International Journal of Soft Computing 2 (3): 361-366, 2007

Comparative Analysis of Colour Models for Colour Textures Based on Feature Extraction

[1]G. Wiselin Jiji and [2]L. Ganesan
[1]Department of Information and Communication, Anna University, Chennai, India
[2]Department of Computer Science and Engineering,
A.C. College of Engineering and Technology, Karaikudi, India

Abstract: In this study we focus on the performance of colour models in colour textures. We investigate the effect of using different colour models and the contribution of colour and texture features collectively. This study presents a new set of colour texture features. The presence of colour texture is represented locally by fuzzy texture unit and globally by Colour Fuzzy Texture Spectrum. Based upon the feature extraction computing time, we can suggest best colour model that suite for colour Texture images. From the results, it is evident that the incorporation of RGB colour models that best suite for colour textures.

Key words: Colour models, colour textures, features, images, RGB

INTRODUCTION

Colour is the intrinsic attribute of an image and provides more information than a single intensity value. There have been a limited number of attempts to incorporate chrominance information into textural features. Texture and Colour are the two important key issues in image analysis. Most of the research in the area has been limited only to gray images. Researchers like Tucerian and Jain (1993), Haralick (1979), Sklansky (1978), Unser (1996), He and Wang (1990) have already represented texture features. The feature extraction techniques can be broadly classified into 4 categories namely statistical, model based, signal processing and structural. Among them, the co-occurrence matrix based, gray level run length based, Texture Spectrum based approaches were popular.

In texture Spectrum method, in a texture image, a small 3×3 image region (called texture Unit) is quantized as texture number and the frequency of occurrence of texture numbers for the entire image is represented as a spectrum called Texture Spectrum. In this method, the central pixels of 3×3 images are compared with its 8 neighbors and the result of comparison is coded as 0, 1 or 2. The equivalent 8-digit ternary number is texture number. The main problem in this representation was stated as:

- Unable to distinguish between less and far less or greater or far greater. It is proposed in this research to suggest a modified texture unit for representing texture accurately using fuzzy logic concept. Result of comparison is represented at more levels so as to represent the textures accurately, which in turn leads to more exact.

In Texture spectrum technique, the information is obtained in a single fuzzy texture spectrum for color images. This drawback is overcome by employing Colour Fuzzy Texture Spectrum

- Feature extraction for colour models consist of processing of each band separately.

Based on the time complexity to extract features, we can choose a colour model that best suite for colour textures a great extent during texture analysis.

COLOUR MODELS

RGB colour model: RGB is a colour space originated from Cathode Ray Tube (CRT) (or similar) display applications, when it is convenient to describe Colour as a combination of three colored rays (red, green and blue). It is one of the most widely used colour spaces for processing and storing of digital image data. However, high correlation between channels, significant perceptual non-uniformity, mixing of chrominance and luminance data make RGB not a very favorable choice for colour analysis and colour based recognition algorithms. The model is visualized as a unit cube (Fig. 1) with corners of black, white, the three primary colours (red, green, blue) and the three secondary Colours (cyan, magenta, yellow).

Corresponding Author: G. Wiselin Jiji, Department of Information and Communication, Anna University, Chennai, India

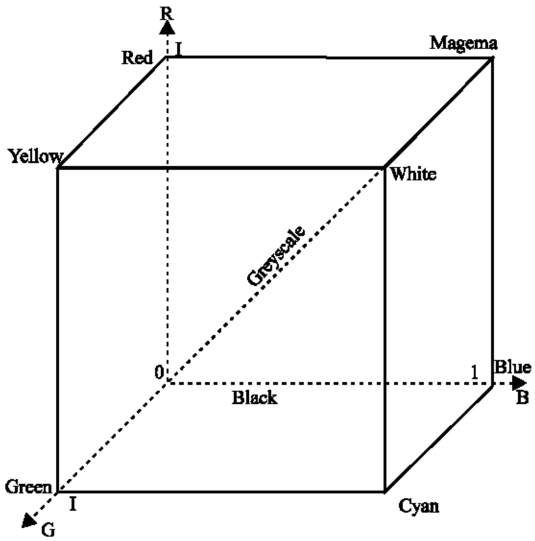


Fig. 1: Colour cube for normalized RGB coordinates

HSV colour model: The HSV-color space is a non-linear transform of the RGB-cube. It is widely used in the field of color vision. The chromatic components hue, saturation and value correspond closely with the categories of human color perception. One disadvantage is labile values near zero saturation and a singularity at S = 0. Therefore, the HSV-space should only be used on images with saturated colors. Hue is an angular coordinate, which is stored as a scalar value. This implies high frequencies only for soft color changes between red and magenta. In HSV, with V at maximum, it goes from saturated color to white. Travis gives the RGB-HSV conversion. To convert from RGB to HSV (assuming normalized RGB values), first find the maximum and minimum values from the RGB triplet. Saturation, S, is given by

S = (max-min) / max

and the value, V, is
V = max

The Hue is calculated as follows. First Calculate R', G', B'

R' = (max-R) / (max-min)
G' = (max-G) / (max-min)
B' = (max-B) / (Max-min)

If saturation, S, is zero, then hue is undefined (i.e., Color has no hue means, the image is monochrome) otherwise:

If R = max and G ≠ min then H = 5+B'
Else if R=max and G ≠ min then H = 1-G'
Else if G = max and B = min then H = R'+1
Else if G = max and B min≠ min then H = 3-B'
Else if R = max then H = 3+G'
Otherwise H = 5-R'

Hue, H is then converted to degrees by multiplying by 60 giving HSV with S and V between 0 to 1 and H is in between 0 to 360. The HSV (Hue, Saturation and Value) Colour model (also referred to as HSB model, with B for brightness) is suitably equipped to meet human perception of Colour.

HSI colour model: The HSI-color space is also a non-linear transform of the RGB-cube. It is also used in the field of color vision. The conversion from RGB to HSI is given by

$$H = \cos^{-1}\frac{(0.5*(R-G)+(R-B)}{(((R-G)^2+(R-B)(G-B))^{0.5})}$$

$$S = 1-(\frac{3}{(R+G+B)})*a$$

$$I = \frac{R+G+B}{3}$$

Where a is the minimum of R, G and B.

PROPOSED SCHEME OF COLOUR FUZZY TEXTURE SPECTRUM FOR VARIOUS COLOUR MODELS

Fuzzy texture unit (base 5): Greater or lesser quantities are further quantized using fuzzy logic based approach as follows. Here, two more levels of comparison are introduced. The texture number representation is shown in Fig. 2.

$$Ei = \begin{cases} 0 \text{ if } v_i < v_0 \text{ and } v_i < x \\ 1 \text{ if } v_i < v_0 \text{ and } v_i > x \\ 2 \text{ if } v_i == v_0 \text{ For } i=1,2,3,..8 \\ 3 \text{ if } v_i > v_0 \text{ and } v_i > y \\ 4 \text{if } v_i > v_0 \text{ and } v_i < y \end{cases}$$

Where x,y are user-specified values.

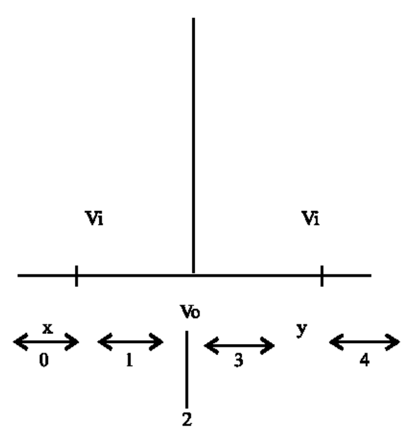


Fig. 2: Texture number (Base5) representation

Fuzzy texture number (base5): The fuzzy Texture number is computed in Base5 as

$$FT_{nu}S=\sum_{i=1}^{8} Ei * S^{(i-1)/2} \quad (1)$$

The total texture numbers range from 0 to 2030 by the formula (1) e.g.,

$$\begin{bmatrix} 90 & 130 & 145 \\ 160 & 140 & 200 \\ 100 & 140 & 250 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 & 1 & 3 \\ 4 & & 4 \\ 0 & 2 & 4 \end{bmatrix}$$

3×3 Neighborhood Fuzzy texture unit

TU= {0, 1, 3,4, 4, 2, 0, 4}

FT_{nu5} = 1392.

Fuzzy texture unit (base7): The texture number is represented as shown in Fig. 3.

In Base 7 method, it is defined as

$$EI=\begin{cases} 0 & \text{if } v_i < v_o \text{ and } v_i < x \\ 1 & \text{if } v_i < v_o \text{ and } v_i > x \text{ and if } v_i < y \\ 2 & \text{if } v_i < v_o \text{ and } v_i > y \\ 3 & \text{if } v_i == v_o \text{ For } i=1,2,3,..8 \\ 4 & \text{if } v_i > v_o \text{ and } v_i < p \\ 5 & \text{if } v_i > v_o \text{ and } v_i > p \text{ and } v_i < q \\ 6 & \text{if } v_i > v_o \text{ and } v_i > q \end{cases}$$

Where x, y,p,q are user-specified values.

Fuzzy texture number(base7): The fuzzy Texture number is computed in Base7 as

$$FTnu7=\sum_{i=1}^{8} Ei * 7^{(i-1)/3} \quad (2)$$

The total texture numbers range from 0 to 1128 by the formula (2) e.g.

$$\begin{bmatrix} 90 & 130 & 145 \\ 160 & 140 & 200 \\ 100 & 140 & 250 \end{bmatrix} \Rightarrow \begin{bmatrix} 1 & 2 & 5 \\ 5 & & 6 \\ 1 & 0 & 6 \end{bmatrix}$$

3×3 Neighborhood Fuzzytexture unit

TU={ 1,2,5,6,6,0,1,5 }

N_{TU} = 626.

Colour fuzzy texture spectrum: In the proposed scheme, we applied the concept for three Colour models namely RGB, HSV and HIS. In all three Colour models, Colour fuzzy texture spectrum approach gives three planes separately in a single spectrum. Colour Fuzzy Texture Spectrum for base7 (base5) is termed as the frequency of distribution of all fuzzy texture units, with the abscissa indicating the texture unit number FT_{nu7} (Ft_{nu5}) and the ordinate representing its occurrence frequency.

A RGB color image could be described as three-layered image, with each layer as red, green and blue. The representation of RGB Colour space Colour Fuzzy texture spectrum is shown in Fig. 4.

For HSV colour Model, the representation for Colour Fuzzy texture spectrum is shown below. Here, the first segment denotes the spectrum for H Plane and II for S Plane and III for V Plane, respectively. It is shown in Fig. 5.

Similarly, for HSI Colour model, the representation for Colour Fuzzy texture spectrum is shown below. Here, the

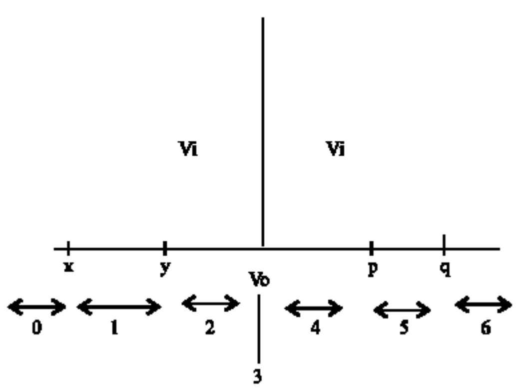


Fig. 3: Texture number (Base7) representation

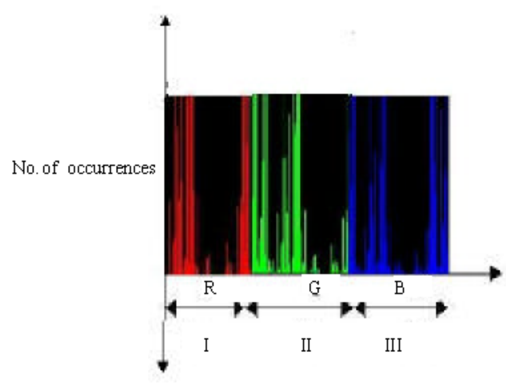


Fig. 4: Representation of colour texture spectrum for a image in RGB colour model

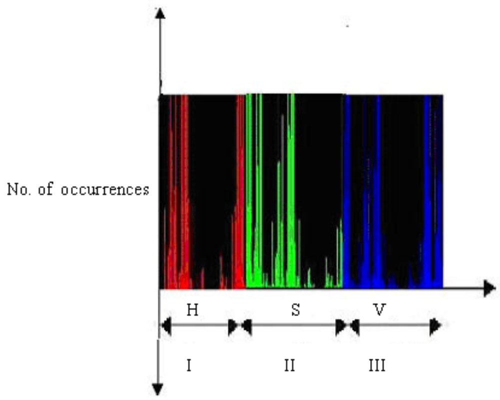


Fig. 5: Representation of colour texture spectrum for a image in HSV colour model

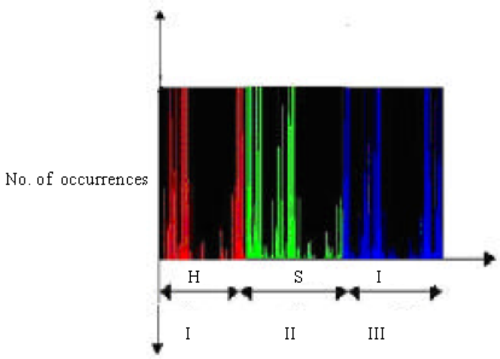


Fig. 6: Representation of colour texture spectrum for a image in HSI colour model

first segment denotes the spectrum for H Plane and II for S Plane and III for I Plane, respectively. It is shown in Fig. 6.

PROCEDURE

The steps involved for feature extraction using proposed approach is shown in Fig. 7. Using this procedure, for any Colour texture image, the features are computed for RGB, HSI and HSV colour Models.

Algorithm:

- For a Given Color Texture image

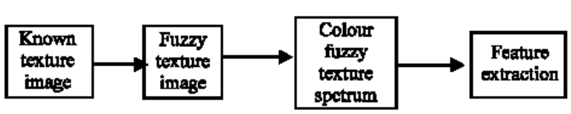


Fig. 7: Texture feature extraction steps

Step I: Consider a 3×3 image from top left corner (of R or G or B)

Step II: Compute Fuzzy Texture Spectrum as per Eq. 1 for Base5 and as per Eq. 2 for Base7 scheme and store it in separate arrays.

Step III: Scan through the row, leaving one column and consider new (3×3) as a texture primitive and repeat step (II) till the bottom right corner of the image is reached.

Step IV: Compute the frequency of occurrence of the texture numbers. Repeat step (I) to (IV) for the other planes and arrange them in order forming the Global Descriptor as Color Fuzzy Texture Spectrum.

The above algorithm is repeated for HSV and HSI colour models.

EXPERIMENTS AND EVALUATION

Using the above-described method, colour texture image features are extracted for RGB, HSI and HSV Colour Models. The corresponding Colour Fuzzy Texture Spectrums in RGB, HIS and HSV Colour model for Base3, Base5 and Base7 are shown in Fig. 8-14.

To select a particular Colour model, Experiments conducted for 1000-colour texture images collected at VisTex (Web address) texture database for Base3, Base5 and Base7 levels. Here, for a sample Colour texture, calculated computing time of feature extraction is shown in Table 1. From that, RGB Colour model takes less computing time required for extracting Colour texture features, when compared to other Colour models. In addition, Several researchers have evaluated different colour models for the purpose of image retrieval under varying sets of imaging condition (Geuers and Smeulders, 1996). It has been argued that the RGB colour model closely corresponds with the physical sensors of the human eye, although the human perception is more accurately reflected using the HSV colour space. The RGB colour

Table 1: Comparison of colour models based on computing time of feature extraction

Image	Colour plane	3Level (ms)	5Level (ms)	7Level(ms)
Fabrc 00069	RGB	390	410	401
Fabrc 00069	HIS	400	421	411
Fabrc 00069	HSV	671	681	441

Fig. 8: Colour texture image fabric 00069 of size (128×128)

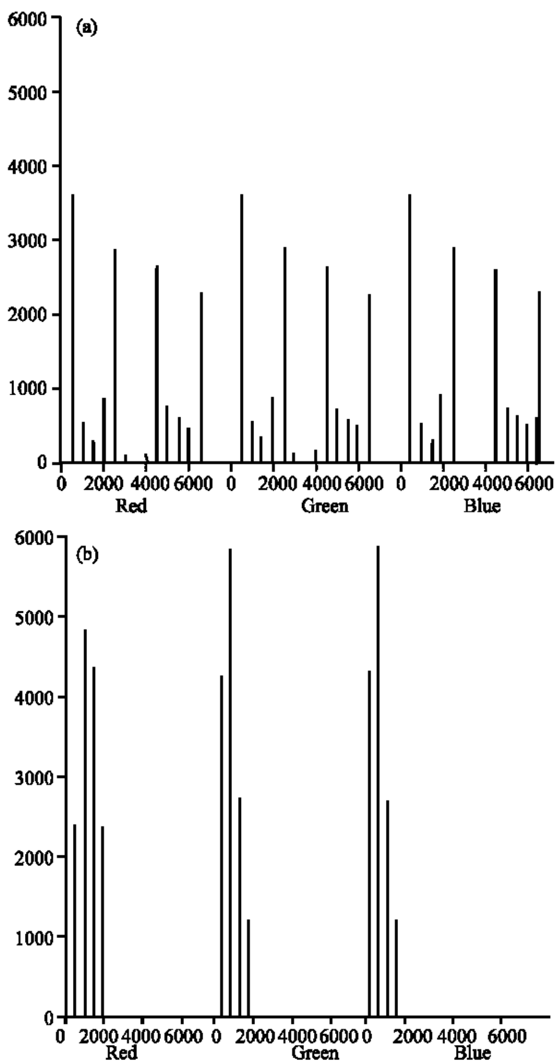


Fig. 9: Colour Fuzzy Texture Spectrum in RGB for the image in Fig. 8

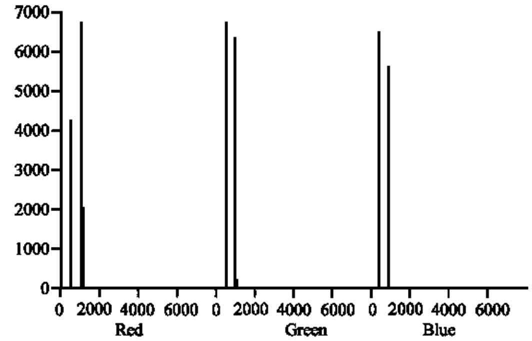
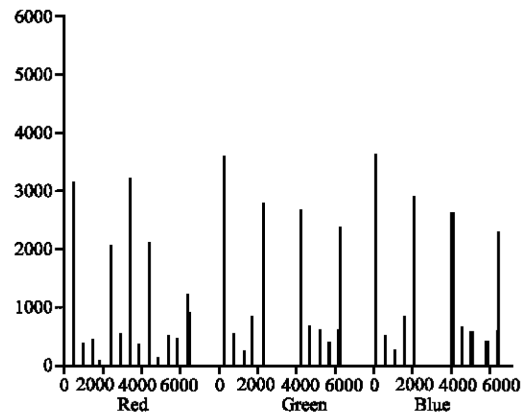


Fig. 10: Colour fuzzy texture spectrum in RGB (Base7) for the image in Fig. 8



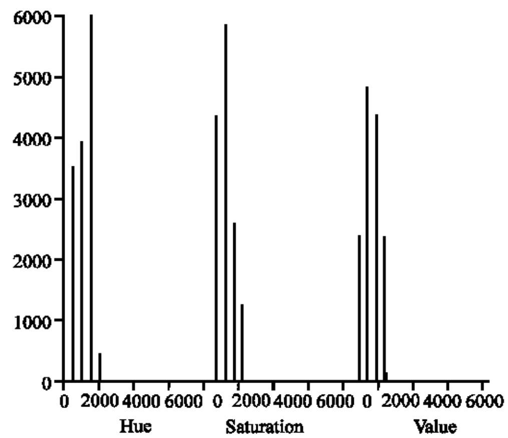


Fig. 11: Colour Fuzzy Texture Spectrum in HSV for the image in Fig. 8

space is an additive colour space in which red, green and blue lights are combined in various ways to create other colours. Therefore, RGB Colour model is chosen as the best choice to extract discriminant features to perform operations.

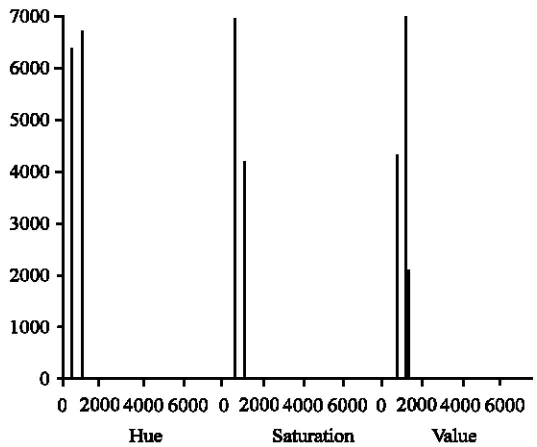


Fig. 12: Colour Fuzzy Texture Spectrum in HSV (Base7) for the image in Fig. 8

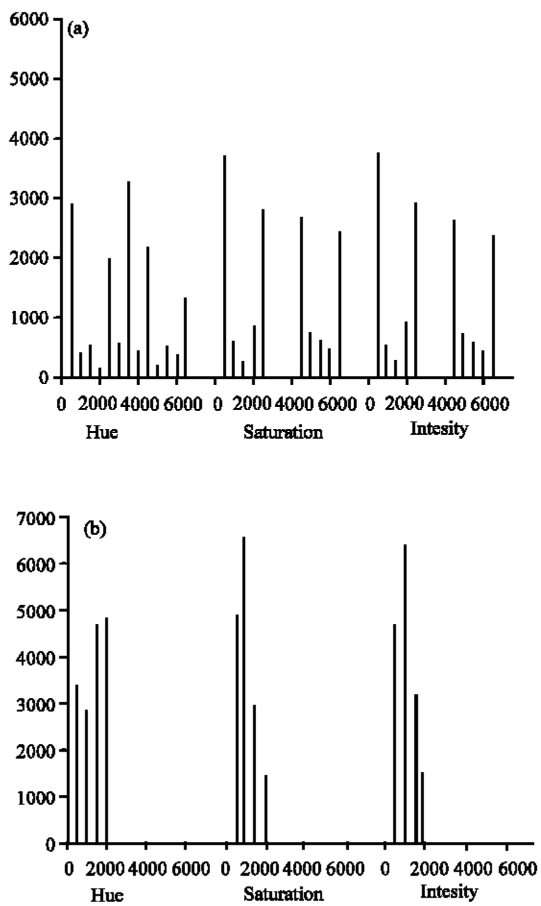


Fig. 13: Colour Fuzzy Texture Spectrum in HSI for the image in Fig. 8

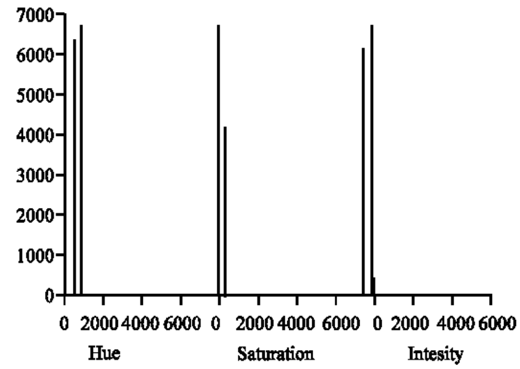


Fig. 14: Colour Fuzzy Texture Spectrum in HSI (Base7) for the image in Fig. 8

CONCLUSION

This research clearly explained in detail about Colour models and texture characterization system using Colour Fuzzy Texture Spectrum. The proposed feature for texture characterization has been computed and is used for rigorous experiments with many Colour texture Collected from Brodatz and Vistex Album. The aim of this preliminary research is to examine the contribution of colour to texture features for RGB, HIS and HSV colour Models. By examining the colour models, it shows that RGB colour model is best suited for colour texture analysis.

REFERENCES

Dong-Chen He and L. Wang, 1990. Texture Unit, Texture Spectrum and Texture Analysis. IEEE Trans. Geo Science Remote Sensing, 28: 509-512.

Gevers, T. and A.W.M. Smeulders, 1996. A comparative study of several Colour Models for Colour image invariant retreival. In Proceedings of the First International Workshop on Image Database and Multimedia Search. Amsterdam, Holland, pp: 17-23.

Haralick, R., 1979. Statistical and structural approaches to texture. Proc. IEEE., 67: 786-804.

Sklansky, J., 1978. Image segmentation and feature extraction. IEEE. Trans. Sys. Man Cybernetics, 4: 237-247.

Tucerian, M. and A. Jain, 1993. Texture analysis in Chen, C., L. Pau and P. Wang Editors, Handbook Pattern Recognition and Computer Vision, Chapter 2. Word Scientific, pp: 235-276.

Unser, M., 1996. Local linear transforms for texture measurements. Signal Processing, 11: 61-79.

Vis Tex. Colour Image Database http:// www.white-media.mit.edu/vismod/imagery/VisionTexture.