A Novel Texture Feature – Similarity, its Concept and Algorithm

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Abstract

Texture feature is an important study about the textural image which helps to understand the nature and characteristics of the texture. So, we have introduced a novel texture feature – Similarity which describes the textural image in term of similar regions available in image and help to identify the same texture appearing with some angle. This feature can also recognize the same texture in different light. Our paper describes the concept of the similarity verses dissimilarity and proposes an algorithm for calculating it. Every textural image's region can be expressed by similarity histogram as discussed in this paper.

Keywords-*Texture feature, similarity, image processing, histogram, LSP(Local Subtration Pattern)*

1. Introduction

Image processing is a very wide field. Processing of images is a very useful for current technology and blind navigation. Images are categories in various types according to processing methods. Textural images are also a type which is most important to process and quite complicated comparing to other types in term of computing speed and microstructure. Textures are defined as:-

"A region in an image has a constant texture if a set of local statistics or other local properties of the picture function are constant, slowly varying, or approximately periodic" [1].

"We may regard texture as what constitutes a macroscopic region. Its structure is simply attributed to the repetitive patterns in which elements or primitives are arranged according to a placement rule" [2].

So textures are specified with the help of its features. Features have an interpretation quality of any textural image. These render an image in a unique and differentiable way so that analysis and processing can be more effective and approach to find some important results. To understand the texture is a difficult task and requires more computing compare to other type of images. Now due to the availability of high speed computing, its become easy and approaching to the most of the technologies. So now much work is going to do better define the textural images and its internal structure and specialty. Texture regions which were

complicated to understand, separate and process in the image, became easy by using texture features and its properties. If an image contains more than one texture then its features make possible to simplify and process [8]. So we can say texture features have an important role to define any texture.

Various kind of textural features are already introduced [2, 4] such as coarseness [3, 5], contrast [6], directionality [7], linelikeness, regularity, and roughness. A novel textural feature –Similarity verses dissimilarity is introduced, this feature also defines the texture in other way for contribute the processing of image. We have designed an algorithm for similarity histogram. This histogram represents the number of similarities or different regions possibly available in the image according to human perception.

Similarity in a textural image can be compared with its histogram. It is possible an image to be non-periodic or irregular then similarity feature shows image's behavior by using histogram. Similarity feature also effected with the grid size of the texture. Texture's grids distributes the intensities of pixels and affect them, this factor is also considered in this algorithm. Sometimes single texture has more noise or special object appearance then this feature can be useful to show the similarity of texture pixels.

The concept of the algorithm is discussed in next section and then proposed algorithm is described with example in third section. An analysis has been done with the experimental results in fourth section and result has been shown, supported by textural images and corresponding histograms. At last fifth section conclude the paper.

2. Concept of the Similarity Feature

Various types of textural features, which are already defined provides useful features but does not able to give information about the similarity. This feature works on the texture's pixels intensities within a group of 3*3 neighborhood pixels. LSP makes easy to understand the behavior of same texture with uniform changes within the group. For example an image of a texture taken in noon will be differing with the same textural image taken in evening. There is only difference with the uniform pixel intensity at every level and LSP removes this difference and shows the same histogram with a little difference.

Sometimes we take some images at different angle of same texture, but mostly methods fails to identify it. This method works for it and show a similar histogram as displayed in our experiment at last figure 5. This feature describes textural behavior in term of its grids and shows the variation according to the size of the grid as discussed in the analysis section of this paper. The main reason of variation in histogram due to grid says that grids bring some extra changes of pixels in a small area rapidly. This is the main factor of lying LSP value in more bins correspondingly graph's bins having frequency increases. So in this algorithm, we have analyzed the neighborhood pixels and then developed a histogram. Similarity algo works with the difference of texture pixel's intensities at the neighborhood.

3. Proposed Algorithm

Similarity is also a feature as other textural features having some different characteristics and results. It is more understandable with the similarity histogram. Pixels arrangement has been showed with the histogram and results are determined. This algorithm is completed in two phases. First of all LSP is calculated then LSP occurring in same range is counted in a bin and histogram is developed.

3.1 LSP (Local Subtraction Pattern) :-

As we know every pixel have 8 neighborhood pixels, these pixels have more important role to understand the behavior of the texture. Here we have used them to calculate the similarity measure. First of all we have been calculated LSP (Local Subtraction Pattern) as follows:-

P_1	P_2	P_3
P_8	CP	P_4
P_7	P_6	P_5

Figure 1: A gray level Textural image's pixels

$$CP_{LSP} = \sum_{i=1}^{7} (abs\left|P_i - P_{i+1}\right|) + abs\left|P_8 - P_1\right| \quad (1)$$

Where, CP_{LSP} shows local subtraction pattern of central pixel and abs shows absolute value of the difference of neighborhood pixels. Figure (1) shows any pixel's neighborhood of the gray level textural image and equation (1) calculates LSP for every pixel then make an matrix of LSP equal size of gray level textural image matrix. The procedure of calculating LSP can also be understood by following example (figure 2) :-

70	96	83
34	49	97
120	92	32

Figure 2 : Example of LSP calculation

$$LSP = \left|70 - 96\right| + \left|96 - 83\right| + \left|83 - 97\right| + \left|97 - 32\right| + \left|32 - 92\right| + \left|92 - 120\right| + \left|120 - 34\right| + \left|34 - 70\right|$$

LSP = 328

3.2 Similarity Histogram

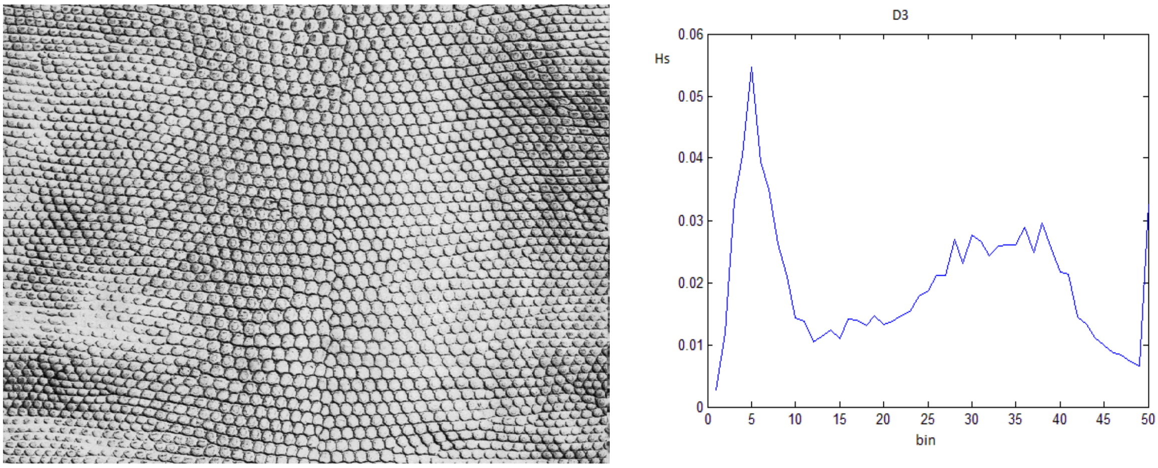
It is found that LSP is a large value so we have divided LSP in bins having a range of 10 values. For example LSP value having 0-9 is assigned 1st bin, 2nd bin for 10-19 and so on. Experimentally it is observed that mostly LSP values vary between 0-490. So we have defined 50 bins for an image and last bin for the LSP value exceeding 490 (due to the very very less frequency of this value). According to these bin's range number of LSP are counted occurring in particular bin.

$$H_S(k) = N_{LSP}(k) / \sum_{i=1}^{n} N_{LSP}(i) \quad (2)$$

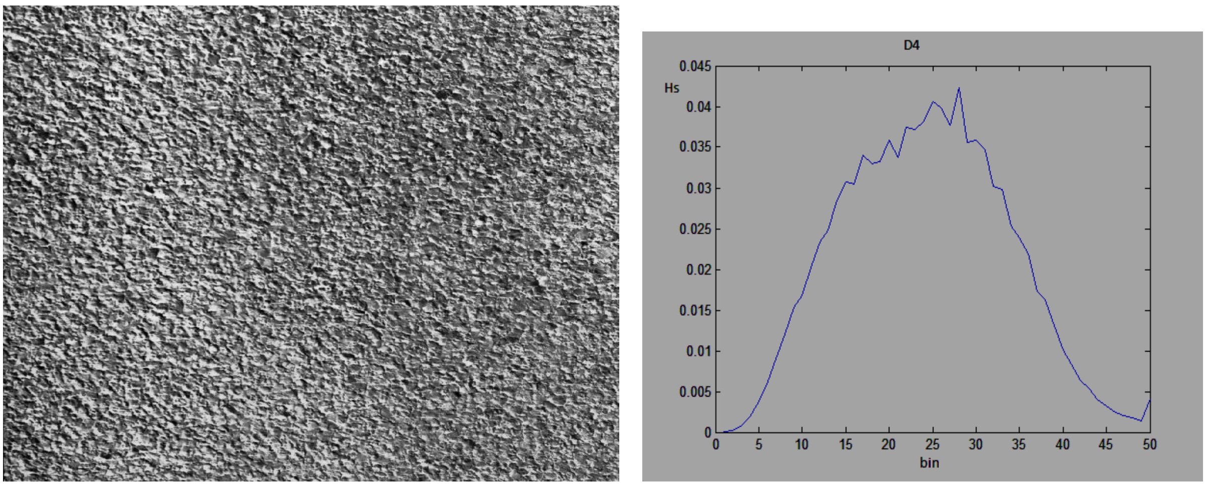
where k = 1, 2, 3 …… n
$N_{LSP}(k)$ is defined as number of points in k^{th} bin of LSP value and n is taken as 50 experimentally as discussed. H_s represent the histogram of the similarity measure.

4. Experimental Analysis and Results

This proposed algorithm is implemented in MATLAB 7.4.0 (R2007a) and experiment is done on some standard Brodatz textures [9] and results has been shown with the help of histograms. Figure 3 shows the Brodatz textures and corresponding histograms. We can observe that first texture (Broadatz texture D3) (figure 3(a)) has LSP value in all bins 0-50 because texture grids are enough large and having different intensities in a single grid of texture. There are many numbers of peaks in the histogram also showing directions possible in texture (as we can see in D3 texture). Similarly in figure 3(b) grids are much small to compare with previous texture so more uniform histogram is obtained. These grids distribute the intensities in the texture, and produce the effect of distribution of frequencies in all bins as shows both a and b in figure 3.



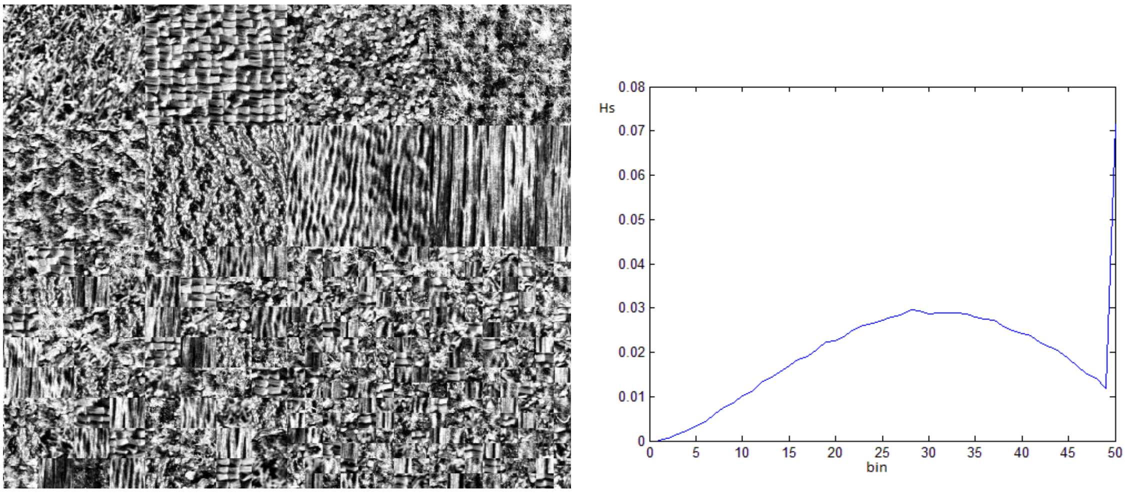
(a) D3 texture



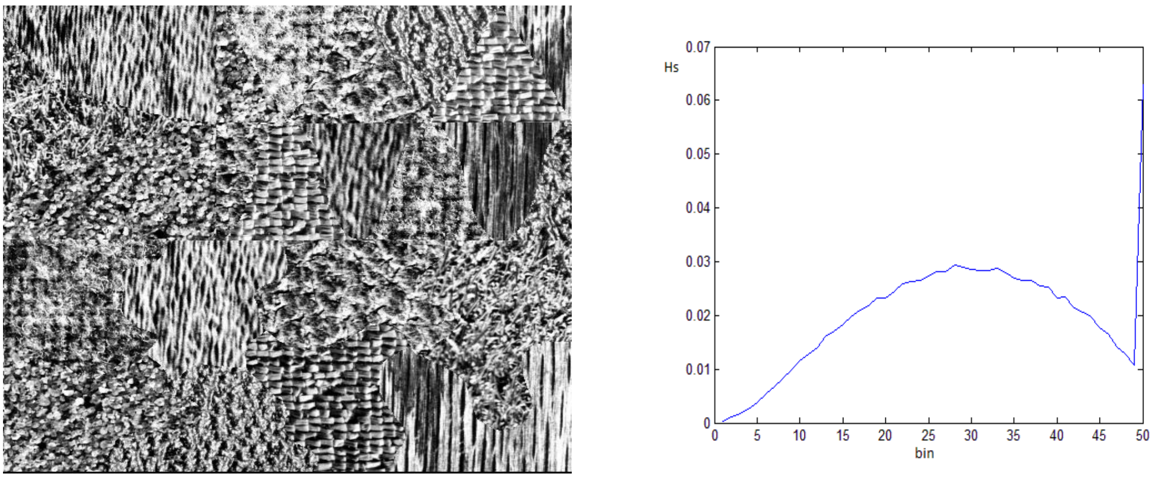
(b) D4 Texture

Figure 3 : Brodatz Textures with similarity histogram

Now in figure 4 shows the combination of textures also representing a new texture. Both texture images (a) and (b) contains many textures at the different coordinates show no similarity but have been developed with same textures, can be seen with their corresponding histograms. So the similarity feature also identifies the similar regions in different textural images as shown in figure 4(a) and (b). These both figure are uniform showing that grids are enough to distribute the intensities.



(a)

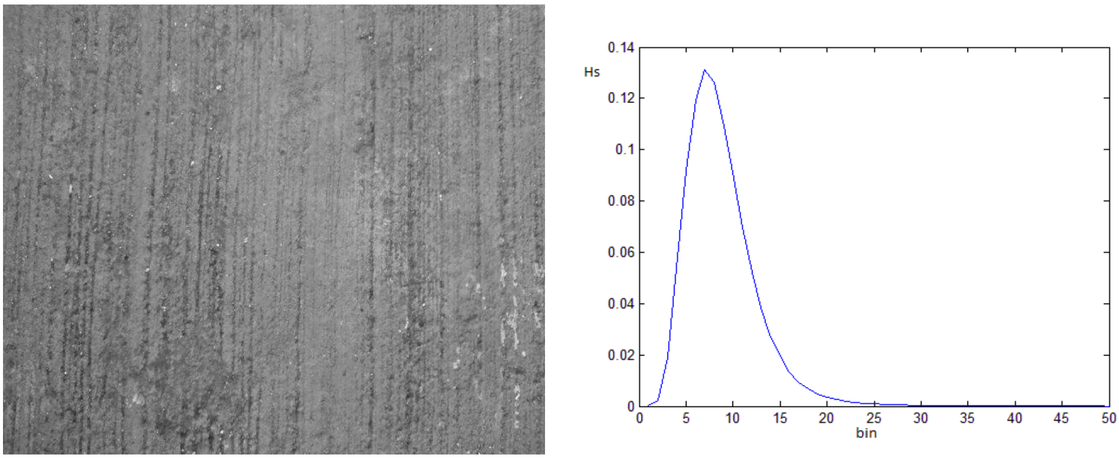


(b)

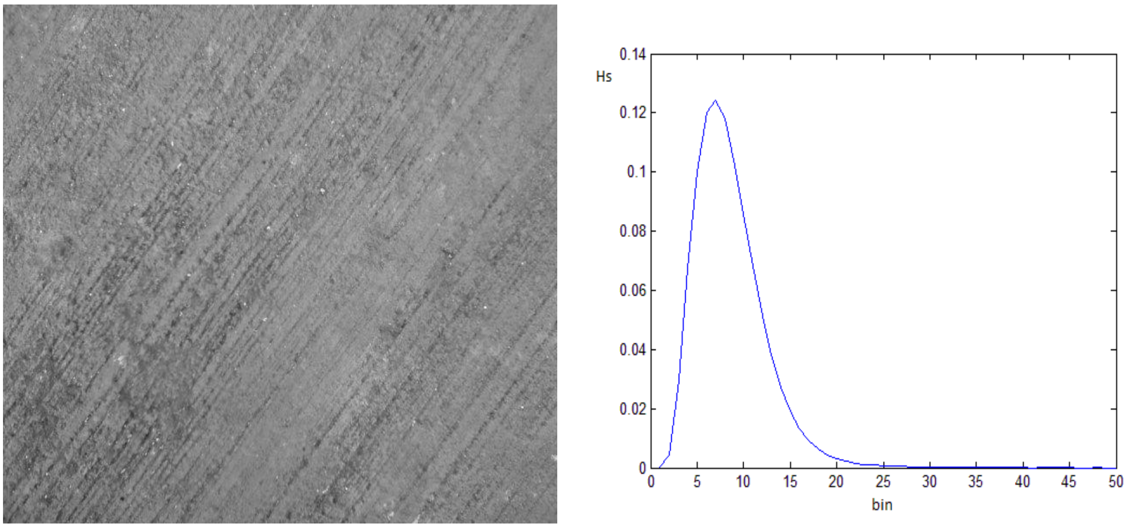
Figure 4 : Similar Regions in Different Textures

Similarity feature also identify the same texture at different angles as shown in figure 5. There are three textural images taken by the camera with different angles. Being variation of the angle, histogram does not effect and showing the same behavior of the texture. Figure 5(a) is the original texture and histogram is displayed. A new image (figure 5(b)) is taken at 45^o angle of the original texture having same variation, similarly another image (figure 5(c)) is taken at 90^o angle. All these images have the same histogram, which results the same texture.

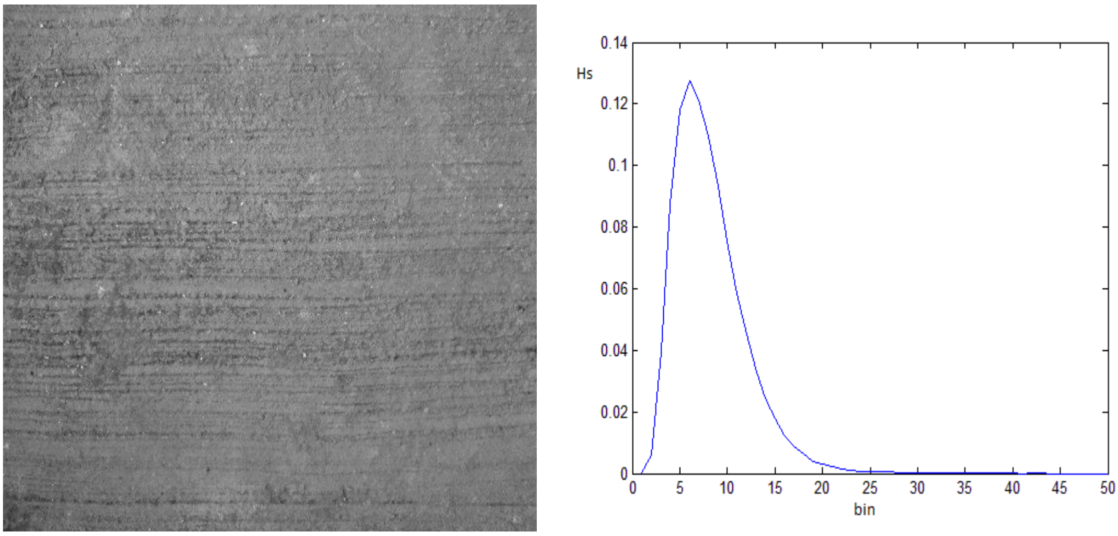
Figure 5 image's histograms contain only one peak point at 8^{th} bin, which shows that texture's grids are much small and there is not so much intensity distribution. This histogram shows there is only type of similarity region available rather than a large grid textural image.



(a) Original Textural image



(b) Texture with 45^{o} angle



(c) Texture with 90^{o} angle

Figure 5 : Textures at different angles

5. Conclusion

In this paper we have introduced a novel texture feature-similarity, discussed its concept and proved with the experimental results. According to this paper description, we can identify the texture with its histogram in term of angle variation, different small regions, texture's grid variation and many more things which are discussed. If images are taken of any texture in different light then this method also works and shows the similarity in images with the help of histogram.

This feature is successful for many tasks due to working on the pixels intensities but sometimes may be possible there will not be good result if pixels intensities variation is much-much large or texture grids become much large. However design of algorithm is considered to be more flexible with the results.

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