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# Textile Image Segmentation Using a Multi-resolution Markov Random Field Model on Variable Weights in the Wavelet Domain

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**Abstract**

This paper proposes a new texture image segmentation algorithm using a Multi-resolution Markov Random Field (MRMRF) model with a variable weight in the wavelet domain. For segmentation on textile printing design, firstly it combines wavelet decomposition to multi-resolution analysis. Secondly the energy of the label field and the feature field are calculated on multi-scales based on variable weight MRMRF algorithm. Finally new segmentation results are obtained and saved. Compared with traditional algorithms, experimental results prove that the new method presents a better performance in achieving the edge sharpness and similarity of results.

*Keywords*: Texture; Image Segmentation; MRMRF Model; Wavelet Domain; Weight

## 1 Introduction

Segmentation of fabric printing design is a very important process in textile printing and the quality of segmentation will directly affect the subsequent drawing crispening, the precision and accuracy of fabric printing [1]. In the process of segmentation, the most important thing is to reduce the interference of noise. When there is no better method, there is no more apparent in the printing design, and even there will be wrong segmentation.

Textile image segmentation is the basis of image processing and image recognition. The purpose is to divide the textile fabrics into regions with their own characteristics and extract the interested target [2]. At present, a lot of methods are proposed for segmentation on textile fabrics, such as meanCshift [3], K-mean [4, 5] clustering, Sobel, Laplacian, Canny, single scale MRF, the traditional FCM algorithm [6] and so on. The characteristic of several algorithms mentioned considers only the color information but not space information. And in the case of texture more noticeable, segmentation effect is not satisfying. While there are some problems on single scale MRF model, such as the fixed domain size, difficulties of estimating parameters and large amount of calculations, etc. Single scale MRF which is based on MAP estimation [7] combines the

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anisotropy on the edge of the area with the consistency of regional internal to be as a condition for regular the graphics segmentation in the future, which may easily blurres the edges of the graph, and loses details [8]. And similarity of segmentation results of single scale MRF is not high. Although traditional FCM algorithm has won a wide range of applications in fabric segmentation, it can only consider gray information of pixel itself in the fabric segmentation process, without considering the space information of the pixels and the pixels around. That is the reason why the mentioned algorithms is more sensitive to noise, and the segmentation performance is reduced [9]. The similarity of segmentation results of traditional FCM algorithm is low and resolution of segmentation results is still low. To solve these problems, this paper proposes a new solution named Multi-resolution Markov Random Field (MRMRF) algorithm on variable weight in the wavelet domain and good segmentation effects could be achieved.

# 2 In the Wavelet Domain

With wavelet transform, signals can be decomposed into different resolution, different frequencies and subband signals of different directions, which has good local time domain and frequency domain features.

Pyramid decomposition [10] is the core step of the multi-scale transformations. Through the pyramidal decomposition, an image can be decomposed into high or low frequency coefficients matrix on different scales. Pyramidal decomposition can be divided into linear and nonlinear. Morphological wavelet which is nonlinear is a kind of pyramidal decomposition. It makes morphology operator introduce to the multi-scale transform, and morphology operator is adjunction on morphology, such as erodent and dilation, open and close form, and analysis of granules, skeleton decomposition, morphological filter and median filter and so on. So it describes feature of morphology image on multi-scales. After pyramidal decomposition, morphological wavelet can be reconstructed completely.

This paper uses two-dimension haar morphological wavelet. Haar wavelet is selected as the mother wavelet. After wavelet transform, the images can be decomposed into low frequency ($LL$), intermediate ($LH, HL$) and high-frequency ($HH$) of wavelet [11]. It is mainly considered that among the wavelets, haar wavelet has the best space positioning accuracy on different scales, computational complexity is low relatively, and it can better keep the signal details. It supposes that fabric printing design $I$ has $Np$ bands on the mesh $L$ whose size is $M \times M$. The image $I$ is decomposed into $D$ levels by wavelet transform. Wavelet decomposition image is defined as $K$. Each wavelet scale is shown with the corresponding level number $s (1 \leq s \leq D)$. After $D$ levels wavelet decomposition, $L$ can be decomposed into that:

$$L = LL(D), LH(D), HL(D), HH(D), ..., LL(1), LH(1), HL(1), HH(1) \tag{1}$$

Each element on the mesh $L$ defined the $Np$ subband images respectively corresponds to decomposition results with each band in the subband.

Lattice is $L_S = \{(a, b); 1 \leq a, b \leq \frac{M}{2^s}\}$ on the scale $s \in \{1, 2, ..., D\}$. It is defined that on the lattice $L_S$, the feature field can be represented with the vector field which is made up of wavelet decomposition coefficients on each band.