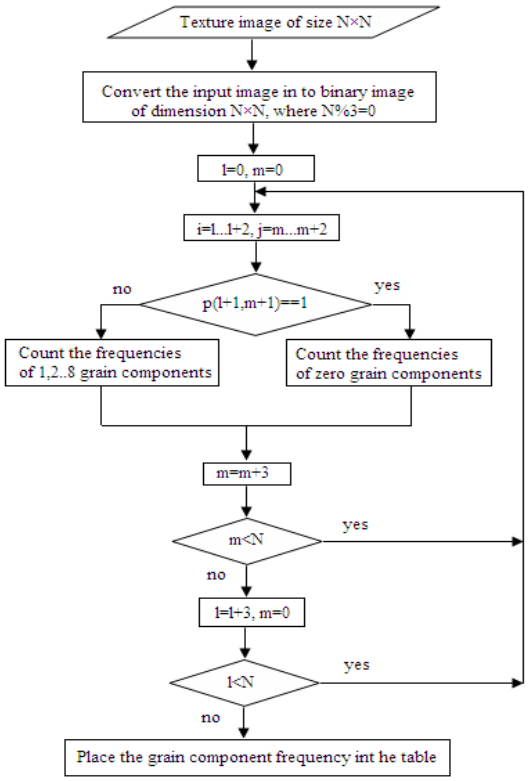

Figure 5. Block Diagram for counting no. of occurrences of grain components.

3. Results and discussions

The above methodology has been implemented on many natural marble textures, and Table 1 lists 13 out of them. The present study advocated a new method of counting grains i.e., grains are counted if and only if the Central pixel is '1'. This ensures the concept for 8-neighborhood and also the linkage of complex patterns like triangles, diagonals lines etc. The Table 2 clearly indicates the number of grain components.

Table 1: Original Marble Textures

Texture Number	Name of the Texture
T_1	Acpathi White
T_2	Arna
T_3	Jangir
T_4	Green
T5	Parade Green
T_6	Bansuvara
T_7	Royal Green
T_8	Bansuvara Pink
T_9	Morchana
T_{10}	Pink
T_{11}	Imperial Jangir
T_{12}	Pista
T_{13}	Rajnagar

Table 2: 3×3 pixel configuration for raw marble textures.

Texture	Grains								
	0	1	2	3	4	5	6	7	8
T_1	363	4	1	12	30	52	78	81	279
T_2	346	1	3	3	8	20	29	26	464
T_3	460	5	5	11	17	41	22	30	309
T_4	344	2	4	15	13	46	50	81	345
T5	391	0	2	8	18	62	70	67	282
T_6	444	2	2	2	6	24	42	35	343
T_7	510	2	6	6	12	23	20	31	290
T_8	440	5	8	15	22	28	45	37	300
T_9	319	0	0	4	4	39	46	81	407
T_{10}	280	0	1	4	8	18	24	28	537
T_{11}	320	1	4	8	15	25	55	45	427
T_{12}	355	1	0	3	11	42	46	32	410
T_{13}	330	1	5	6	14	35	28	39	442

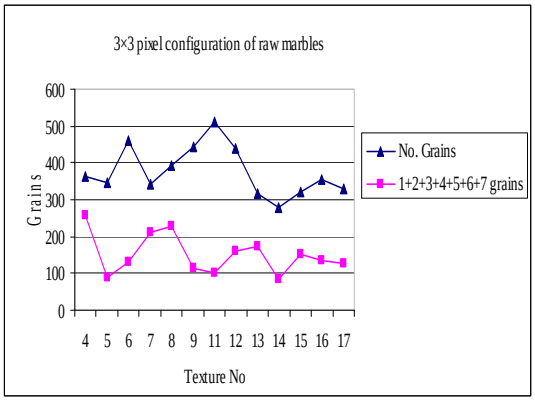

Figure 6. Representation of zero *grains* components Vs sum of grain components ranging from 1 to 7.

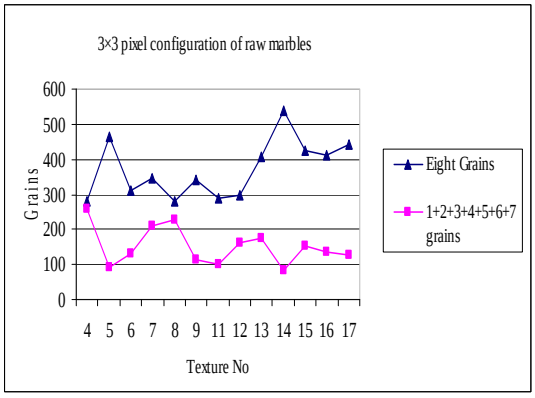

Figure 7. Representation of *Eight grains* components Vs sum of grain components ranging from 1 to 7.

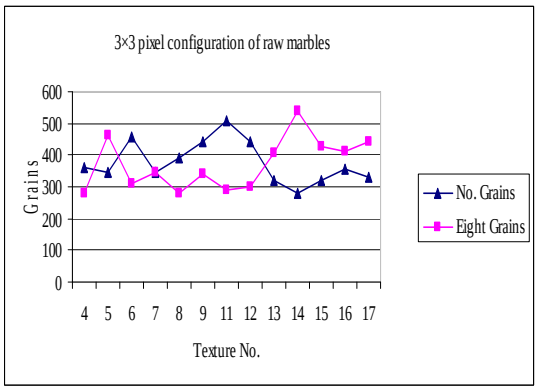

Figure 8. Representation of *zero grains* components Vs *Eight grains* components.

A graph shown in Figure 6 is plotted on the number of zero grain components versus sum of all other grain components from 1 to 7 (except eight). The graph clearly discriminates the number of grain components present in the marbles. In the same way other graph shown in Figure 7 is plotted based on the number of eight grain

components versus sum of grain components ranging from 1 to 7. This graph also clearly shows the high tendency of eight grain components in the marbles. A good discrimination is also found where the number of eight grain components (total grains on 3×3 window) is dominating because they have plotted at higher regions than sum of 1 to 7 grain components. The graph in Figure 8 is plotted based on zero grain components versus eight or total grain components falls into one region. This means that the zero grains are not discriminated with eight grains. This gives a good result about the property of marble textures i.e. if the central pixel is a grain then 70% of fair chances will be there for a total grain on a 3×3 window.

3. Conclusions

The graph shown in Figure 7, clearly indicates the domination of 8 grains or full grains including central pixel in all marble textures. It clearly indicates the strength of the marble texture, which is the basic descriptive parameter of marble texture. Even, from graph shown in Figure 7, it is clearly evident that sum of all 1 to 7 grain components are far less than 8 grain components. The present method clearly gives a new direction for description and discrimination of textures based on frequencies of occurrences of grain components instead of counting patterns on a 3×3 window. Thus this method out performs the previous methods.

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