Texture Classification of 3D Mr Color Images using 3D Orthogonal Rank Filters

run Kumar A[1]

[1] Mysore UNiversity

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Abstract

The term ?texture? refers to patterns arranged in an order in a line or a curve. Textures allow one to make a meaningful interpretation of certain geometric regularity of spatially repeated patterns. In addition, texture also exhibits useful information about spatial distribution of color or gray intensities in an image. Correct interpretation of latent textures of various tissues in a body is an important requirement for a surgeon as a preoperative measure. In this context, extraction of textures in an MR scanned 3D image would assist a medical professional in the preoperative decision making process. This paper proposes a novel technique for extracting directional textures of a 3D MR image in all three axes separately.

Index terms— 3D color images, superficial and volumetric features, texture classification.

1 I. INTRODUCTION

his paper describes a computationally efficient technique to detect various texture characteristics as directional features in a given 3D digital image. The computational tool used for this purpose is '3D Rank Filters', which are essentially directional filters. These filters cause radical changes in the original content of a given image but precisely extract various textures.

Any given 3D MR image consists of texture features of tissues corresponding to muscle fibers in almost all directions. One can visualize major muscle fibers of a body component with naked eye. But most of the finer textures cannot be visualized even by an expert, in which case machine vision support system becomes quite handy. The algorithms presented in this paper could be used to detect texture patterns in al the three orthogonal axes of a 3D rectangular discrete coordinate system in which 3D digital image is displayed.

2 II. LITEERATURE SURVEY

Apart from detecting latent textures in a given image, one can also artificially create texture images. Fig. 1 shows a 3D texture image, which is artificially generated using a cellular automaton rule. Two texture features are usually considered for image segmentation. They are (i) spatial frequency features and (ii) average gray level features. Either 'structural approach' or 'statistical approach' could be used for developing texture detection algorithms. Mostly statistical approach is considered for texture classification because of ease in parametrization and quantification of texture features.

Edge detection is a method by which one would be able to detect edge pixels details which help determine characteristics of texture complexities. For instance, directions of edges could be treated as characteristics of textures in determining patterns in the textures.

Consider a region with N pixels in a given image. Any gradient-based edge detector algorithm could be applied to this region, which would yield two outputs for every pixel p, viz, 'gradient magnitude Another technique to quantify texture is 'cooccurrence matrix', which defines features of a texture using certain spatial relations of similar gray values. Such numerical features could be used for texture classification. Some of the standard features from a normalized co-occurrence matrix are given below. where p[i, j] is the [i, j] th entry in a gray-level spatial dependence matrix, and Ng is the number of grayvalues in the quantized image. It is to be noted that the co-occurrence matrix based feature extraction will not yield comfortable visual perception.

3 III. PROPOSED METHOD

As outlined earlier, the term 'textures' refers to 'repeated patterns' in a given image. Consider the 27neighborhood window shown in Fig. 3. The cells 1, 2, 3, 4, 5, 6, 7, 8, 9 form the first plane, 10, 11, 12, 13, 14, 15, 16, 17, 18 the middle plane and cells 19, 20, 21, 22, 23, 24, 25, 26, 27 form the rear plane of the window. The given 3-D digital image is plane-wise raster-scanned by this window (See Fig. 3). In order to extract 3-D linear textures along an axis with a directional twist, one has to choose that particular axis and its associated rank of a particular directional twist. For example if one chooses the X axis and rank1 of zero directional twist, values in cells 2,11,20,23,26,17,8,5 would be read and stored in an array. The reading pattern is shown in Fig. 4. X-axis rank 2 consists of cells 11, 20, 23, 26, 17, 8, 5, 2 and the corresponding plane is perpendicular to X axis as given in Fig. 4 but with a directional twist of 45 degrees. One can construct four ranks in X-axis, four in Y-axis and another four in Z-axis as shown in Table 1. A total of 12 rank filters could be constructed in three axes which are called "3D Orthogonal Rank Filters".

4 IV. TEXTURE CLASSIFICATION OF 3D MEDICAL IMAGES

Textures of a medical image play an important role in support of a surgeon to decide the angle at which the surgical blade should be used to make incision so that the loss of blood due to surgery is kept minimum. A case study was carried out to verify the validity of the algorithm and the result of the study presented in Fig. 5, which is self-explanatory.

( ) All four texture versions of the image obtained using rank filters could be seen to provide a visual proof of the fact textures in an image are direction sensitive and so they could be used for image segmentation purposes.Year 2021 [1]

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Figure 1: Figure 1 :

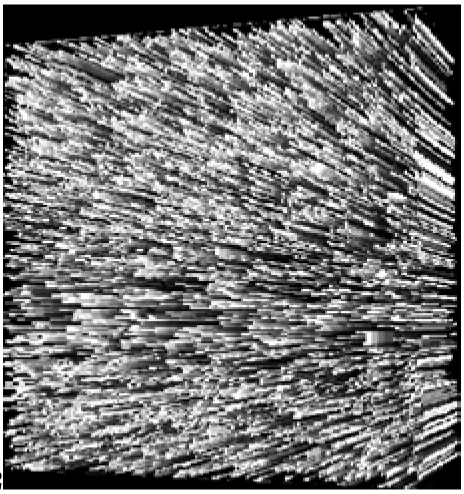
2 

Figure 2: Figure 2 :

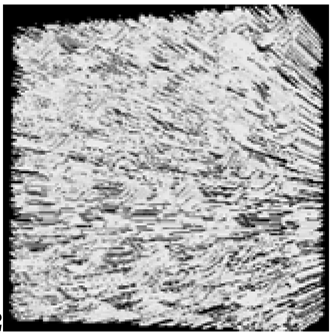
2 

Figure 3: Fig. 2

3 

Figure 4: Figure 3 :

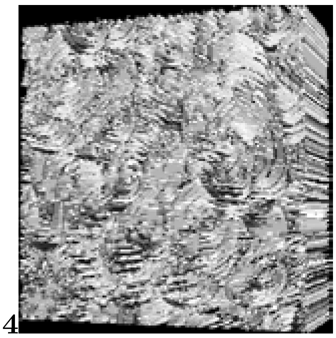
4 

Figure 5: Figure 4 :

5 $$\sum_{i}\sum_{j} p[i,j]^2$$

Figure 6: FFigure 5 :

67 $$\sum_{i=1}^{Ng}\sum_{j=1}^{Ng} n^2 p[i,j], \text{ where } |i-j| = n$$

Figure 7: Figure 6 :Figure 7 :

8910 $$\frac{\sum_{i=1}^{Ng}\sum_{j=1}^{Ng}(ij)p[i,j] - \mu_x\mu_y}{\sigma_x\sigma_y}$$

Figure 8: Figure 8 :Figure 9 :Figure 10 :

13 $$-\sum_{i}\sum_{j} p[i,j] ln(p[i,j])$$

Figure 9: Figure 13 :

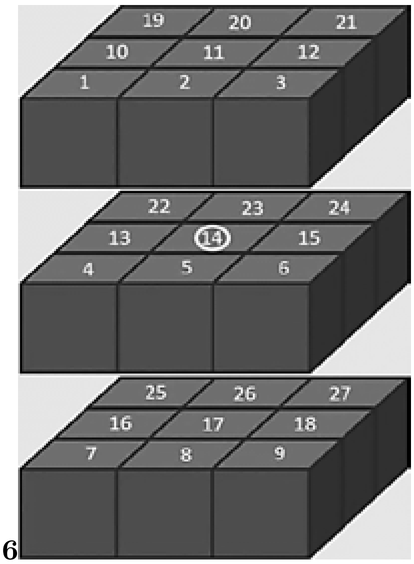
16 

Figure 10: Figure 16 :

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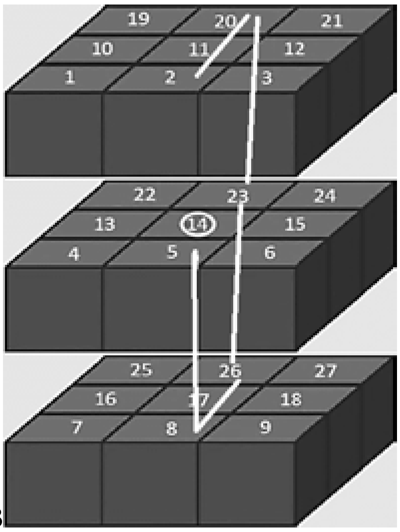

Figure 11: Figure 18 :

1

AxesRanks		Cell sequences
	X1	2,11,20,23,26,17,8,5
X	X2 X3	11,20,23,26,17,8,5,2 20,23,26,17,8,5, 2,11
	X4	23,26,17,8,5, 2,11,20
	Y1	4,13,22,23,24,15,6,5
Y	Y2 Y3	13,22,23,24,15,6,5,4 22,23,24,15,6,5,4,13
	Y4	23,24,15,6,5,4,13,22

[Note: Z Z1 10, 11,12,15,18,17,16,13 Z2 11,12,15,18,17,16,13,10 Z3 12,15,18,17,16,13,10, 11 Z4 15,18,17,16,13,10, 11,12 Texture Classification of 3d Mr Color Images using 3d Orthogonal Rank Filters]

Figure 12: Table 1 :

2

Original 3D image statistics	
Pixels Count	568089
Pixels without black	449360
Red Min	0
Red Max	252
Red Mean	90.0212677943069
Red Standard Deviation	65.4300367403954
Red Median	92
Red Total Count	568089
Green Min	0
Green Max	249
Green Mean	48.2296154299766
Green Standard Deviation 56.6653938791041	
Green Median	33
Green Total Count	568089
Blue Min	0
Blue Max	249
Blue Mean	48.2296154299766
Blue Standard Deviation 56.6653938791041	
Blue Median	33
Blue Total Count	568089
Saturation Min	0
Saturation Max	1
Saturation Mean	0.347210377454758

Figure 13: Table 2 :

.1 ACKNOWLEDGMENT

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